2023 CANNABIS RESEARCH CONFERENCE

In Photo:
Dr. Sang-Hyuck Park
Institute of Cannabis Research
Senior Scientist and Research Liaison

AUGUST 3-5, 2023
AURARIA CAMPUS
DENVER, COLORADO

HOSTED BY

Institute of Cannabis Research
COLORADO STATE UNIVERSITY PUEBLO

Oregon State University
Global Hemp Innovation Center

Exploring new cannabis research frontiers...

TABLE OF CONTENTS

THE CONFERENCE

The 7th annual 2023 Cannabis Research Conference (CRC) is held on August 3-5, 2023, on Auraria Campus in Denver, Colorado.

**Registration/Check-in will be located at the
Tivoli Tavern Atrium - in the Tivoli Student Union
Nearest to the PLAZA Building.**

This is a multi-disciplinary, three-day conference that explores the latest in cannabis science and innovation for applications in medicines, foods, materials, and textiles that can improve people's lives and better society.

The 2023 Cannabis Research Conference allows you to connect with the brightest innovators addressing unique and timely topics and will feature:

- More than 100 Live Presentations
- Exhibit Hall
- Poster Hall
- Student Poster Content and More!

There is no better time or place to connect with cannabis experts actively conducting new research and business ventures in:

- Biology, Chemistry, Physiology, and Agronomy of Cannabis
- Business and Economic Development
- Cannabis Education
- Hemp Cultivation, Processes, and Uses
- Medical and Clinical Research
- Public Policy and Regulation

Quality Assurance and Quality Control of Cannabis Products

Thank you for joining us in exploring
NEW cannabis research frontiers...

THE VENUE

TIVOLI STUDENT UNION > TAVERN ATRIUM

CONFERENCE CHECK-IN AREA IS NEAREST TO THE PLAZA BUILDING - OPPOSITE SIDE OF PARKING LOT

CONFERENCE REGISTRATION - ALL ATTENDEES | EXHIBIT HALL
GENERAL SESSIONS | BREAKS | REFRESHMENTS | LUNCH | RECEPTION

******

PLAZA

ALL CONCURRENT SESSIONS - FIRST FLOOR | ROOMS 112 - 132

THE HOSTS

This is the nation's most innovative collaboration in cannabis research...

The Institute of Cannabis Research (ICR) was established in 2016 at Colorado State University Pueblo, becoming the first multi-disciplinary cannabis research center at a regional, comprehensive institution of higher education.

The ICR supports and facilitates unbiased and innovative cannabis research in wide-ranging areas in the sciences, medical (including basic and clinical research), economic impacts, the social sciences, and other areas. In addition to its research efforts, the ICR also supports disseminating cannabis research results through various mechanisms, including this annual conference, the publication of the Journal of Cannabis Research, and a monthly webinar series..

For more information about ICR, visit
csupueblo.edu/institute-of-cannabis-research

OSU's Global Hemp Innovation Center is home to the world's leading experts in hemp research. The largest of its kind in the nation, it promises to advance the research of hemp and its market potential across multiple diverse industries and research fields to serve the growing international demand for innovative approaches to food, health, and fiber.

For more information about the OSU Global Hemp Innovation Center, visit agsci.oregonstate.edu/hemp

THE PARTNERS

2023 **CANNABIS** **RESEARCH** **CONFERENCE**

Institute of **Cannabis Research**
COLORADO STATE UNIVERSITY PUEBLO

Oregon State University
Global Hemp
Innovation Center
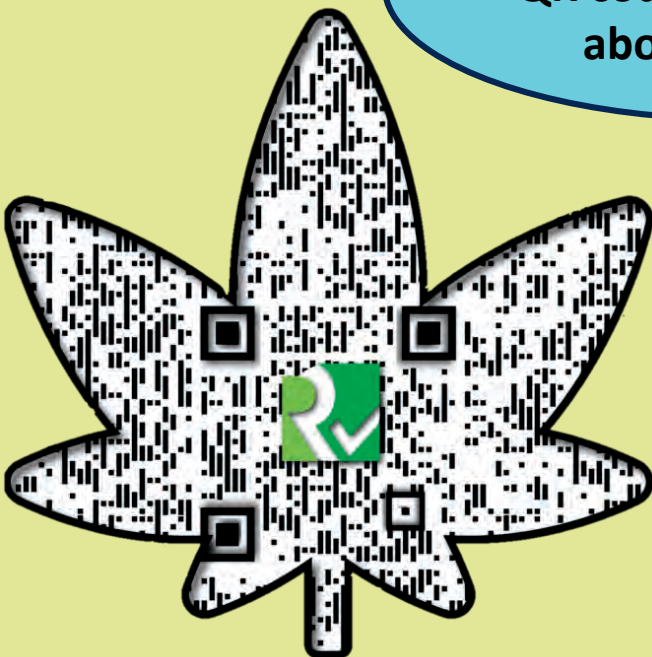
IN HONOR

RAPHAEL MECHOULAM, THE "FATHER" OF CANNABIS

Raphael Mechoulam, a pioneering Israeli chemist credited with opening the field of cannabis science after identifying the structure and function of the critical compounds of cannabis, died on March 9, 2023, at his home in Jerusalem. He was 92.

Professor Mechoulam's groundbreaking work with cannabis began in the early 1960s, just before the use of marijuana and other drugs exploded in countries around the world, bringing seismic changes to popular culture while also kicking off decades-long battles about health effects and enforcement. His research earned him the unofficial title of "the father of cannabis research."

JEFF SMITH, PH.D.
INTERIM DIRECTOR
OF THE ICR AND
PROFESSOR OF BIOLOGY

INSTITUTE OF CANNABIS RESEARCH (ICR) GOVERNING BOARD

The Board was created through HB19-1311. The role and mission of the institute are to conduct or fund research related to cannabis and publicly disseminate the research results. The Governing Board oversees the institute and approves its annual budget. The Governing Board shall advise any Colorado institution of higher education to develop a cannabis-related curriculum and provide input to the Colorado Commission on Higher Education before it approves any cannabis-related degrees or certifications.

GOVERNING BOARD MEMBERS

JOANNA ZEIGER
SERVE AS A SCIENTIST FROM A RELEVANT FIELD
BOULDER, COLORADO

MALIK MUHAMMAD HASAN
SERVE AS A MEMBER ASSOCIATED WITH
CANNABIS-RELATED INDUSTRIES
PUEBLO, COLORADO

SHERARD MARSHON ROGERS
SERVE AS A MEMBER ASSOCIATED WITH
CANNABIS-RELATED INDUSTRIES
DENVER, COLORADO

SALVATORE PACE
SERVE AS A MEMBER ASSOCIATED WITH
CANNABIS-RELATED INDUSTRIES
PUEBLO, COLORADO

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L. CINNAMON BIDWELL
SERVE AS A SCIENTIST FROM A RELEVANT FIELD
AND AS CHAIR
BOULDER, COLORADO

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DESIGNEE OF THE CHANCELLOR OF THE CSU SYSTEM
PRESIDENT OF COLORADO STATE UNIVERSITY PUEBLO

SCOTT MCWHORTER
DESIGNEE OF THE EXECUTIVE DIRECTOR OF THE COLORADO COMMISSION
ON HIGHER EDUCATION
CEO ROCKY MOUNTAIN EXTRACTION SERVICES

JON REUTER
DESIGNEE OF THE PRESIDENT OF THE UNIVERSITY OF COLORADO, ASSISTANT
VICE-CHANCELLOR OF RESEARCH INTEGRITY & COMPLIANCE
UNIVERSITY OF COLORADO BOULDER

ELYSE CONTRERAS
DESIGNEE OF THE EXECUTIVE DIRECTOR OF THE COLORADO
DEPARTMENT OF PUBLIC HEALTH & ENVIRONMENT
MANAGER AND SENIOR EPIDEMIOLOGIST, MARIJUANA HEALTH
MONITORING & RESEARCH GRANTS SECTION

MEET & GREET

COLORADO STATE UNIVERSITY PUEBLO'S

INSTITUTE OF CANNABIS RESEARCH

GOVERNING BOARD

THURSDAY

AUGUST 3

5:30 PM - 6:00 PM

COCKTAIL RECEPTION

TIVOLI STUDENT UNION /TURNHALLE - BALCONY

FOLLOWED BY THE
CONFERENCE OPENING RECEPTION

THE CONFERENCE COMMITTEE

THE EXECUTIVE PROGRAM COMMITTEE

Karli Swenson
Ph.D. & MPH Candidate
University of Colorado Anschutz
2023 CRC Program Chair

Jeff Smith, PhD
Professor
Interim Director
Colorado State University Pueblo
Institute of Cannabis Research

Joanna Zeiger, MS, PhD
Founder
Canna Research Foundation
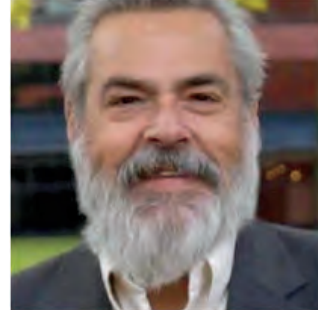
John Williamson, PhD
Sr Director of Research
Colorado State University Pueblo
Institute of Cannabis Research

AUGUST 3, 2023
6:00 PM - 7:00 PM
CONFERENCE RECEPTION
TIVOLI STUDENT UNION
TURNHALLE

2023 CANNABIS RESEARCH CONFERENCE

THE PROGRAM COMMITTEE

Leaders from some of the top cannabis research institutions have joined forces to form a Program Committee for the 2023 Cannabis Research Conference.

Nirit Bernstein, PhD
Sr Research Scientist
Volcani Institute

Massimo Bionaz, PhD
Associate Professor
Oregon State University

Benjamin Blount
Chief, Tobacco & Volatiles Branch
Centers for Disease Control
and Prevention

David Bush
Attorney at Law
Lakeside Partners, LLC

Ruth Charbonneau, JD, RN
Associate Director
Lambert Center for the Study
of Medicinal Cannabis & Hemp
Thomas Jefferson University

Tessa Crume, PhD
Associate Professor
Colorado University Anschutz

Jennifer Duringer, PhD
Associate Professor
Oregon State University

Dr. David Gang
Professor
Washington State University

Justin Goss, PhD
Professor
Colorado State University Pueblo

Kimberly Guay, PhD
Professor
Tarleton State University

Elias Jackson, PhD
Sr. VP of Government &
Scientific Affairs
Vyripharm
Biopharmaceuticals

David Kroll, PhD
Professor
University of Colorado

THE PROGRAM COMMITTEE

This dynamic group comprises educators, scientists, chemists, and researchers are passionate and dedicated to advancing cannabis research.

Emily Lindley, PhD
Associate Professor
University of Colorado

Jonathan Lisano, PhD
Research Scientist
University of Colorado Boulder

Jacob MacWilliams
Research Associate III

Amy Marasco
Certified Health & Wellness Coach
Cannabis Coaching and Consulting

Desmond Mortley, PhD
Research Professor
Tuskegee University

Sang-Hyuck Park, PhD
Senior Scientist
Colorado State University Pueblo

Melissa Reynolds
Boettcher Investigator, Professor
Director, Panacea Life Sciences
Cannabinoid Research Center
Colorado State University

Kristin Rifai
Oregon State University

John Simonsen, PhD
Professor
Oregon State University

Jeffrey Steiner, PhD
Director
Global Hemp Innovation Center
Oregon State University

Beau Whitney
Founder, Whitney Economics

The future of hemp and cannabis growth is here!

JuanaGrow has been designed specifically to enhance cannabis and hemp growth for hydroponic and all other soil-less growers! You can anticipate an increase in productivity, a decrease in the costs associated with the application of nutrients and more frequent harvests of your exceptional crops!

Whether you are growing in a greenhouse or field, JuanaGrow can get you to harvest quicker and decrease your cost. JuanaGrow has a large water retention capacity, can easily be rewet from dry and a offers a great aeration rate. The absorbed water and the nutrient elements are released gradually.

Stop by Booth #3 to learn more!

BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
NIRIT BERNSTEIN

BUSINESS AND ECONOMIC DEVELOPMENT
KARLI SWENSON

CANNABIS EDUCATION
RUTH CHARBONNEAU

HEMP CULTIVATION, PROCESSES, AND USES
MASSIMO BIONAZ, KIMBERLY GUAY, ERNST CEBERT, JACOB MACWILLIAMS

MEDICAL AND CLINICAL RESEARCH
JOANNA ZEIGER, JONNY LISANO, BENJAMIN BLOUNT

PUBLIC POLICY AND REGULATION
ELIAS JACKSON

QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
AMY MARASCO & EILAS JACKSON

7:30 AM - 4:00 PM | TIVOLI STUDENT UNION/ATRIUM
Registration | Information Desk | Exhibit Hall Open

8:15 AM - 8:45 AM | TURNHALLE
Featured Speaker
Investigating the Difference in Microbial Test Results Between
QPCR and MICROARRAY Technologies
Presented by Tyler Secor, MS

9:00 AM -10:25 AM | PLAZA
CONCURRENT SESSIONS

10:30 AM - 10:45 AM | TIVOLI STUDENT UNION/ATRIUM
Break

12:15 PM - 1:45 PM | TIVOLI STUDENT UNION/TURNHALLE
Lunch
Mechoulam Lecture
"The Protective Role of Endocannabinoids in Traumatic Brain Injury"
Presented by Dr. Esther Shohami

2:00 PM - 3:30 PM | PLAZA
CONCURRENT SESSIONS

3:30 PM - 3:45 PM | TIVOLI STUDENT UNION/ATRIUM
Break

3:45 PM - 5:15 PM | PLAZA
CONCURRENT SESSIONS

5:30 PM - 6:00 PM | TIVOLI STUDENT UNION/ATRIUM
Meet & Greet with ICR Board of Directors
Cocktails will be served

6:00 PM - 7:00 PM | TIVOLI STUDENT UNION/ATRIUM
Conference Opening Reception

7:00 PM
ICR Board Dinner

Center for Cannabis Policy, Research, and Outreach

WASHINGTON STATE
UNIVERSITY

Our four-fold mission

Improving Health and Wellbeing

WSU conducts translational science related to the impact of cannabis on health, ranging from animal studies of the impact of cannabis on brain development, the impact of THC and CBD on pain, the impact of cannabis on mental health and stress, and the prevention of problematic cannabis use.

Agricultural Research

WSU conducts agricultural research on industrial hemp grown for CBD extract, textiles, food, and fiber. Key to product development and sales is a strong crop production and pest management practices optimized for industrial hemp grown in Washington state.

Economic Improvement

WSU conducts research on issues relevant to the cannabis industry, such as industry taxation and banking, economic impact, and cannabis workplace issues.

Public Policy and Safety

WSU conducts research on roadside detection and workplace safety and cannabis use, the impacts of de-criminalization on crime and the justice system, and federal and state cannabis policy.

Contact us at wsu.ccpro@wsu.edu

MECHOULAM LECTURE

ESTHER SHOHAMI, PHD

THE PROTECTIVE ROLE OF ENDOCANNABINOIDS IN TRAUMATIC BRAIN INJURY

THURSDAY, AUGUST 3
12:45 PM – 1:45 PM

📍 **TURNHALLE**

LUNCH WILL BE SERVED @ 12:15 PM

Esther Shohami, PhD received her doctorate in Physiology from the Hebrew University (HU), Jerusalem, Israel, and did her post-doc at MC-Gill University in Montreal, Canada. She later joined the HU School of Pharmacy at the faculty of medicine and is currently a Professor Emerita in Pharmacology at the HU Institute for Drug Research. Between 2006 - 2011 she served as the Dean of students at her University, and between 2012-2014 as the president of the Israel Society for Neuroscience. She is a member of the executive board of the International Neurotrauma Society (INTS) and serves on the editorial boards of J. Neurotrauma. She also served as a council member of the US National Neurotrauma Society and on the editorial board of J. CBF & M.

Prof. Shohami has published over 220 articles, reviews, and book chapters. Her research is focused on experimental traumatic brain injury (TBI) in rodents. It addresses mechanisms of injury (e.g, inflammation, oxidative stress, the glutamate NMDAR) and endogenous neuroprotection (e.g. endocannabinoids and heat-acclimation-induced preconditioning). Currently, her work focuses on the effects of TBI on cognitive functions and mechanisms involved in ameliorating these TBI-induced deficits. She also studies the involvement of the endocannabinoid system in the pathophysiology and rehabilitation after TBI and is involved in developing cannabinoid-like novel drugs for TBI—the protective Role of Endocannabinoids in Traumatic Brain Injury.

This presentation is dedicated to the memory of Prof. Rafi Mechoulam, the pioneer and founding father of cannabis as a novel research field in basic and clinical science.

7:30 AM - 4:00 PM | TIVOLI STUDENT UNION/ATRIUM
Registration | Information Desk | Exhibit Hall Open

8:15 AM - 8:45 AM | TIVOLI STUDENT UNION/TURNHALLE
Keynote Speaker
"Hemp and the Future of Clothing"
Presented by Sofia Thankhauser

9:00 AM -10:25 AM | PLAZA
CONCURRENT SESSIONS

10:30 AM - 10:45 AM | TIVOLI STUDENT UNION/ATRIUM
Break

12:15 PM - 1:45 PM | TIVOLI STUDENT UNION/TURNHALLE
Lunch
Poster Viewing

2:00 PM - 3:30 PM | PLAZA
CONCURRENT SESSIONS

3:30 PM - 3:45 PM | TIVOLI STUDENT UNION/ATRIUM
Break

3:45 PM - 5:15 PM | PLAZA
CONCURRENT SESSIONS

5:30 PM - 6:00 PM | TIVOLI STUDENT UNION/TURNHALLE
Academic Career "Cannabis Research" Panel Discussion and Networking Session

A Better Life

GO COUGS MEANS

Cannabis and hemp research at Washington State University makes lives better
Our research impacts your sleep, your health and your home

Go Cougs means a better life.

Learn more at
www.wsu.edu/cannabis

WASHINGTON STATE UNIVERSITY

PULLMAN   VANCOUVER   TRI-CITIES   SPOKANE   EVERETT   GLOBAL

KEYNOTE SPEAKER
SOFIA THANHAUSER

HEMP AND THE FUTURE OF CLOTHING

🕐 **8:15 AM – 8:45 AM**
BREAKFAST WILL BE SERVED @ 7:15 AM – 8:15 AM

📅 **FRIDAY, AUGUST 4 | TURNHALLE**

Sofia Thanhauser is the author of Worn: A People's History of Clothing (Pantheon, 2022). She teaches in the writing department at Pratt Institute. She has received fellowships from the Fulbright Program, MacDowell, and Ucross Foundation. Her writing has appeared in The Guardian, Vox, Essay Daily, and The Establishment, among other publications.

AT-A-GLANCE | SATURDAY, AUGUST 5

7:30 AM - 12:30 PM | TIVOLI STUDENT UNION/ATRIUM
Registration | Information Desk | Exhibit Hall Open

8:30 AM - 10:25 AM | PLAZA
CONCURRENT SESSIONS

10:30 AM - 10:45 AM | TIVOLI STUDENT UNION/ATRIUM
Break

10:45 AM - 12:45 PM | PLAZA
CONCURRENT SESSIONS

12:45 PM - 1:45 PM | TIVOLI STUDENT UNION/TURNHALLE
Lunch & Awards Ceremony

2:00 PM
Conference Adjourns

FEATURED SPEAKER
SERGIY KOVALENKOV
CHANGING THE WORLD NATURALLY

FRIDAY, AUGUST 4
2:00 PM - 2:25 PM
ROOM 114

Sergiy's love for the environment and passion for finding sustainable solutions has driven his career. He has worked in the construction industry across three continents, which led to his development of sustainable building materials made from hemp.

These hemp-based alternative construction materials have won numerous awards for their innovation, and now Sergiy has become a key professional speaker on hemp and sustainability.

Sergiy's career highlights include:

- Founder of the US Hemp Building Association
- Head of the Ukrainian Cannabis Business Association
- Fostering partnerships in international import and export across the globe

Saluting Our 2023 Sponsors
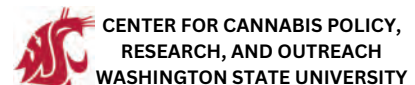
AUGUST 3, 2023

8:15 AM - 8:45 AM, TURNHALLE
FEATURED SPEAKER
INVESTIGATING THE DIFFERENCE IN MICROBIAL TEST RESULTS BETWEEN QPCR
AND MICROARRAY TECHNOLOGIES
Presented by Tyler Secor, MS

9:00 AM - 9:25 AM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: ADVANCES IN CANNABIS PLANT SCIENCE AND CULTIVATION

EFFECTS OF RELATIVE HUMIDITY ON THE DEVELOPMENT AND CANNABINOID PRODUCTION OF
CANNABIS SATIVA L.
Presented by Ingrid Carolina Corredor Perilla

9:00 AM - 9:25 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABIS IN ANIMALS: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT,
HEMPSEED, AND THE REGULATORY ENVIRONMENT

FEEDING SHEEP DIETS CONTAINING HEMP BIOMASS INCREASES DRIP LOSS BUT HAS NO EFFECTS ON
OTHER MEAT QUALITY ATTRIBUTES
Presented by Sarah Stevens

9:00 AM - 9:25 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABINOIDS AND CANCER

ANTI-TUMORAL EFFECT OF CANNABIS SATIVA OIL IN HUMAN AND CANINE PROSTATIC CARCINOMA
CELL LINES
Presented by Renee Laufer-Amorim

9:00 AM - 9:25 AM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: Problems in Cannabis Regulation

Cannabis – the Latest Contraband Federalism Dispute
Presented by James Thorburn

AUGUST 3, 2023

9:30 AM - 9:55 AM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: ADVANCES IN CANNABIS PLANT SCIENCE AND CULTIVATION

EVALUATING NEW BIOSTIMULANTS IN CANNABIS PRODUCTION: A CASE STUDY WITH PINK-PIGMENTED FACULTATIVE METHYLOTROPHS (PPFMS)
Presented by Allison Jack

9:30 AM - 9:55 AM, ROOM 114
TRACK: CANNABIS EDUCATION
SESSION: The Present and Future of Cannabis in Higher Education

CREATING AND CLOSING A CANNABIS SCHOOL IN OHIO AND MICHIGAN: THE LEAF MEDIC STORY
Presented by Karen Korn

9:30 AM - 9:55 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABIS IN ANIMALS: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT, HEMPSEED, AND THE REGULATORY ENVIRONMENT

HEMP SEED CAKE DOES NOT AFFECT HEN'S PERFORMANCE, ENHANCES EGG FATTY ACIDS PROFILE, AND DOES NOT TRANSFER TETRAHYDROCANNABINOL (THC) RESIDUES
Presented by Fausto Solis

9:30 AM - 9:55 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABINOIDS AND CANCER

ANTINEOPLASTIC PROPERTIES OF THCV, HHC, HHCV AND THEIR ANTI-PROLIFERATIVE EFFECTS ON HPAF-II, MIA-PACA2, ASPC-1, AND PANC-1 PANCREATIC DUCTAL ADENOCARCINOMA CELL LINES
Presented by Giovanni Ramirez

9:30 AM - 9:55 AM, ROOM 131
TRACK: PUBLIC POLICY & REGULATION
SESSION: PROBLEMS IN CANNABIS REGULATION

CANNABIS IN INTERSTATE COMMERCE
Presented by David Bush

10:00 AM - 10:25 AM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: ADVANCES IN CANNABIS PLANT SCIENCE AND CULTIVATION

MFDETECT TM, A NOVEL HIGH THROUGHPUT, LOW COST, AND RELIABLE DETECTION METHOD FOR HOP LATENT VIROID IN CANNABIS
PRESENTED BY AJITH ANAND

AUGUST 3, 2023

10:00 AM - 10:25 AM, ROOM 114
TRACK: CANNABIS EDUCATION
SESSION: THE PRESENT AND FUTURE OF CANNABIS IN HIGHER EDUCATION

PROBLEMS AND CHALLENGES IN CANNABIS EDUCATION IN ILLINOIS AND BEYOND
PRESENTED BY STEVE FIX

10:00 AM - 10:25 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABINOIDS AND CANCER

CANNABIS USE AND POSTOPERATIVE OUTCOMES IN PATIENTS UNDERGOING HEPATECTOMY
Presented by Michael Kirsch

10:00 AM - 10:25 AM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: PROBLEMS IN CANNABIS REGULATION

EMERGING TECHNOLOGIES IN WORKPLACE IMPAIRMENT TESTING
Presented by Mary Jo Mcguire

10:00 AM - 10:25 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABIS IN ANIMALS: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT, HEMPSEED, AND THE REGULATORY ENVIRONMENT

HUMAN EXPOSURE ASSESSMENT TO CANNABINOID RESIDUES PRESENT IN EDIBLE TISSUES OF BEEF CATTLE AFTER A 16-WEEK HEMPSEED CAKE FEEDING PERIOD
Presented by David J. Smith

10:45 AM - 11:10 AM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: ADVANCES IN CANNABIS PLANT SCIENCE AND CULTIVATION

OPTIMIZED LIGHTING STRATEGIES TO INCREASE YIELD AND CHEMICAL UNIFORMITY IN CANNABIS SATIVA
Presented by Justin Bohemen

10:45 AM - 11:10 AM, ROOM 114
TRACK: CANNABIS EDUCATION
SESSION: THE PRESENT AND FUTURE OF CANNABIS IN HIGHER EDUCATION

USING ACTIVE LEARNING AND EVIDENCE-BASED AGRICULTURAL PRACTICES TO TEACH CANNABIS CULTIVATION PRACTICES AT RUTGERS UNIVERSITY
Presented by Connie Pascal

AUGUST 3, 2023

10:45 AM - 11:10 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABINOIDS AND CANCER

RATES OF CANNABIS USE VERSUS OTHER ILLICIT SUBSTANCES IN SURGICAL ONCOLOGY PATIENTS
PRESENTED BY SALVADOR RODRIGUEZ FRANCO

10:45 AM - 11:10 AM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: PROBLEMS IN CANNABIS REGULATION

HEAVY METALS AND COLORADO CANNABIS: ANALYSIS OF 21 HEAVY METALS OF CONCERN IN COLORADO-MARKET CANNABIS FLOWER AND VAPE OIL
Presented by Mike Van Dyke

10:45 AM - 11:10 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABIS IN ANIMALS: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT, HEMPSEED, AND THE REGULATORY ENVIRONMENT

WHAT RESEARCH IS NEEDED TO PROCEED WITH THE LEGALIZATION OF HEMP BYPRODUCTS AS FEED INGREDIENTS IN THE UNITED STATES?
Presented by Massimo Bionaz

11:15 AM - 11:45 AM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: CANNABINOID SYNTHESIS AND BIOSYNTHESIS

DISTRIBUTION OF CADMIUM AND OTHER HEAVY METALS AMONG PLANT PARTS OF LEADING CANADIAN INDUSTRIAL HEMP VARIETIES OF DIFFERENT USAGE TYPES
Presented by Jan Slaski

11:15 AM - 11:45 AM, ROOM 114
TRACK: CANNABIS EDUCATION
SESSION: THE PRESENT AND FUTURE OF CANNABIS IN HIGHER EDUCATION

ESTABLISHING A CANNABIS CORE: CASH POSITIVE, SUSTAINABLE, TRANSFORMATIVE CANNABIS EDUCATION FOR POST-SECONDARY INSTITUTIONS
Presented by Melissa Ausbrooks

11:15 AM - 11:45 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABINOIDS: DRUG INTERACTIONS AND SUBSTITUTIONS

CO-USE OF CANNABIS AND PSYCHEDELIC COMPOUNDS: EVIDENCE FROM FIELD DATA COLLECTION IN COLORADO
Presented by Cianna Piercey

11:15 AM - 11:45 AM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: PROBLEMS IN CANNABIS REGULATION

THE CONUNDRUM OF FEDERAL CANNABIS REGULATION
PRESENTED BY SALVADOR GARRETT GRAFF

11:15 AM - 11:45 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABIS IN ANIMALS: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT, HEMPSEED, AND THE REGULATORY ENVIRONMENT

INFLUENCE OF A HEMPSEED-SUPPLEMENTED DIET ON THE GUT MICROBIOME IN YOUNG GROWING FEMALE C57BL/6 MICE
Presented by Annette Gabaldon

11:50 AM - 12:15 PM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: CANNABIS GENOMICS AND GENETICS

FROM MANGO TO SKUNK - THE REMARKABLE DIVERSITY OF CANNABIS AROMA AND ODOR VOLATILES
Presented by Mark Lange

11:50 AM - 12:15 PM, ROOM 114
TRACK: CANNABIS EDUCATION
SESSION: GROWING DIVERSITY IN THE CANNABIS INDUSTRY-EDUCATIONAL PROGRAMS AND APPROACHES

CANNABIS EDUCATION AT WHAT LEVEL? ENROLLMENT AND DEMOGRAPHIC DATA ACROSS CANNABIS DEGREE PROGRAMS AT THE COMMUNITY COLLEGE OF DENVER
Presented by John Frost

11:50 AM - 12:15 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: WHAT TO EXPECT IN THE NEXT 5 YEARS FOR FIBER HEMP

ANTIMICROBIAL EFFECT OF NANOFIBERS LOADED WITH HEMP (CANNABIS SATIVA SP) EXTRACT
Presented by Aaron Dudley

11:50 AM - 12:15 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABINOIDS: DRUG INTERACTIONS AND SUBSTITUTIONS

GESTATIONAL CANNABIDIOL (CBD) CONSUMPTION IMPACTS OFFSPRING BRAIN DEVELOPMENT AND POSTNATAL BEHAVIOR
Presented by Lillian Folts

AUGUST 3, 2023

12:45 PM - 1:45 AM, TURNHALLE
MECHOULAM LECTURE

THE PROTECTIVE ROLE OF ENDOCANNABINOIDS IN TRAUMATIC BRAIN INJURY
Presented by Esther Shohami

2:00 PM - 2:25 PM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: CANNABIS GENOMICS AND GENETICS

GENETIC BASIS FOR HERMAPHRODITISM RESISTANCE
Presented by Alisha Holloway

2:00 PM - 2:25 PM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: BIOLOGY AND MANAGEMENT OF CANNABIS PESTS AND DISEASES

ASSESSING THE ADAPTIVE ROLE OF CANNABINOIDS IN HERBIVORE DEFENSE IN HEMP
Presented by Jacob MacWilliams

2:00 PM - 2:25 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

CANNABIDIOL AND YOUR IMMUNE HEALTH
Presented by Laura Stewart

2:00 pm - 2:25 pm, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: SAFETY CONSIDERATIONS FOR TRAFFIC SAFETY FOLLOWING CANNABIS USE

DRIVING PERFORMANCE AND OTHER MEASURES OF IMPAIRMENT AMONG PARTICIPANTS USING
COMMERCIALLY AVAILABLE CANNABIS
Presented by Ashley Brooks-Russell

2:00 PM - 2:55 PM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: CANNABIS GENOMICS AND GENETICS

VALIDATION AND IDENTIFICATION OF MASCULINIZATION-RELATED GENES IN CANNABIS SATIVA BY
RANDOM WALK WITH RESTART ON MULTIPLEX GENE TO PROTEIN-PROTEIN INTERACTION NETWORK
Presented by Leonardo Orozco

AUGUST 3, 2023

2:30 PM - 2:55 PM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: BIOLOGY AND MANAGEMENT OF CANNABIS PESTS AND DISEASES

OLD VIRUS, NEW HOST: EPIDEMIOLOGY AND MANAGEMENT OF BEET CURLY TOP VIRUS, AN EMERGING VECTOR BORNE VIRUS OF HEMP IN WESTERN U.S.
Presented by Nachappa Punya

2:30 PM - 2:55 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

CANNABINOIDS AND CARDIOMETABOLIC PHYSIOLOGY AT REST AND DURING EXERCISE
Presented by Christopher Bell

2:30 PM - 2:55 PM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: SAFETY CONSIDERATIONS FOR TRAFFIC SAFETY FOLLOWING CANNABIS USE

MEDICINAL CANNABIS AND DRIVING
Presented by David Grelotti

3:00 pm - 3:25 pm, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: Cannabis Genomics and Genetics

PREDICTING TERPENE PROFILES IN CANNABIS THROUGH PCR-BASED ASSAYS FOR GENE FAMILY ANALYSIS
Presented by Christopher Pauli

3:00 PM - 3:25 PM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: BIOLOGY AND MANAGEMENT OF CANNABIS PESTS AND DISEASES

EVALUATION OF HEMP AS AN ALTERNATIVE HOST PLANT FOR NOCTUID PESTS
Presented by Jeffrey Davis

AUGUST 3, 2023

3:00 PM - 3:25 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

CANNABIS USE IN PHYSICALLY ACTIVE INDIVIDUALS IS ASSOCIATED WITH ALTERED MONOCYTE PHENOTYPE BUT NOT ACUTE IMMUNE RESPONSE
Presented by Jonny Lisano

3:00 PM - 3:25 PM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: SAFETY CONSIDERATIONS FOR TRAFFIC SAFETY FOLLOWING CANNABIS USE

THE ROLE OF INDIVIDUAL DIFFERENCES IN MODELING CANNABIS DRIVING IMPAIRMENT
Presented by Thomas Burt

3:45 PM - 4:10 PM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: CANNABIS GENOMICS AND GENETICS

TERPENE SYNTHASE GENE FAMILY VARIATION IN CANNABIS
Presented by Keith Allen

3:45 PM - 4:10 PM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: BIOLOGY AND MANAGEMENT OF CANNABIS PESTS AND DISEASES

UNDERSTANDING AND MANAGING HOP LATENT VIROID IN CANNABIS
Presented by Zamir Punja

AUGUST 3, 2023

3:45 PM - 4:10 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

CONGRATS ON THE AUTISM: A VISUAL PROJECT ON THE USE OF CANNABIS TO IMPROVE MOVEMENT EXPERIENCES IN AUTISM
Presented by Jersey Noah Deutsch

3:45 PM - 5:15 PM, ROOM 131, *PANEL DISCUSSION*
TRACK: PUBLIC POLICY AND REGULATION
SESSION: UPDATE ON HB 21-1317

PHYSICAL AND MENTAL HEALTH EFFECTS OF HIGH-POTENCY THC MARIJUANA AND CONCENTRATES, RESULTS FROM A STATE FUNDED SCOPING REVIEW
Presented by Gregory Kinney

4:15 PM - 4:40 PM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: FRONTIERS IN SEPARATION AND DETECTION OF MINOR CANNABINOIDS AND CONCOMITANT MOLECULES

AN HPLC-QQQ METHOD FOR SIMULTANEOUS ANALYSIS OF 25 CANNABINOIDS AND 8 PESTICIDES IN VARIOUS CANNABIS PROCESSING MATRICES
Presented by Ava Chard

4:15 PM - 4:40 PM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: BIOLOGY AND MANAGEMENT OF CANNABIS PESTS AND DISEASES

PARASITIZATION OF COMMERCIALLY AVAILABLE PARASITOID SPECIES AGAINST THE HEMP APHIDS, PHORODON CANNABIS (PASSERINI) (HEMIPTERA: APHIDIDAE)
Presented by Govinda Shrestha

4:15 PM - 4:40 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

LOCATION, LOCATION, LOCATION: VARIABILITY IN EXPERIENCE OF EXERCISE DURING CANNABIS USE IN THE NATURAL ENVIRONMENT VERSUS THE LAB
Presented by Angela Bryan

AUGUST 3, 2023

4:45 PM - 5:15 PM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: FRONTIERS IN SEPARATION AND DETECTION OF MINOR CANNABINOIDS AND CONCOMITANT MOLECULES

THERMO-CHEMICAL DECARBOXYLATION KINETICS OF CANNABINOID ACIDS IN HEMP (CANNABIS SATIVA L.) BY PRESSURIZED LIQUID SYSTEM
Presented by Urvashi U.

4:45 PM - 5:15 PM, ROOM 131, *PANEL DISCUSSION*
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

ROLE OF CANNABIGEROL IN ALLEVIATING THE HIGH-FAT-DIET INDUCED NON-ALCOHOLIC FATTY LIVER DISEASE IN MICE MODEL
Presented by Yuyan Han

4:45 PM - 5:15 PM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: BIOLOGY AND MANAGEMENT OF CANNABIS PESTS AND DISEASES

SEASONAL ABUNDANCE OF ARTHROPODS ON HEMP (CANNABIS SATIVA L.) GROWN FOR FIBER AND CBD IN EAST-CENTRAL ALABAMA
Presented by Olufemi Ajayi

5:15 PM - 5:40 PM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: FRONTIERS IN SEPARATION AND DETECTION OF MINOR CANNABINOIDS AND CONCOMITANT MOLECULES

USING ECO-SUSTAINABLE SEPARATION TECHNOLOGIES TO PRODUCE SAFE AND COMPLIANT EXTRACTS AND ISOLATES OF CANNABINOIDS
Presented by Gerard Rosse

5:15 PM - 5:40 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

THE INFLUENCE OF CANNABIS INHALATION ON EXERCISE PHYSIOLOGY AND CARDIOVASCULAR FUNCTION: EXPLORING THE EFFECTS OF CANNABINOIDS AND MODE OF ADMINISTRATION
Presented by Christian Cheung

POSTERS

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RESEARCH

SOUND LEGISLATION

COLLABORATION

Our "Team Hemp" members are hemp farmers and professionals that represent companies at all levels of the hemp supply chain. We are united, working to engage hemp stakeholders to find common ground to move our industry forward. We represent western states and the Western Free World.

www.westernhemppros.org

AUGUST 4, 2023
POSTERS
12:15 PM - 1:45 PM, TURNHALLE

**TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: ADVANCES IN CANNABIS PLANT SCIENCE AND CULTIVATION**

INVESTIGATING INSECTICIDAL EFFECTS OF CANNABIGEROLIC ACID (CBGA) IN TOBACCO HORNWORM MANDUCA SEXTA - PRESENTED BY CHRIS MOODY

INVESTIGATING THE NUTRITIONAL DEFICIENCY RESPONSE OF CANNABIS SATIVA L. VAR. CHERRY WINE PRESENTED BY IAN NOONAN

MANIPULATING THE PLOIDY LEVEL FOR HEMP CULTIVAR DEVELOPMENT - PRESENTED BY MOHAMED ELHITI

POTENTIAL ROLE OF MULCHES AND PLANTING TIME IN MANAGING SOUTHERN BLIGHT AND ENHANCING CANNABINOID PRODUCTION IN FLORAL HEMP IN TENNESSEE - PRESENTED BY MADDELA SAI SUVIDH

**TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: CANNABIS GENOMICS AND GENETICS**

QUANTITATIVE TRAIT LOCI (QTL) MARKER DEVELOPMENT FOR SEED PROTEIN CONTENTS IN HEMP (CANNABIS SATIVA L.) - PRESENTED BY MOHAMED ELHITI

UNDERSTANDING THE ENVIRONMENTAL EFFECTS AND GENETIC CONTROL OF ANTHOCYANIN ACCUMULATION IN CANNABIS SATIVA - PRESENTED BY SEAN KIM

**TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: FRONTIERS IN SEPARATION AND DETECTION OF MINOR CANNABINOIDS
AND CONCOMITANT MOLECULES**

ISOLATION OF NEOLIGNANS FROM CANNABIS SATIVA (L.) - PRESENTED BKOREY BROWNSTEIN

**TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: UPDATE ON THE NATIONAL HEMP GERMPLASM COLLECTION**

MORPHOMETRIC EVALUATION OF NINE NORTHERN FERAL HEMP (CANNABIS SATIVA) GERMPLASM IN ALABAMA - PRESENTED BY XINHUA XIAO

**TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: JERSEY'S MARKET SEED TO SALE**

RELATIONSHIP BETWEEN NEW JERSEY CANNABIS DISPENSARY LOCATION AND RESIDENT SOCIO-ECONOMIC STATUS CHARACTERISTICS - PRESENTED BY BEN HALLADAY

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: BIOLOGY AND MANAGEMENT OF CANNABIS PESTS AND DISEASES

BIOLOGY AND MANAGEMENT OF THE HEMP RUSSET MITE (ACULOPS CANNABICOLA)
PRESENTED BY OLIVIA CARTER

CAN YOU RESIST ME? SCREENING HEMP LINES FOR RESISTANCE TO EMERGING VIRUSES AND VIROIDS
UTILIZING THE HEMP VIROME - PRESENTED BY LAINE HACKENBERG

LABORATORY STUDIES TO EVALUATE SWEET CORN AS A TRAP CROP TO CONTROL CORN EARWORM
(HELICOVERPA ZEA) IN OUTDOOR HEMP - PRESENTED BY DILLS JERA

ORGANIC PESTICIDE USE: A GREENHOUSE STUDY - PRESENTED BY CHELSEA LAWRENCE

USING GREEN LACEWINGS FOR BIOLOGICAL CONTROL OF TWO SPOTTED SPIDER MITES IN CANNABIS:
POTENTIAL INTERFERENCE WITH INTRAGUILD PREDATION - PRESENTED BY ANNA WILLIAMS

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABINOIDS: DRUG INTERACTIONS AND SUBSTITUTIONS

INHIBITION OF ANGIOTENSIN-CONVERTING ENZYME (ACE) ACTIVITY BY CANNABINOIDS FROM CANNABIS
SATIVA L. - PRESENTED BY FRANCISCO CHACON

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABIS, EXERCISE, AND HEALTH: HOW IT'S USED, AND ITS KNOWN EFFECTS

CHARACTERIZING THE CANNABIS-EXERCISE RELATIONSHIP: PRELIMINARY RESULTS OF A DAILY DIARY STUDY
PRESENTED BY VANESSA STALLSMITH

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
**SESSION: CLINICAL CANNABIS RESEARCH TO UNCOVER NEUROBIOLOGICAL EFFECTS OF
CANNABIS ON USERS**

CANNABIS USE EFFECTS ON REACTION TIME IN DAILY VERSUS, OCCASIONAL RECREATIONAL USERS
PRESENTED BY ALEXIS KRAUSE

AUGUST 4, 2023
POSTERS
12:15 PM - 1:45 PM, TURNHALLE

RACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CLINICAL CANNABIS RESEARCH TO UNCOVER NEUROBIOLOGICAL EFFECTS OF CANNABIS ON USERS

DVORCHAK L. PROPHYLACTIC USE OF CBD PRESERVES HINDLIMB SENSORIMOTOR REFLEXES IN FEMALE RATS SUBJECTED TO MILD TRAUMATIC BRAIN INJURY (2022) - PRESENTED BY LAUREN DVORCHAK

EXPECTANCY VS BEHAVIOR: IS OUR CONSUMPTION OF CANNABIS RELATED TO OUR EMOTIONAL EXPERIENCES AND EXPECTED EFFECTS? - PRESENTED BY LUIZA ROSA

THE EFFECT OF CANNABIDIOL ON LEARNING AND MEMORY IN ADULTS - PRESENTED BY HANNA GEBREGZI

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: EMERGING PATIENT-CENTERED MEDICAL CANNABIS RESEARCH

PRIMING CANINE ADIPOSE-DERIVED MESENCHYMAL STEM CELLS WITH CBD-RICH CANNABIS EXTRACT MODULATES NEUROTROPHIC FACTORS EXPRESSION PROFILE - PRESENTED BY AMORIM ROGERIO

THE EFFECTS OF FULL SPECTRUM HEMP OIL ON EXTINCTION OF STRESS ENHANCED FEAR LEARNING IN A RODENT MODEL OF PTSD - PRESENTED BY TIPHANIE CHANEL

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

COMPARING MOTIVATIONS FOR CANNABIS USE ACROSS CANNABIS USERS WHO HAVE AND HAVE NOT RECENTLY USED PSILOCYBIN - PRESENTED BY MADELINE STANGER

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: HEMP AS ANIMAL FEED: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT, AND THE REGULATORY ENVIRONMENT

ANAEROBIC FERMENTATION OF DIETARY HEMPSEED BY A MOUSE FECAL SLURRY GENERATES HEALTH-BENEFICIAL SHORT CHAIN FATTY ACIDS - PRESENTED BY ANNETTE GABALDON

EFFECT OF INDUSTRIAL HEMP (CANNABIS SATIVA) ON RUMINATION BEHAVIOR PARAMETERS OF ANGUS CATTLE - PRESENTED BY NATHANIEL OGUNKUNLE

AUGUST 4, 2023
POSTERS
12:15 PM - 1:45 PM, TURNHALLE

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: HEMP AS ANIMAL FEED: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT, AND THE REGULATORY ENVIRONMENT

EVALUATION OF THE EFFECT OF INDUSTRIAL HEMP SUPPLEMENTATION ON THE HEMOGRAM AND BIOCHEMICAL CHARACTERISTIC IN ANGUS HEIFERS - PRESENTED BY FELIX SAMUEL

EFFECT OF HEMP (CANNABIS SATIVA) SUPPLEMENTATION ON VITAL AND BEHAVIORAL RESPONSES OF WEANED BEEF CATTLE - PRESENTED BY MONYA SIMPSON

HEMP SEED OIL SUPPLEMENTATION EFFECT ON CANNABINOIDS IN SERUM AND SYNOVIAL FLUID IN HORSES PRESENTED BY KRISTINE ELY

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: HEMP BUILDING PRODUCTS: MANUFACTURING AND APPLICATIONS

PI CONTROLLER DESIGN FOR HEMP-BASED PAPER ROLL-TO-ROLL (R2R) MANUFACTURING PRESENTED BY TRUNG DUONG

TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: POTENTIAL USE OF HEMP BYPRODUCTS FOR FARM ANIMALS AND PETS

EFFECTS OF ORAL SUPPLEMENTATION OF CANNABIDIOL ON STALLION SPERMATOGENESIS PRESENTED BY PAYTON BYARS

IMPACT OF VARYING INCLUSION RATES OF HEMPSEED MEAL IN THE DIET OF BOAR X SPANISH INTACT MALE GOATS ON CARCASS QUALITY VALUES - PRESENT BY KHIM ALE

THE EFFECTS OF DAILY ORAL FULL-SPECTRUM NANO-TREATED CANNABIDIOL ON GESTATING RABBITS, LITTER PARAMETERS, AND KIT GROWTH - PRESENTED BY MADELYNN HAYEN

TRACK: PUBLIC POLICY AND REGULATION
SESSION: FOSTERING INTERACTIONS BETWEEN POLICY MAKERS, REGULATORS, AND RESEARCHERS

VAPING, CANNABIS, AND TOBACCO USE: PATTERNS AND POPULATIONS OF CONCERN IN COLORADO ADULTS (2015-2022) - PRESENTED BY FRANCESCA MACALUSO

AUGUST 4, 2023
POSTERS
12:15 PM - 1:45 PM, TURNHALLE

TRACK: PUBLIC POLICY AND REGULATION
SESSION: PROBLEMS IN CANNABIS REGULATION

AN EXAMINATION OF THE EXTENT OF ILLICIT USE OF CANNABIS IN BOTSWANA GABAIKANNGWE
PRESENTED BY ETHEL MAMBO

TRACK: PUBLIC POLICY AND REGULATION
SESSION: THE FUTURE OF CANNABIS REGULATION: DELTA-8, MINOR CANNABINOIDS, AND A PATCHWORK OF STATE REGULATIONS

WHAT'S NOT ON THE LABEL? DETERMINING THE CONCENTRATION OF 10 MAJOR AND MINOR CANNABINOIDS IN REPRESENTATIVE SAMPLES OF THE COLORADO RECREATIONAL CANNABIS MARKET
PRESENTED BY COLIN BROOK

TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY IS WHAT YOU SEE WHAT YOU GET? EVALUATING THE ACCURACY OF CANNABIS PRODUCT LABELS ASHLEY MASTER

IS WHAT YOU SEE WHAT YOU GET? EVALUATING THE ACCURACY OF CANNABIS PRODUCT LABELS
PRESENTED BY ASHLEY MASTER

WEED OUT THE MISINFORMATION: THE PROCESS OF VERIFYING CANNABIS PRODUCT LABELS
PRESENTED BY CAMDEN MCFARLAND

TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: THE MYSTERY OF MYCOTOXIN TESTING IN CANNABIS AND HEMP PRODUCTS

AFLATOXIN AND OCHRATOXIN PREVALENCE IN HYDROCARBON EXTRACTS OF MICROBIAL CONTAMINATED MARIJUANA - PRESENTED BY STEPHEN COB**B**

AUGUST 4, 2023

9:00 AM - 9:25 AM, ROOM 112
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: UPDATE ON THE NATIONAL HEMP GERMPLASM COLLECTION

ROAD BANK TO SEED BANK: REBUILDING THE US HEMP GERMPLASM COLLECTION
Presented by Shelby Ellison

9:00 AM - 9:25 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: POTENTIAL USE OF HEMP BYPRODUCTS FOR FARM ANIMALS AND PETS

FEEDING MORE THAN 5% SPENT HEMP BIOMASS TO BROILERS DECREASES GROWTH AND
NEGATIVELY AFFECTS MEAT QUALITY
Presented by Massimo Bionaz

9:00 AM - 9:25 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

A METHOD TO MEASURE URINARY CANNABINOIDS WITH ADEQUATE SENSITIVITY TO DETECT
EXPOSURE TO SECONDHAND CANNABIS SMOKE
Presented by Kevin Caron

9:00 AM - 10:25 AM, ROOM 131, *PANEL DISCUSSION*
TRACK: PUBLIC POLICY AND REGULATION
SESSION: POLICY DEFINITIONS BACKED BY SCIENCE: ALTERNATIVES TO "IMPAIRING,"
"INTOXICATING," "PSYCHOTROPIC" SUBSTANCES

POLICY DEFINITIONS BACKED BY SCIENCE: ALTERNATIVES TO IMPAIRING,
INTOXICATING, PSYCHOTROPIC
Presented by David Gang

9:00 AM - 9:25 AM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

AUTOMATED PRESSURIZED LIQUID EXTRACTION (PLE) METHOD FOR NATIVE QUANTITIES OF
COMMON CANNABINOIDS IN CANNABIS SATIVA L.
Presented by Chad Kinney

AUGUST 4, 2023

9:30 AM - 9:55 AM, ROOM 114
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: POTENTIAL USE OF HEMP BYPRODUCTS FOR FARM ANIMALS AND PETS

INCREASED LENGTH OF EXPOSURE DOES NOT INCREASE CANNABINOID RESIDUES IN
ANIMAL TISSUES
Presented by Gaye Krebs

9:30 AM - 9:55 AM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

CHALLENGES OF ENSURING FITNESS FOR THE PURPOSE OF MICROBIOLOGY METHODS IN A
CONTINUALLY EVOLVING CANNABIS MARKET
Presented by John Mills

10:00 AM - 10:25 AM, ROOM 114
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: POTENTIAL USE OF HEMP BYPRODUCTS FOR FARM ANIMALS AND PETS

RECENT UPDATES OF THE USE OF INDUSTRIAL HEMP BYPRODUCTS IN RUMINANTS: NUTRITIONAL
PROFILE, ANIMAL RESPONSE, POTENTIAL CONSTRAINTS, AND FUTURE RESEARCH DIRECTIONS
Presented by Agung Irawan

10:00 AM - 10:25 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

CANNABIDIOL REDUCED ALCOHOL CRAVING AND DRINKING BEHAVIOR IN INDIVIDUALS WITH
ALCOHOL USE DISORDER
Presented by Raeghan Mueller

AUGUST 4, 2023

10:45 AM - 11:10 AM, ROOM 112
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CANNABINOIDS: DRUG INTERACTIONS AND SUBSTITUTIONS

EXPLORING THE EFFICACY OF CANNABIS IN PAIN MANAGEMENT AND OPIOID REDUCTION
Presented by Alan Morris

10:45 AM - 11:10 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: POTENTIAL USE OF HEMP BYPRODUCTS FOR FARM ANIMALS AND PETS

THE EFFECTS OF CANNABIDIOL ON CAMP PRODUCTION AND STEROIDOGENESIS IN
YOUNG STALLIONS
Presented by Kimberly Guay

10:45 AM - 11:10 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

CANNABIS USE AND SUICIDALITY: A MULTI-SITE, CO-TWIN CONTROL STUDY FROM ADOLESCENCE
THROUGH MIDDLE ADULTHOOD
Presented by Jarrod Ellingson

10:45 AM - 11:10 AM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: NAVIGATING THE SHIFTING REGULATORY ECOSYSTEM OF CANNABIS AND HEMP
RESEARCH AT AN R1 LARGE UNIVERSITY

NAVIGATING THE SHIFTING REGULATORY ECOSYSTEM OF CANNABIS AND HEMP RESEARCH AT AN
R1 LARGE UNIVERSITY
Presented by Thomas Heddleston

10:45 AM - 11:10 AM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

INTEGRATING RISK MANAGEMENT STRATEGIES IN CULTIVATION TO REDUCE LEVELS OF
MICROBIAL CONTAMINATION
Presented by Tess Eidem

AUGUST 4, 2023

11:15 AM - 11:45 AM, ROOM 116
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: CANNABIS IN ANIMALS: AN UPDATE ON CURRENT RESEARCH, METHOD DEVELOPMENT, HEMPSEED, AND THE REGULATORY ENVIRONMENT

HEMP AS ANIMAL FEED: A REGULATORY REVIEW AND THE RESEARCH NEEDED TO FINALLY GAIN FEDERAL APPROVAL
Presented by Hunter Buffington

11:15 AM - 11:45 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

COMPARISON OF KNOWLEDGE, ATTITUDES, AND PRACTICE (KAP) IN ALLERGISTS AND ALLERGIC AND ASTHMATIC PATIENTS
Presented by Joanna Zeiger

11:15 AM - 11:45 AM, ROOM 130
TRACK: PUBLIC POLICY AND REGULATION
SESSION: PROBLEMS IN CANNABIS REGULATION'

CANNABIS RESEARCH AT THE NATIONAL INSTITUTE ON DRUG ABUSE
PRESENTED BY HEATHER KIMMEL

11:15 AM - 11:45 AM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

ISO 17025 LABORATORY ACCREDITATION - UNDERSTANDING THE BENEFITS AND LIMITATIONS
Presented by Seth Wong

11:50 AM - 12:15 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

EVIDENCE-BASED CUSTOMER DISCOVERY CONFIRMS VALUE OF MEDICAL CANNABIS RESEARCH PLATFORM
Presented by Cheryl Fitzer-Attas

11:50 AM - 12:15 PM, ROOM 131
TRACK: PUBLIC POLICY AND REGULATION
SESSION: POLICY DEFINITIONS BACKED BY SCIENCE: ALTERNATIVES TO "IMPAIRING," "INTOXICATING," "PSYCHOTROPIC" SUBSTANCES

CANNABIS: SAFE AND EFFECTIVE
Presented by Michael Steward

AUGUST 4, 2023

11:50 AM - 12:15 PM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

PROFICIENCY TESTING CHALLENGES FOR CANNABIS AND CANNABIS PRODUCTS
Presented by Julia Bramante

2:00 PM - 2:25 PM, ROOM 114 - FEATURED SPEAKER***
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: WORKING TOWARDS A SUSTAINABLE HEMP INDUSTRY IN THE U.S.

CHANGING THE WORLD NATURALLY
Presented by Sergiy Kovalenkov

2:00 PM - 2:25 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

IDENTIFICATION OF VAPED VITAMIN E ACETATE AS THE PRIMARY CAUSE OF E-CIGARETTE, OR VAPING, PRODUCT ASSOCIATED LUNG INJURY (EVALI)
Presented by Ben Blount

2:00 PM - 3:25 PM, ROOM 131, *PANEL DISCUSSION*
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: USING TECHNOLOGIES TO ADVANCE CANNABIS RESEARCH AND PERSONALIZE MEDICAL OUTCOMES FOR PATIENTS

USING TECHNOLOGY TO ADVANCE CANNABIS RESEARCH AND MAXIMIZE BENEFITS TO MEDICAL CANNABIS PATIENTS
Presented by Cheryl Fitzer-Attas, Joanna Zeiger

2:00 PM - 2:25 PM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

RISK ASSESSMENT OF HEAVY METAL ACCUMULATION IN HEMP ON NON-CONTAMINATED AGRICULTURE SOIL
Presented by Josh Kraft

AUGUST 4, 2023

2:30 PM - 2:55 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

IMPACT OF PRENATAL EXPOSURE TO DELTA 9-TETRAHYDROCANNABINOL AND CANNABIDIOL ON NEONATAL ADIPOSITY AND POSTNATAL GROWTH TRAJECTORIES: THE HEALTHY START STUDY
Presented by Brianna Moore

2:30 PM - 2:55 PM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

THE SCIENCE BEHIND UTILIZING OZONE AS A KILL-STEP: DIVING DEEP INTO THE DATA
Presented by Carly Bader

2:30 PM - 3:25 PM, ROOM 114, *PANEL DISCUSSION*
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: WORKING TOWARDS A SUSTAINABLE HEMP INDUSTRY IN THE U.S.

STATE OF THE HEMP INDUSTRY IN THE U.S. AND FUTURE PROSPECTS—PANEL DISCUSSION
Presented by Abdel Berrada

3:00 PM - 3:25 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

STEM: SYSTEMATICALLY TESTING THE EVIDENCE ON MARIJUANA
Presented by Beth Shaw

3:00 PM - 3:25 PM, ROOM 132
TRACK: QUALITY ASSURANCE AND QUALITY CONTROL OF CANNABIS PRODUCTS
SESSION: STRATEGIES TO ENSURE OPTIMAL CANNABIS QUALITY

VOLTAMMETRIC DETERMINATION OF Δ9-TETRAHYDROCANNABINOL AND CANNABIDIOL IN CANNABIS SAMPLES USING SCREEN-PRINTED ELECTRODES CHEMICALLY MODIFIED WITH REDUCED GRAPHENE OXIDE (RGO-SPE)
Presented by Marcelo De Oliveira

AUGUST 4, 2023

3:45 PM - 4:10 PM, ROOM 114
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: WORKING TOWARDS A SUSTAINABLE HEMP INDUSTRY IN THE U.S.

PRACTICES TO OPTIMIZE HEMP PERFORMANCE BASED ON END USE
Presented by Abdel Berrada

3:45 PM - 4:10 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EMERGING PATIENT-CENTERED MEDICAL CANNABIS RESEARCH

FETAL CANNABIDIOL (CBD) EXPOSURE INDUCES GLUCOSE INTOLERANCE AND INSULIN RESISTANCE IN A SEX- AND DOSE-DEPENDENT MANNER
Presented by Karli Swenson

3:45 PM - 4:10 PM, ROOM 131
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CLINICAL CANNABIS RESEARCH TO UNCOVER NEUROBIOLOGICAL EFFECTS OF CANNABIS ON USERS

CONNECTING THE PHARMACOKINETICS AND PHARMACODYNAMICS OF CANNABIS IN HUMANS BASED ON THE METHOD OF DELIVERY
Presented by Gary Milavetz

3:45 PM - 5:15 PM, ROOM 132, PANEL DISCUSSION
TRACK: PUBLIC POLICY AND REGULATION
SESSION: PROBLEMS IN CANNABIS REGULATION

REGULATORY CHALLENGES IN THE CANNABIS INDUSTRY: THE RISE OF INTOXICATING PRODUCTS, SYNTHETIC CANNABINOIDS, AND STATE RESPONSES. A PANEL DISCUSSION.
Presented by John Harloe

4:15 PM - 4:40 PM, ROOM 114
TRACK: HEMP CULTIVATION, PROCESSES, AND USES
SESSION: WORKING TOWARDS A SUSTAINABLE HEMP INDUSTRY IN THE U.S.

THE CHANGING ECONOMIC VIABILITY AND IMPACT OF FLORAL, GRAIN, AND FIBER HEMP PRODUCTION
Presented by Tyler Mark

4:15 PM - 4:40 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EMERGING PATIENT-CENTERED MEDICAL CANNABIS RESEARCH

THE USE OF CANNABIDIOL AS ADJUNCT THERAPY FOR REFRACTORY IDIOPATHIC EPILEPSY IN 51 DOGS: A DOUBLE-BLINDED CROSSOVER DESIGN
Presented by Breonna Kusick

4:15 PM - 4:40 PM, ROOM 131
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CLINICAL CANNABIS RESEARCH TO UNCOVER NEUROBIOLOGICAL EFFECTS OF CANNABIS ON USERS

THE SAFETY AND COMPARATIVE EFFECTIVENESS OF NON-PSYCHOACTIVE CANNABINOID FORMULATIONS FOR THE IMPROVEMENT OF SLEEP: A DOUBLE-BLINDED, RANDOMIZED CONTROLLED TRIAL
Presented by Antonija Kolobaric

4:45 PM - 5:15 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EMERGING PATIENT-CENTERED MEDICAL CANNABIS RESEARCH

AN LCMS-MS ASSAY OF CANNABIDIVARIN & METABOLITES IN PHASE TRIAL FOR TREATMENT OF EPILEPSY IN GIRLS WITH RETT SYNDROME
Presented by Gordon Rebecca

4:45 PM - 5:15 PM, ROOM 131
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: CLINICAL CANNABIS RESEARCH TO UNCOVER NEUROBIOLOGICAL EFFECTS OF CANNABIS ON USERS

CANNIBIDIOL STUDY IN AUTISM SPECTRUM DISORDERS (CASCADE): PROGRESS TO DATE AND ADVERSE EVENTS OF CBD IN CHILDREN WITH ASD
Presented by Steffany Contreras

8:30 AM - 8:55 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EMERGING PATIENT-CENTERED MEDICAL CANNABIS RESEARCH

LET'S TALK TERPENES: A STUDY OF MEDICAL CANNABIS
PRESENTED BY CATHIE HIEGEL

8:30 AM - 10:55 AM, ROOM 132, PANEL DISCUSSION
TRACK: PUBLIC POLICY AND REGULATION
SESSION: FOSTERING INTERACTIONS BETWEEN POLICY MAKERS, REGULATORS, AND RESEARCHERS

FOSTERING INTERACTIONS BETWEEN POLICY MAKERS, REGULATORS AND RESEARCHERS
PRESENTED BY DAVID GANG

9:00 AM - 9:25 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: USING TECHNOLOGIES TO ADVANCE CANNABIS RESEARCH AND PERSONALIZE MEDICAL OUTCOMES FOR PATIENTS

LC-MS/MS QUANTIFICATION OF Δ8-THC, Δ9-THC, THCV ISOMERS AND THEIR MAIN METABOLITES IN HUMAN PLASMA
PRESENTED BY CRISTINA SEMPIO

9:30 AM - 9:55 AM, ROOM 116
TRACK: *BUSINESS AND DEVELOPMENT*
SESSION: *CANNABIS AND HEMP DEVELOPMENT IN OTHER NATIONS*

CANNABIS AND DEVELOPMENT IN OTHER NATIONS
PRESENTED BY DANIELA ONOFRE

9:30 AM - 9:55 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: IMPLICATIONS OF CANNABIS AND SLEEP

COMPARING THE EFFECTIVENESS OF CANNABIS TO TREAT SLEEP IMPAIRMENTS BETWEEN THOSE WITH AND WITHOUT SLEEP DISORDERS
Presented by Allison Herens, Kayla Madden

AUGUST 5, 2023

9:30 AM - 9:55 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: IMPLICATIONS OF CANNABIS AND SLEEP

COMPARING THE EFFECTIVENESS OF CANNABIS TO TREAT SLEEP IMPAIRMENTS BETWEEN THOSE
WITH AND WITHOUT SLEEP DISORDERS
Presented by Allison Herens, Kayla Madden

10:00 AM - 10:25 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: IMPLICATIONS OF CANNABIS AND SLEEP

DON'T HIT SNOOZE ON CANNABIS: INFLAMMATORY MEDIATED EFFECTS ON SLEEP QUALITY IN MILD
TO MODERATELY ANXIOUS INDIVIDUALS
Presented by Lisano Jonathon

10:45 AM - 11:10 AM, ROOM 116
TRACK: BUSINESS AND ECONOMIC DEVELOPMENT
SESSION: USING DATA TO TRACK PROCUREMENT NEEDS AND IMPROVE SUPPLY CHAIN
MANAGEMENT

THE ECONOMIC IMPACT OF CANNABIS WITH SEVERAL STATES AND NATIONS
Presented by Orland Yee

AUGUST 5, 2023

10:45 AM - 11:10 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EMERGING PATIENT-CENTERED MEDICAL CANNABIS RESEARCH

ENDOCANNABINOID SYSTEM AND LONG COVID
Presented by Michael Stewart

10:45 AM - 12:45 PM, ROOM 116, *PANEL DISCUSSION*
TRACK: BUSINESS AND ECONOMIC DEVELOPMENT
SESSION: CANNABIS AND HEMP DEVELOPMENT IN OTHER NATIONS

CANNABIS AND HEMP DEVELOPMENT IN INDIAN COUNTRY
Presented by David Gang

11:15 AM - 11:40 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EMERGING PATIENT-CENTERED MEDICAL CANNABIS RESEARCH

FEASABILITY OF HEMP-DERIVED MINOR CANNABINOIDS AND TERPENES FOR SKIN REPAIR AND
WOUND HEALING
Presented by Traci Kimball

11:45 AM - 12:10 AM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: Emerging Patient-centered Medical Cannabis Research

QUANTITATIVE ANALYSIS OF E-CIGARETTES/VAPE PRODUCTS RELATED TO A LUNG
INJURY OUTBREAK
Presented by Clifford Watson

12:15 PM - 12:45 PM, ROOM 114
TRACK: BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS
SESSION: ADVANCES IN CANNABIS PLANT SCIENCE AND CULTIVATION

NUTRIENT MANAGEMENT FOR OPTIMIZED PRODUCTION OF SECONDARY METABOLITES
IN CANNABIS
Presented by Nirit Bernstein

12:15 PM - 12:45 PM, ROOM 130
TRACK: MEDICAL AND CLINICAL RESEARCH
SESSION: EPIDEMIOLOGY AND PUBLIC HEALTH

THE TOLERABILITY OF SUPPLEMENTING CBD AT TWO DOSES FOR 9 MONTHS TO HEALTHY DOGS
Presented by Isabella Corsato Alvarenga

ABSTRACTS

ABSTRACTS:
BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS

AN HPLC-QQQ METHOD FOR SIMULTANEOUS ANALYSIS OF 25 CANNABINOIDS AND 8 PESTICIDES IN VARIOUS CANNABIS PROCESSING MATRICES

Ava Chard, Dr. Jamie Cuchiaro, Dr. Melissa Reynolds

Pesticide contamination of cannabis source material is a primary concern in producing cannabis products. Although direct use of pesticides on hemp products is regulated, occasionally, the plants are indirectly exposed to banned pesticides. An analytical method that includes pesticides and cannabinoids allows for simultaneous potency and safety analysis. This work was performed using a dual liquid-liquid and solid-phase extraction procedure and analyzed by high-performance liquid chromatography with tandem mass spectrometry. The method was validated according to the Association of Analytical Chemists (AOAC) single laboratory guidelines for six different cannabis processing matrices. The result of this work was the development of a simple, binary High-performance liquid chromatography-tandem mass spectrometry method to analyze 25 cannabinoids and eight pesticides in a single 14-minute injection. The method is quantifiable over two orders of magnitude (ng/mL). This method reports the highest number of cannabinoids and pesticides in a single analysis, thus present in the literature. The development of a simultaneous pesticide and cannabinoid method allows for faster potency and quality control testing of cannabis samples. The transferability of the method between sample types facilitates in-process quality verification with high specificity due to using tandem mass spectrometry as the detection system.

DISTRIBUTION OF CADMIUM AND OTHER HEAVY METALS AMONG PLANT PARTS OF LEADING CANADIAN INDUSTRIAL HEMP VARIETIES OF DIFFERENT USAGE TYPES

Jan Slaski

Relatively high levels of cadmium and other heavy metals occur naturally in Canadian soils with a significant component of regional variation. Heavy metals are also added to the soil due to anthropogenic activities. Soil pH, organic matter, and soil management factors greatly affect the bioavailability of heavy metals, including cadmium. Industrial hemp is known for its tolerance of elevated cadmium content in soils and for the ability to accumulate high levels of this toxic element in grain and other plant organs, often without apparent adverse effects on growth and yield. However, consuming foods or feeds containing high levels of cadmium may induce chronic toxicity. The study's objective was to identify and mitigate a risk that could severely impact the hemp grain industry and affect domestic consumption and exportability of Canadian hemp seed/food/feed products due to contamination of hemp grain with cadmium. The project was conducted over three growing seasons and involved a controlled environment study aimed at screening Canadian hemp germplasm to identify putative cadmium hyper-accumulators (Year 1), quantification of cadmium in the grain of Canadian hemp varieties tested in the National Hemp Variety Trials (Year 2), and quantification of cadmium levels in the grain of Canadian hemp varieties grown at commercial fields (Year 3). Cadmium and other metals in plant tissues and corresponding soil were analyzed using the Inductively Coupled Plasma (ICP) mass spectrometer. The greenhouse study revealed that low soil pH significantly enhanced cadmium uptake by the hemp plants. The uptake of cadmium was strongly correlated with cadmium concentrations in soil. While the roots were the primary organ accumulating between 50 and 70% of the absorbed metal, only 5 and 9% of total cadmium taken up by the plants was stored in the seeds. Grain collected from the leading varieties grown in the non-contaminated farm soils in distinct agro-climatic zones of the country exhibited a very low propensity of cadmium accumulation in the grain. None of the tested grain samples exceeded the proposed maximum acceptable contamination limit of cadmium (0.1 µg/g seeds) for international trade.

ABSTRACTS:
BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS

EFFECTS OF RELATIVE HUMIDITY ON THE DEVELOPMENT AND CANNABINOID PRODUCTION OF CANNABIS SATIVA L.

Ingrid Carolina Corredor Perilla, Sang-Hyuck Park

Cannabis cultivation is expanding for various purposes, including fiber, seed, and cannabinoid production. However, the effects of environmental factors, particularly relative humidity (RH), on cannabis growth and cannabinoid production are not fully understood. This study aimed to investigate the effects of RH on the Cherry Berry (CB) cultivar, which produces approximately 10% cannabidiol (CBD). Twenty hemp plants grew in a growth chamber, ten maintained at 37-58% RH and ten at 78-98% RH. Temperature, RH, and dewpoint were monitored throughout the experiment. Plant morphology, biomass, and cannabinoid production were evaluated across the cultivar development. Morphological measurements showed that high RH resulted in a significant increase in stem length (118.9cm±3.3) compared to low RH (116cm±2.3) ($P<0.0001$) at week 14. In contrast, low RH significantly increased trunk diameter (13.9mm±0.6) compared to high RH (10.5mm±0.6) ($P<0.0001$). Furthermore, with low RH the number of nodes was 43.5±0.6 compared to 33.8±2.3 high RH ($P< 0.0001$). The dry weight of the CB biomass exhibited a significant increase in low RH (78.8g±8.8) compared to the high RH (29.4g±3.4) ($P<0.0001$). The dry-flower biomass obtained a significant increment in low RH (33.8g± 2.3) compared to high RH (9.8g±2.3) ($P<0.0001$). To examine how RH affects cannabinoid production, we conducted cannabinoid analysis with dried flower samples from both RH conditions using High-Performance Liquid Chromatography. This analysis showed that the total amount of CBD and THC from high RH was 83.4%±0.6 and 5.8%±0.2, respectively, compared to the significantly higher amount of produced CBD (78.4%±4.1) and THC (3.4%±0.6) grown at low RH ($P<0.0001$). Total cannabinoid yield was estimated to reflect the impact of high RH in yield. CBD yield per plant appeared to increase by 563.8%±2.5 compared to the low RH of 532.8%± 26.9 ($P<0.0001$). This is the first study to examine the effect of RH on Cannabis growth and cannabinoid production. Our study demonstrated that HR affected plant structure, biomass, and metabolic production. These insights suggest that high RH negatively impacts biomass and cannabinoid yield.

EVALUATING NEW BIOSTIMULANTS IN CANNABIS PRODUCTION: A CASE STUDY WITH PINK-PIGMENTED FACULTATIVE METHYLOTROPHS (PPFMS)

Allison Jack, Jonathan Sprinkle, Allison Justice, CJ Schwartz, Anne Phillips

Pink Pigmented Facultative Methylotrophs (PPFMs) are alphaproteobacteria whose beneficial symbiotic associations with a wide range of crop plants have been well-documented in the scientific literature. To investigate the potential value of PPFMs as biological inputs to commercial cannabis production, we carried out three proof of concept field trials in CBD oil cannabis varieties. In 2020, trials were conducted by Sunrise Genetics in Greeley, CO, on five varieties. Cuttings were immersed in a PPFM bacterial suspension before wounded stems were dipped in synthetic rooting hormone, and then cuttings were stuck in transplant media. Rooted cuttings were assessed visually for rooting success. Plants were harvested, dried, and weighed individually for aboveground dry biomass. All three PPFMs tested significantly increased visible rooting when applied in addition to synthetic rooting hormone with a range of 10 to 18% increase (significant at $p < 0.05$ Mann Whitney U test, n = 10 plants per treatment, per variety over five varieties). All three isolates showed a trend of increased aboveground biomass with a range of 18 to 38% increase (one isolate significant at $p < 0.05$ Students t-test). The top performing isolate was tested again in 2021 and 2022 trials conducted by The Hemp Mine in Fair Play, SC, on their variety "Southern Belle" and "Janet's G" (2022 only). PPFMs were applied as a transplant liner dip to rooted cuttings on the day of transplanting to field soil. Plants were harvested, dried, and weighed individually, then processed to measure the biomass of shucked flowers. PPFM-treated plants showed a 15% and 16% increase in dry-shucked flower biomass for 2021 and 2022, respectively (trends reported for n = 30 plants per treatment in 2021 and 25 plants per treatment per variety in 2022). PPFMs can potentially add value to commercial cannabis production, both in their ability to enhance the rooting of vegetative cuttings and increase flower yield. Ongoing studies include PPFM impacts on rooting, growth rate, tissue nutrients, and oil quality.

FROM MANGO TO SKUNK - THE REMARKABLE DIVERSITY OF CANNABIS AROMA AND ODOR VOLATILES

Mark Lange Polito J.T., Lange I., Srividya N., Alt A.J.

Terpenes are partly responsible for the characteristic aroma of different cannabis cultivars. Short-chain aldehydes and esters form an additional class of volatiles with important aroma-related properties in cannabis. Furthermore, sulfur-containing volatiles impart garlicky or skunky smells. We will present protocols for the comprehensive identification and quantitation of terpenes, short-chain aldehydes, esters, and sulfur-containing volatiles. In addition, we will provide an overview of the genetics and biochemistry underlying terpene formation, including analyses of structure-function relationships for terpene synthases and the enzymes that catalyze the first committed step in the biosynthesis of these volatiles. The functions of all characterized terpene synthases across cannabis cultivars will be discussed. An analysis of the locations of genes coding for volatile-related terpene synthases in the chromosome-level assembly of the reference cultivar CBDRx will be provided. We demonstrate that some terpene synthases are highly specific, accepting only one precursor and generating mostly one signature product, whereas others are promiscuous and catalyze the formation of multiple products, in some cases from multiple substrates. By employing sequence comparisons and homology structural modeling, we inferred which amino acid residues are likely to constrain the available space in the active sites of cannabis terpene synthases, thereby contributing to the experimentally observed substrate binding selectivity. Key Conclusions: The analytical methods presented here allow, for the first time, the comprehensive analysis of all major aroma- and odor-related volatiles emitted by cannabis. Our structure-function analyses are laying the foundation for future studies to understand better the substrate and product specificity determinants in these fascinating enzymes.   The implications of our findings for the aroma and odor characteristics of cannabis cultivars and efforts to enhance volatile-related traits by breeding will be discussed.

GENETIC BASIS FOR HERMAPHRODITISM RESISTANCE

Alisha Holloway, Erica Bakker

Cannabis typically occurs as either female or male plants (dioecious) as determined by their sex chromosomes, XX for female and XY for male. Dioecious cannabis plants that are genetically female usually bear female flowers, although genetic makeup, environmental stressors, and application of growth hormones or certain chemicals can result in the production of male and/or hermaphroditic flowers on genetically female plants. For simplicity, we refer to both types as hermaphroditic. In the commercial production of cannabis flowers, female flowers are desired as they are the only flowers that produce appreciable quantities of valuable cannabinoids. Female plants bearing hermaphroditic flowers lead to the pollination of female flowers and subsequent seed production, which severely reduces the value of the crop. We sought to identify genetic loci responsible for sensitivity or resistance to the production of hermaphroditic flowers. A diverse set of 205 seed lots (n=1317) were genotyped using an Illumina bead array. Plants were grown in a greenhouse under standard growing conditions. Plants were inspected for the formation of hermaphroditic flowers. We then performed nested association mapping to identify SNPs associated with hermaphroditic flowers. Additionally, QTL mapping was performed with an F2 mapping population (n=294) derived from a cross between cannabis and a dioecious hemp variety which segregated for hermaphroditic and female flowering plants (n=clonal replicates per plant). A logistic regression was performed on a subset of the data for which an accession had either all replicates developing hermaphroditic flowers or none of the three replicates developing hermaphroditic flowers. We identified two major loci on the X chromosome that are strongly associated with the production of hermaphroditic flowers. We validated these results in 88 seed lots (n=1172 plants) that were not used for mapping. At both loci, genes near associated SNPs are involved in response to environmental stresses, such as light, heat, and drought. We deployed genetic markers in our breeding program to select plants that will be resistant to the production of hermaphroditic flowers.

INVESTIGATING INSECTICIDAL EFFECTS OF CANNABIGEROLIC ACID (CBGA) IN TOBACCO HORNWORM MANDUCA SEXTA
Chris Moody, Abigal Blanchard

Cannabis plants produce more than 120 cannabinoids within their glandular trichomes located on the flowers and leaves. Cannabigerolic acid (CBGA) is the precursor cannabinoid molecule that leads to the formation of tetrahydrocannabinolic acid (THCA), cannabidiolic acid (CBDA), and cannabichromenic acid (CBCA) through their respective synthases. Our previous study showed that high doses of cannabidiol (CBD) have insecticidal properties by interfering with the exoskeleton development of the tobacco hornworm Manduca sexta. This study aimed to investigate if CBGA has a similar defensive role. We used M. sexta as an insect model system and reared them on a wheat germ-based artificial diet (AD). The larvae were divided into five groups: control (AD), vehicle (AD+0.1% medium-chain triglyceride; MCT), and CBGA-treated (AD+0.1%MCT with CBGA ranging from 10uM, 100uM, and 500uM). We recorded the length and weight of the larvae in 2-3 day intervals to investigate the effect of CBGA on growth and development.

Our results showed that the highest CBGA treated group (500µM) had a significantly lower average weight (6.0g ±2.0) and length (6.53cm ±0.88cm) compared to averages of 8.89g and 7.78cm in the AD group, respectively (n=3, P<0.05). Significant differences in mortality rates were not observed, varying between AD (33.3%), 100µM (41.6%), and 500µM (33.3%) on day 19. Due to the contamination of fungus at the beginning of the experiment, groups only saw 4-5 subjects survive to the end. We also observed delayed pupation in the high CBGA-treated groups compared to the control group, which entered pupation at day 19. Our findings support the hypothesis that cannabinoids have insecticidal effects, as higher concentrations of CBGA were found to inhibit the development of M. sexta and prevent pupation in even the moderately dosed groups.

INVESTIGATING THE NUTRITIONAL DEFICIENCY RESPONSE OF CANNABIS SATIVA L. VAR. CHERRY WINE
Ian Noonan, Sang-Hyuck Park

Early diagnosis of nutrient imbalances in cannabis cultivation is crucial for maintaining optimal growth and successful cannabinoid production. The development of ideal nutrient solutions relies on balancing elemental composition, concentration, and interaction. Cannabis plants with prolonged exposure to insufficient nutrient solutions will develop physiological symptoms that indicate poor plant health and diminished yields. This study aimed to generate a better understanding of the manifestation of nutrient-deficient symptoms associated with Phosphorous, Boron, Molybdenum, and Manganese. This was accomplished by identifying and documenting early onset, intermediate and advanced symptoms of a specific nutrient deficiency. The study utilized hemp clones derived from mother plants of Cannabis sativa L. (cv, Cherry Wine) that produce approximately 10% cannabidiol (CBD). Selected clones were transferred to a hydroponic system utilizing Rockwool as the inert media. Plants were maintained in environments with a 65-85 degrees Fahrenheit temperature range, 20-55 degrees relative humidity, and 400 micromoles of light intensity. Working solutions maintained a nutrient concentration of 400 ppm and a pH range of 5.5-5.8. At week six, control plants have shown uniform healthy canopy development. The phosphorous deficiency group has begun to show symptoms of necrosis and yellowing throughout some leaves. Micronutrient deficiencies are not presenting any observable symptoms at week six. Our team anticipates being able to locate symptoms of micronutrient deficiencies as the study progresses. Upon the study's conclusion, cannabinoid analysis will be conducted using high-performance liquid chromatography (HPLC) to examine how each nutrient deficiency affects cannabinoid production. The team will correlate how single nutrient deficiencies affect changes in overall and/or specific cannabinoid content. Leaf tissue analysis will be conducted to confirm that the nutrient removed was present below the minimum required amount for growth. Our team anticipates providing data that will serve as a diagnostic tool for hemp farmers and researchers concerned with nutrient deficiencies in their cultivars.

ISOLATION OF NEOLIGNANS FROM CANNABIS SATIVA (L.)

Korey Brownstein, Grace Nieukirk, Karl E. Vermillion, Mark A. Berhow

The 2018 Farm Bill states that cultivars of Cannabis sativa (industrial hemp) are legal for industrial use if total tetrahydrocannabinol (THC) concentrations are less than 0.3%. Due to this legislation, hemp has found a wide range of uses, from animal feeds to paper production. Although cannabinoids are the most widely studied compounds in hemp, hemp produces numerous flavonoids as well. These phytochemicals may have uses in the functional food industry. Initial HPLC profiling of hemp samples revealed a set of unknown compounds. Most of these unknowns were later identified using chemical reference standards. For the remaining unknown compounds, we used techniques in liquid-liquid extraction and preparative HPLC to purify them. An Orbitrap mass spectrometry was used to accurately determine the molecular formulas and predict the structures of these compounds. This was followed up with NMR analysis to elucidate the structures fully. Our analyses revealed that these compounds had not been previously characterized in hemp.

MANIPULATING THE PLOIDY LEVEL FOR HEMP CULTIVAR DEVELOPMENT

Mohamed Elhiti, Mr. Dikan Gjuric

Mr. Marko Gjuric – Farmers Business Network Canada Inc." Over the past decade, there has been a growing interest in the production of phytocannabinoids from hemp. To meet this demand, farmers must engage in a labor-intensive and costly process of "roguing" the hemp males from the field. This is necessary to prevent a decrease in the concentration of phytocannabinoids in the plants when fertilized. It has been reported that triploid plants produce flowers that can be pollinated, yet the fertilization process does not seem to be effective and results in fruit without endosperm or embryos. Therefore, the development of triploid hemp varieties has become a priority of our focus. In this regard, seeds of an elite cultivar (S0) were treated with colchicine at different doses to different exposure times. Flowcytometry technology was employed to screen the S1 germinated seeds for ploidy level detection, and tetraploid (4N) plants were selected. Clonal propagation and STS-induced pollen for tetraploid hemp were used to carry out full-sib crosses and produce feminized tetraploid seeds (S2). Our observation indicated that approximately 60% of the S2 seed germinated and showed diploid levels among the tested population. This suggests that the tetraploid plants were still producing haploid gametes, likely due to the instability of the tetraploid. To increase the stability of polyploid plants, we intended to establish microspore culture in hemp. Our results showed that isolating early binucleate developmental stages of microspores and culturing them in MS basal salt medium fortified with 13% sucrose at a dilution of 2×104 cells/ml followed by stressing at 32 °C for 72 hours and transferring to room temperature in the dark for two weeks is an effective culture condition for the development of microspores to the heart stage. However, further studies are needed to develop the protocol for the successful cultivation of fully matured embryos from hemp microspores in culture.

MFDETECT TM, A NOVEL HIGH THROUGHPUT, LOW COST, AND RELIABLE DETECTION METHOD FOR HOP LATENT VIROID IN CANNABIS

Ajith Anand, VP of R&D, MyFloraDNA Inc.

Cannabis sativa L is susceptible to a wide range of viral, viroid, and fungal pathogens. Hop Latent Viroid (HLVd) is one of the most devastating diseases of cannabis that is associated with "dudding" or "duds" disease. The disease causes substantial economic losses in plant yield, vigor, and crop value. Plants infected with HLVd may remain asymptomatic for an extended period, allowing the disease's rapid spread through cannabis plants and grow facilities.

We describe a novel and reliable HLVd detection method, MFDetect™. MFDetect™ method combines high-throughput handling procedures, RT-LAMP, and quantitative real-time PCR to facilitate rapid, high-volume, and reliable diagnostics. We share the data from the most extensive research conducted on over 5000 independent plants, followed by the analysis of 600 plant samples comparing different tissue types (leaf, petiole, and stem) to identify the most suitable plant tissue for HLVd detection.

MORPHOMETRIC EVALUATION OF NINE NORTHERN FERAL HEMP (CANNABIS SATIVA) GERMPLASM IN ALABAMA

Xinhua Xiao, Blake Long, Jarius Whitehead, Tyler Gordon, Zachary Stansell, Xianyan Kuang, Ernst Cebert

Hemp (Cannabis sativa L., < 0.3% THC) has become an important emerging crop in the U.S. However, there is limited access to hemp genetic resources and a lack of genetic knowledge on priority traits. To this end, USDA-ARS Plant Genetic Resources Unit (PGRU; Geneva, NY) has initiated a national hemp germplasm collection effort to collect, conserve, evaluate, and distribute diverse hemp genetic resources and apply these efforts to breed adapted/improved cultivars. For newly-collected hemp germplasm, especially feral entries lacking prior genetic knowledge, extensive evaluation in various climate zones and soil types is required. As part of the collaborative efforts, we conduct morphometric phenotyping for novel hemp germplasm in northern Alabama. As a pilot study, in 2022, we evaluated nine northern feral hemp entries (8 collected from Iowa and one from New York) at Winfred-Thomas Agricultural Research Station (34.90° N, 86.56° W, Hazel Green, AL). For each entry, plant stands, sex ratio (female: male), plant architecture, biomass and grain yield, and post-harvest terminal sampling data were collected; stress in weed pressure, insect, and disease were also monitored. The field and post-harvest measurements showed that these entries exhibited significant variations in most traits. Specifically, the female: male ratio ranged from 0.74 to 2.0. Taking an average of 10 female plants for each entry, the dry mass of the primary branch had a range of 28.08-81.68 g per plant and the seed 6.46-33.11 g per plant. There exist significant variations in the canopy architecture (range of 1.33-2.05 m in plant height; 24.13-36.29 in the number of branches; 8.82-17.09 mm in stem diameter, 4.48-34.88 cm in trunk length; 57.20-97.80 cm in maximum canopy diameter). Additionally, dry biomass positively correlates with plant height, stem diameter, and canopy architecture parameters. The morphometric phenotypic data for the nine entries have been reviewed and deposited to the Germplasm Resources Information Network (GRIN-Global) and made publicly available. This pilot germplasm evaluation research provided a proof-of-concept test to evaluate a larger number of entries on our site and beyond.

NUTRIENT MANAGEMENT FOR OPTIMIZED PRODUCTION OF SECONDARY METABOLITES IN CANNABIS

Nirit Bernstein

Secondary metabolism in plants is known to be affected by environmental/cultivation conditions. We have recently demonstrated high sensitivity of the secondary metabolite profile in cannabis to various exogenous factors, including mineral nutrition. Therefore, knowledge of the cannabis plant's response to fertigation schemes is essential for the optimization of cultivation for the production of high-quality yield and for the development of plant products containing specific desirable phytochemical profiles. We studied the response of 'drug-type' medical cannabis plants to various micro and micronutrients in pot cultivation under controlled conditions. Our findings demonstrated the induction of changes to the cannabinoid and terpene profiles in cannabis by N, P, K, NH4/NO3 ratio, Mg, and Ca nutrition. For the primary macronutrients, N, P, and K, the required supply for optimal yield quantity differs from the nutritional conditions needed for optimizing yield chemical quality, and cannabinoid and terpenoid production is highest under restricted supply. For Mg, the response differs, and limited supply restricts the production of cannabinoids. The uptake rate of individual macronutrients changes between the vegetative and the reproductive developmental stages and along the reproductive phase. These findings highlight the potential of nutrient management to regulate secondary metabolism in cannabis and the need to standardize nutrient supply to optimize quality of the medical product.

OPTIMIZED LIGHTING STRATEGIES TO INCREASE YIELD AND CHEMICAL UNIFORMITY IN CANNABIS SATIVA

Justin Bohemen, Mark Lefsrud

Cannabinoid uniformity plays an important role in the quality and marketability of commercial cannabis. Energy consumption becomes a primary concern as lighting is one of the main input costs for controlled environment cannabis production systems accounting for approximately 60% of total costs. The objective of this study was to evaluate lighting strategies to maximize the yield and uniformity of cannabinoids throughout cannabis plants. A randomized complete block design with two factors (toplight type and use of interlighting) was used to determine differences between treatments. Four lighting treatments included HPS toplight, LED toplight, HPS toplight + interlight and LED toplight + interlight. Each treatment plot contained 11 plants (176 total) surrounded by polyethylene film to reduce light interference between treatments. Two cycles were completed with treatment randomization. Treatments without interlights had a reduction in total PPFD, which was a known limitation. No differences between treatments were observed in canopy temperatures and environmental parameters collected from data loggers (temperature and relative humidity). Plants grown under HPS lighting had an increase in plant height ($p<0.005$). LED treatments produced similar dry biomass quantities as HPS treatments ($p<0.107$). The addition of interlighting increased biomass produced in the lower canopy resulting in a significant increase in biomass produced per plant ($p<0.004$). When comparing light use efficiency, HPS lighting was more efficient at converting light into biomass production($p<0.002$). No significant differences were observed in secondary metabolite production for THC ($p<0.188$). Lower canopy THC values were increased with the use of interlighting during the second replicate of the experiment. CBG concentrations were significantly increased in LED treatments ($p<0.0001$). Major terpenes had no significant differences between treatments. This study looked at the added benefit from implementing interlighting and LED top lighting in indoor controlled environment cannabis production systems. LED toplight and interlight strategies show potential to compete with conventional HPS lighting strategies.

POTENTIAL ROLE OF MULCHES AND PLANTING TIME IN MANAGING SOUTHERN BLIGHT AND ENHANCING CANNABINOID PRODUCTION IN FLORAL HEMP IN TENNESSEE

Maddela Sai Suvidh, Sai Suvidh Maddela, Emmanuel Omondi, Margaret Mmbaga, Anand Kumar, Lucas Mackasmail

There has been a great resurgence in the cultivation of industrial hemp (Cannabis sativa L.) since its removal from the Schedule 1 list of controlled substances in the 2018 Farm Bill. Since industrial hemp [federally defined as having less than 0.3% total tetrahydro cannabidiol (THC)] has not been actively grown in the U.S. for about 80 years, knowledge needed to grow the crop has largely been lost, and there is very little peer-reviewed research on it. Some of the greatest challenges that hemp farmers face are pests and diseases, given that pesticides labeled for use in hemp are scarce to non-existent. One of the most challenging diseases affecting hemp in Tennessee is southern blight (Sclerotium rolfsii) favored by the hot and humid climatic conditions prevalent in southeastern states. Black plastic mulch is the most prevalent method used by vegetable and floral hemp growers to control weeds. However, plastic mulch exacerbates the high humidity and high temperature in which southern blight thrives. Straw mulch is known to reduce high soil temperatures and rainfall impacts, but its role in disease management has not been established. Neither has the role of time of planting. The objective of this study is to evaluate the effect of black plastic, straw mulch, and planting time on southern blight, weed density, cannabinoid production, and THC compliance.

PREDICTING TERPENE PROFILES IN CANNABIS THROUGH PCR-BASED ASSAYS FOR GENE FAMILY ANALYSIS

Christopher Pauli

Cannabis terpenes are highly diverse and complex compounds that contribute to the plant's aroma, flavor, and therapeutic effects. Over 70 genes have been identified in cannabis responsible for terpene biosynthesis. These highly similar genes have various alleles that can significantly alter the resulting terpene profile. In this study, we aimed to better understand the genetic basis of terpene production in cannabis. We designed PCR primers to target the entire gene family of terpene synthases, which includes over 70 genes. We analyzed the genetic variations of each gene and their potential impact on terpene profiles using high-resolution melting (HRM) and qPCR assays. Our analysis revealed a high degree of genetic similarity among the terpene synthase gene family in cannabis. Despite this, we identified genetic variations that can significantly impact the production of specific terpenes. Our approach provides a powerful tool for predicting terpene profiles in cannabis based on their genetic makeup. The genetic basis of terpene production in cannabis is highly complex and requires a detailed understanding of the entire gene family of terpene synthases. Our study provides valuable insights into the genetic variations that can significantly impact the production of specific terpenes in cannabis. This knowledge can be used to develop new cultivars with tailored terpene profiles for specific therapeutic and recreational applications. Trial Registration: This study did not involve a healthcare intervention on human participants and therefore was not registered in a clinical trial registry.

QUANTITATIVE TRAIT LOCI (QTL) MARKER DEVELOPMENT FOR SEED PROTEIN CONTENTS IN HEMP (CANNABIS SATIVA L.)

Mohamed Elhiti, Eddy Risseeuw, Dikan Gjuric, Masood Rizvi, Marko Gjuric

By shifting towards a more plant-based diet, we can reduce climate impact and promote healthier lifestyle choices. Hemp protein is highly nutritious and easily digestible, with an average protein content of 25% in dry seeds. It is found to contain all 9 essential amino acids and to have a high level of protein quality comparable to other high-quality proteins such as casein and soy. Hemp also has an especially high amount of arginine and glutamine that help to keep the body healthy and provide the building blocks for muscle growth. We quantified the total protein content of hemp seeds from our germplasm using the combustion method. To study the population structure, we employed Genotyping-by-Sequencing (GBS). To develop Quantitative Trait Loci (QTL) markers associated with higher protein content, we combined traditional breeding techniques, whole genome sequencing analysis, and Genome Wide Association Analysis (GWAS). Our results indicated that protein content in our germplasm ranged from 21.1% to 28.7%. The Admixture analysis of GBS data revealed that Delta K, the most likely number of clusters, is k = 3 with the potential of a 4th cluster. A Rogers genetic distance matrix was estimated from the multilocus marker data and hierarchical clustering using average distance, and the phylogenetic tree was subsequently developed. After assigning the parents, an F2 equivalent segregating population was created, and sequence data were used to develop a set of SNPs that could inform the four segregating haplotypes in the progeny. We identified two major QTL markers that could explain 36% of the variation in the phenotype. Kompetitive Allele-Specific PCR (KASP) markers were developed across the 15 highest Percentages of Variance Explained (PVE) markers to investigate the trait further. These markers were then validated for linkage to protein contents in a set of hemp-segregating populations. The KASP markers can now be effectively utilized in our hemp breeding programs to facilitate the introgression of the high protein trait into elite hemp germplasm.

ROAD BANK TO SEED BANK: REBUILDING THE US HEMP GERMPLASM COLLECTION
Shelby Ellison, Ademola Aina, Pawan Basnet, Jonathan P. Wenger, Joseph Smeenge, George D Weiblen

In the 1940s, there was a significant rise in U.S. hemp production to establish a domestic source of fiber for World War II, which resulted in many seeds escaping cultivation and establishing naturalized populations throughout the country. After 70+ generations of adaptation, these feralized materials occupy many ecological niches and may contain adaptive alleles for biotic and abiotic stress at higher frequency than cultivated materials. With the recent creation of the USDA Hemp Germplasm Repository, it is crucial that we recover and regenerates American hemp descended from the cultivars that researchers developed in the early 20th century but were unable to maintain. The goal of our project is to collect germplasm from these genetically diverse, naturalized populations to build our domestic seed bank. To achieve this goal, we have utilized a broad network of collaborators and citizen scientists to collect over 1,000 accessions across eight states. Collected accessions have been characterized for chemotype and cannabinoid content, with genetic diversity studies underway. Initial genotyping for chemotype has found a range of CBD: THC allele frequencies across populations, indicating the need for genetic characterization before redistribution to ensure compliancy. These materials will be added to the USDA Hemp Germplasm Repository and assist researchers with the characterization of genes, mining of beneficial alleles, and developing new cultivars.

TERPENE SYNTHASE GENE FAMILY VARIATION IN CANNABIS
Keith Allen, Anthony Torres, Reggie Gaudino

One of the distinguishing features of Cannabis is the variety and complexity of aromas, especially from flowers. Most odors in Cannabis come from ten carbon monoterpenes and 15 carbon sesquiterpenes, with dozens of molecules detectable in any given strain. Terpenes are produced by a large and diverse gene family in Cannabis (the TPS family), and there is ample evidence for the diversification of this family through old and relatively recent gene duplication events and gene loss events. The very high degree of sequence variation we see in this species already means that individual TPS genes vary enough from strain to strain that it can be difficult to be certain you're looking at the same gene. Meanwhile, there appears to be abundant presence-absence variation, meaning that the total number of TPS genes is variable from strain to strain. To complicate matters one step further, small sequence changes can be adequate to change the product profile of these enzymes. So while substantial progress has been made in characterizing Cannabis TPS enzymes, we may find it difficult to transfer this characterization from strain to strain. I will present results of our work comparing the composition of this family across different genome assemblies, along with some of our characterization work.

ABSTRACTS:
BIOLOGY, CHEMISTRY, PHYSIOLOGY, AND AGRONOMY OF CANNABIS

THE USDA ARS HEMP DESCRIPTOR AND PHENOTYPING HANDBOOK: A COOPERATIVE APPROACH TO STANDARDIZE HEMP PHENOTYPING

Zachary Stansell, Tyler Gordon, Anthony Barraco, Daniel Meyers

Hemp research is intensifying, and the current patchwork of national and international policies has restricted access and exchange of diverse hemp genetic resources, which hinders germplasm conservation, research, and breeding efforts. To address these constraints, the USDA National Plant Germplasm System has established a hemp genetic resource collection at the Plant Genetic Resources Unit in Geneva, NY, by collecting, conserving, evaluating, and distributing diverse hemp germplasm resources to domestic and international stakeholders. Collaborative public and private partnerships led by the Plant Genetic Resources Unit are gathering high-quality phenotypic data for online publication within the USDA-ARS information management system GRIN-Global (https://www.grin-global.org/). Recently, PGRU published a collaborative Hemp Descriptor and Phenotyping Handbook (https://www.ars.usda.gov/northeast-area/geneva-ny/plant-genetic-resources-unit-pgru/docs/hemp-descriptors/) as a freely distributed, web-based document to standardize data collection and aggregate useful, coherent, and consistent phenotyping protocols within the broader pool of hemp germplasm diversity. The primary goals of the handbook are to:
•	assist breeders and researchers in identifying accessions with specific traits to facilitate germplasm selection within hemp improvement programs;
•	identify gaps in existing hemp genetic resource collections, and help formulate strategies for future collection and conservation efforts;
•	designate and maintain a core collection of critical germplasm;
•	increase National Plant Germplasm System user utility and accessibility to hemp germplasm and associated data;
•	identify duplicate accessions and reduce costs of hemp genetic resource conservation. The framework, methods, and collaborative approach implemented to generate this resource and provide examples of its application in initiating this new public resource will be described.

THERMO-CHEMICAL DECARBOXYLATION KINETICS OF CANNABINOID ACIDS IN HEMP (CANNABIS SATIVA L.) BY PRESSURIZED LIQUID SYSTEM

Urvashi Urvashi, John Hatfield, Sang Hyuck Park, Chad A. Kinney, Joon-Hee Han, Kenneth J. Olejar

In December 2018, hemp (≤ 0.3% THC) was permitted as a crop under US Farm Bill, adding to the resource's availability. The public continues to support cannabis legalization for medical and recreational uses, with an increasing number of states now permitting its usage. Since only acidic cannabinoids are produced by the cannabis plant, the -COOH moiety must be removed to obtain the neutral form, thereby increasing its bioactivity. Decarboxylation is achieved by heating the plant material/extract, but cannabinoids' thermolability can lead to breakdown, evaporation, and/or conversion to undesirable metabolites. To avoid this, a thermo-chemical conversion of acidic cannabinoids during pressurized liquid extraction (PLE) of cannabinoids was reported by our group. PLE functions on the pseudo-closed system at high temperatures and pressure. Temperatures range from 40 to 200 °C, while pressure remains constant (11 MPa). Cannabidiol crystals (CBD) with a purity of > 90% were produced through extraction and purification. We, therefore, investigated the kinetics of hemp's thermo-chemical decarboxylation in the PLE system to determine the ideal reaction temperature and time. Triplicates at five different temperatures were observed at ten various time intervals. Results confirmed previous findings and revealed a pseudo-first-order reaction. The maximal neutral cannabinoid level was reached faster with increasing temperature. It can be noted that higher temperatures, such as 160°C and possibly 140°C, cause the reaction to be completed practically immediately. Rate constants close to zero have been observed upon examining the degradation products of neutral cannabis. As a result, a negligible influence was experienced through the degradation route. For the selected cannabinoids, the activation energies and Arrhenius constants were determined. The current investigation will enable scientists to pinpoint the ideal thermo-chemical decarboxylation circumstances for optimal cannabis conversion.

UNDERSTANDING THE ENVIRONMENTAL EFFECTS AND GENETIC CONTROL OF ANTHOCYANIN ACCUMULATION IN CANNABIS SATIVA

Sean Kim

This research aims to provide a comprehensive understanding of the environmental and genetic factors contributing to anthocyanin accumulation in Cannabis sativa, which will have implications for breeding and the production of cannabis-based products. Anthocyanins are responsible for the red, pink, purple and blue colors found in cannabis. These compounds benefit plant health by protecting them from environmental stresses such as UV radiation, extreme temperatures, and water stress. To investigate the role of anthocyanins in plants under stress we developed stable several day-neutral purple populations. We grew these populations under various cold treatments, without UV exposure, in replicate to see how temperature affects the expression of purple pigments in the floral tissue. Conversely, plants were grown in the greenhouse with UV exposure at room temperature to demonstrate the effect of UV exposure on anthocyanin accumulation. Anthocyanins were extracted from tissue samples and a high-throughput assay was developed to quantify the levels of anthocyanins via a microplate spectrophotometer. To better understand the genetic control of anthocyanin accumulation, a BC2F2 mapping population and an association panel were developed, phenotyped and genotyped to identify quantitative trait loci associated with the trait. By identifying the QTL associated with purple, blue, red and pink pigments in cannabis, breeders will be able to develop varieties more efficiently with techniques such as marker-assisted selection. Identifying what markers are associated with this trait will allow breeders to develop new varieties with higher concentrations of anthocyanins which could lead to plants being more resistant to disease and stress, as well as having enhanced medicinal properties.

USING ECO-SUSTAINABLE SEPARATION TECHNOLOGIES TO PRODUCE SAFE AND COMPLIANT EXTRACTS AND ISOLATES OF CANNABINOIDS

Gerard Rosse

IThe future of the hemp/cannabis industry and the safety of consumers are dependent on consistently producing regulation-compliant formulations of cannabis extracts and isolates. Chromatography is a powerful technique to isolate individual components from complex natural products extracts. Supercritical fluid chromatography (SFC) is a well establish separation technique extremely well suited for the separation of cannabinoids at research and industrial scale. The mobile phase used in SFC is mainly CO_2 which is a non-flammable, non-toxic, FDA approved substance. The workflow of hemp/cannabis sample processing from biomass drying to final product will be reviewed. The importance of SFC to deliver full spectrum extracts and separate high purity minor cannabinoid isolates at >99.7% purity will be exemplified. Recent application of SFC for terpenes separation will also be discussed. A newly developed and cost-efficient design combining both SFC and SFE in a single instrument to expedite the production of clinical grade ingredients will be examined. With operational costs 4-8 folds lower than over techniques and being an environmentally friendly process, SFC and SFE are essential components for successful scientific research and production at scale.

VALIDATION AND IDENTIFICATION OF MASCULINIZATION-RELATED GENES IN CANNABIS SATIVA BY RANDOM WALK WITH RESTART ON MULTIPLEX GENE TO PROTEIN-PROTEIN INTERACTION NETWORK

Leonardo Orozco, Christopher Pauli, Mia Librizzi, Rafael Guerrero, Nolan Kane

Dioecious drug-type Cannabis sativa varieties have highly plastic sex determination, resulting in both genetic and environmental control of male and female flower production. Cannabis cultivators seek to eliminate male and hermaphrodite cannabis plants to prevent unplanned pollination. The current genetic and morphological testing methods are valuable but ultimately unreliable. Herein, we employed RNA-sequencing to generate transcriptomic profiles of three cannabis sex-types: true female, true male, and induced hermaphroditic branches from female plants. A transcriptome was assembled using the cannabis "cs10" reference genome to generate subsequent bam files using STAR (Spliced Transcripts Alignment). FeatureCounts, an RNA-seq read quantifier software, incorporated the bam files to generate a matrix of counts with respect to genes identified in our transcripts. The R-package DESeq2 was used to identify highly differentially expressed genes, which were contextualized using Gene Ontology analysis. We constructed a multilayer gene network analysis of the biochemical pathways involved in cannabis masculinization hormone treatments. Pairwise comparisons of true males and masculinized female cannabis tissues identified differentially expressed genes relevant to comparative results of previous studies published on this matter. Overall, our study provides novel insight regarding the genetic regulation of sex determination in cannabis and has practical implications for cultivators seeking to produce consistent, high-quality crops of one true sex-type.

CANNABIS AND HEMP DEVELOPMENT IN INDIAN COUNTRY

David Gang, Doug Boon, Hunter Buffington

Many Native American tribes are keenly interested in the potential of Cannabis sativa in its various forms for economic development, while also being aware of challenges that face that development. This session includes several panel members, all of whom are members of tribes that are actively engaged in hemp or cannabis production, research and/or related economic development. They will share their experiences in establishing this new old crop by their tribes and lead a discussion on how researchers, industry members and policy makers can more effectively engage with tribes in their areas.

RELATIONSHIP BETWEEN NEW JERSEY CANNABIS DISPENSARY LOCATION AND RESIDENT SOCIO-ECONOMIC STATUS CHARACTERISTICS

Ben Halladay, Margaret Peterson

Background

As more cannabis dispensaries have emerged across the country, some have expressed that there may be disparities among the communities in which dispensaries are located. Different studies have varying results regarding this disparity. New Jersey has made efforts to combat the War on Drugs by incentivizing the placement of cannabis dispensaries in designated "impact zones (IZ)". These IZ were determined by factors such as population, crime index, marijuana-related arrests, and unemployment. The purpose of this study was to determine the distribution of NJ dispensaries with respect to low education, increased poverty, increased non-white populations, and the designated IZ.

Methods

The locations of all recreational and medical dispensaries in NJ as of June 15, 2023 were mapped using ArcGIS. Education, race, and economic indicators were retrieved from websites using census bureau data. In this study, counties were categorized into 4 percentiles for the characteristics of poverty, education, and non-white population. Chi-squared tests were performed on the 4 percentiles of each characteristic to test association between the characteristic and dispensary location and the p-values were set at 0.05. The distribution of dispensaries in counties with and without IZ was also determined.

Results/Discussion

There were 44 dispensaries in 21 counties in NJ. Fourteen dispensaries were medical and 30 were medical and/or recreational. There were 85 total impact zones in NJ, and 17 of them had dispensaries within them (20%). There was no statistically significant association between education level, poverty level, nor non-white population and location of dispensaries (all $p > 0.05$). The chi-squared for non-white population was 0.52 ($p = 0.91$), for poverty it was 0.21 ($p = 0.98$), and for education it was 2.29 ($p = 0.51$).

Conclusions

The results show that there is no disproportionate distribution of cannabis dispensaries among the NJ counties with high poverty, low education and high non-white populations. The majority of impact zones within New Jersey do not have dispensaries in them.

THE ECONOMIC IMPACT OF CANNABIS WITH SEVERAL STATES AND NATIONS

Orland Yee

Cannabis has been a controversial topic for many years, mainly due to its classification as a Schedule I drug by the federal government in the United States. However, in recent years, public opinion towards the legalization of cannabis has shifted, leading several states and nations to legalize it for both medical and recreational use.This speech will examine the economic impact of cannabis in several states and nations that have legalized it. We will gather data on tax revenue, job creation, and tourism from government reports and academic studies. The legalization of cannabis has had a significant impact on the economy of states and nations that have legalized it. Tax revenue generated from the cannabis industry has been substantial. For example, Colorado has generated over $1 billion in tax revenue since legalizing recreational cannabis in 2014. The industry has also created jobs, with California employing over 67,000 people in the cannabis industry in 2019. Furthermore, legalizing cannabis has attracted tourists to some areas, such as Las Vegas, which reported over 40 million visitors in 2019, many of whom were drawn by the legal cannabis industry. However, implementing cannabis policies has not been without challenges. One of the most significant challenges is the conflict between state and federal laws. Despite states legalizing cannabis, it remains illegal at the federal level, creating uncertainty for businesses in the industry. Additionally, concerns about the impact of cannabis on public health and safety, particularly in areas such as driving under the influence, have been raised. In conclusion, the legalization of cannabis has had a significant economic impact on the states and nations that have legalized it. Tax revenue, job creation, and tourism have all seen significant growth. However, challenges remain, such as navigating the conflict between state and federal laws and ensuring public health and safety. By learning from the experiences of those that have already legalized cannabis, other states and nations can maximize the benefits of the industry while minimizing potential risks.

CANNABIS EDUCATION AT WHAT LEVEL? ENROLLMENT AND DEMOGRAPHIC DATA ACROSS CANNABIS DEGREE PROGRAMS AT THE COMMUNITY COLLEGE OF DENVER

John Frost

In the Fall of 2021 the Community College of Denver (CCD) launched an Associate of Applied Science (AAS) in Cannabis Business, and announced the creation of a Bachelors of Applied Science (BAS) in Cannabis Science and Operations and a non-degree program in partnership with Green Flower. As a member of the Colorado Community College System and a designated Hispanic Serving Institution with more than 50% of it's student's identifying as under-represented, CCD is ideally positioned to support a diverse student population enter the cannabis industry quickly to meet the industry's need for a skilled and diverse workforce. In this presentation, we will introduce the three unique cannabis programs at CCD and discuss disaggregated student enrollment and retention data to identify student demand for cannabis education at these three distinct levels.

CREATING AND CLOSING A CANNABIS SCHOOL IN OHIO AND MICHIGAN: THE LEAF MEDIC STORY

Karen Korn

Cannabis education is a necessary component of the cannabis industry to protect patients from harm (Haug, et al, 2016). Cancer patients, whose lives are tenuously managed by treatment teams, seek advice on medication use from staff in the cannabis dispensary landscape (Braun, et al, 2022). The US states that maintain medical cannabis programs have inconsistent educational requirements for employees that vend cannabis medicine. Some states have mandatory education, while others maintain minimal training requirements. Dispensary employee understandings of what is important to know as a budtender vary widely, as knowledge requirements are inconsistent (Carlini, et al, 2022). To satisfy state-mandated training requirements in Ohio, Dr. Karen Korn created Leaf Medic, a licensed cannabis school, in 2018. In 2019, she and Cathleen Graham, RN, BSN, CHPN created a similar program to serve Michigan. Leaf Medic educates dispensary personnel on cannabis science, compliance, and other aspects of dispensary work. Leaf Medic serves adjacent states that have very different regulatory programs. Ohio has mandated education for dispensary employees in their (2016) medical cannabis program, while Michigan has very little to no mandatory training for their medical (2008) and adult use (2018) programs. This study is a first-hand account of the creation and closing of a cannabis school in Ohio and Michigan. It provides a qualitative vignette and analysis of the educational landscape in the contemporary cannabis industry. Dr. Korn and Ms. Graham describe their journey in soliciting state-agency support for their programs, consumer buy-in, and then ultimately converting this asynchronous online curriculum to a business-to-business training program. They discuss who needs good cannabis education, deliberate the challenges in providing education in Ohio and Michigan, and the relationship between formal educational programming, cannabis state programs, and third-party providers. This presentation addresses the domain of formal education within the cannabis industry questioning where such education should be housed, who should oversee it, who should pay for it to be undertaken, and by whom.

ESTABLISHING A CANNABIS CORE: CASH POSITIVE, SUSTAINABLE, TRANSFORMATIVE CANNABIS EDUCATION FOR POST-SECONDARY INSTITUTIONS

Melissa Ausbrooks

Although new in most states, the cannabis market should hardly be considered "emerging." The size and power of the underground market was highly underestimated, disrupting both competitive and complimentary markets. Market analysts currently value the U.S. cannabis market at $13.2 billion with expectations of a 14.2% compound annual growth rate from 2023 to 2030. Intersection with large markets such as food, beverage, cosmetic, and pharmaceutical, drive growth significantly, alongside increasing legalization. Consumer and industry educational options simply cannot keep pace. Patients, for example, often have substantially more information regarding the practical applications of medical cannabis than their physicians, simply through their own grassroots education. They may also understand the endocannabinoid system, cannabinoid mechanic of action, onset and duration of action, and variability by delivery options, which are the underpinnings of therapeutical practice, for which their physicians lack exposure entirely. Most all intersecting markets have similar constraints and it is the responsibility of the academy to address these knowledge gaps. This creates unique opportunities and challenges for postsecondary institutions. Cannabis education is attractive especially for those struggling with waning budgets since these programs can often be cash positive from inception and long-term stabilization is not difficult with strategic planning. However, finding quality faculty and ensuring adequate and sound scope and sequence of curriculum is challenging, especially considering there will be a segment of the student population with robust content knowledge unfamiliar to the professorate. Further, accreditation is complex without content standards and instructors without standard academic credentials. Institutional reputation, donor funding across campus

PROBLEMS AND CHALLENGES IN CANNABIS EDUCATION IN ILLINOIS AND BEYOND

Steve Fix

This presentation will discuss ongoing challenges facing cannabis educators. Since Oakton College started Illinois's first college-credit cannabis curriculum and certificates in August 2019, the cannabis landscape in the state has changed dramatically. I discuss the role of educational institutions in supporting cannabis social equity in the context of several developments in the recent history of Illinois cannabis, including the initial adult-use licensing and regulatory scheme, Covid-19-related disruptions, delays and revisions to licensing policies, and the awarding of and delayed opening of craft-grow and other licenses. Additionally, I discuss broader problems facing all educators and institutions and their implications for cannabis education. These include serving diverse learners/universal design, addressing post-pandemic inequity in education, the looming enrollment cliff, broad patterns of post-pandemic educational change, and increased use and mainstreaming of large language model-based AI tools.

USING ACTIVE LEARNING AND EVIDENCE BASED AGRICULTURAL PRACTICES TO TEACH CANNABIS CULTIVATION PRACTICES AT RUTGERS UNIVERSITY

Connie Pascal, Thomas Gianfagna, Vanessa Williams

As a recipient of $872.8 million in federal research funds, Rutgers University has been cautious in offering cannabis educational and / or research opportunities. Now that New Jersey has a rapidly growing legal cannabis industry there is a demand for educated professionals and researchers in cannabis cultivation and post-harvest processing. To address this need, Rutgers has begun to develop courses and programs on controlled environment cultivation and post-harvest processing of cannabis. However, traditional teaching methods do not fully prepare students for the practical cultivation skills the cannabis industry demands and does little to provide students with the information literacy skills they need to be successful in the cannabis industry. This session showcases how Rutgers professors and instructors use active learning and group participatory instructional design techniques and technology to teach the commercial cultivation of cannabis in controlled environments. Instructional design, information literacy, qualitative research skills, active learning, and group participatory techniques Results show several promising benefits that merit further use and refinement including: 1) incorporating both plant-touching and active learning techniques enhanced student engagement by increasing their critical thinking, information literacy, technology, and hands-on cultivation skills; 2) offering cannabis cultivation curriculum inspired students to gain knowledge about sustainable agricultural practices and environmental stewardship for all types of food production in greenhouses; and 3) hands-on cannabis cultivation education helped students find internships. Consequences include having to navigate legal and regulatory barriers and facing resistance from faculty members and students opposed to cannabis education and research. The challenges of teaching cannabis cultivation are developing effective teaching strategies and curricula that address the unique needs of the cannabis industry including training more qualified instructors with expertise in cannabis cultivation and related fields.

ABSTRACTS:
FEATURED SPEAKER

INVESTIGATING THE DIFFERENCE IN MICROBIAL TEST RESULTS BETWEEN QPCR AND MICROARRAY TECHNOLOGIES

Tyler Secor

Microbial contamination is the leading cause of test failures in cannabis compliance. The two most common microbial testing methods are plating and qPCR. Both require up to a 72-hour incubation period; and qPCR can result in false positives due to late amplification of acellular DNA from dead organisms. An alternative technology, DNA microarrays, provides a faster, more accurate, more reliable method; but requires more rigorous hands-on time during sample preparation. This microarray technology preferentially amplifies DNA from living organisms, has triplicate results for each sample, and eliminates any need for incubation, which provides the ability to obtain results in under 8 hours. These advantages cost marginally more than qPCR. This study analyzes samples from matrices that underwent microbial testing at Reassure from June 20, 2022, to April 26, 2023 (N=3068). We compared Group A qPCR data (n=1738, pass=1517, fail=221, mean pass rate of 84.7%) to Group B microarray data (n=1330, pass=1280, fail=50, mean pass rate of 95.7%). A Welch two sample t-test was performed to examine the relation between the microbiology platform utilized and the average rate of a passing test result. The alternative hypothesis was approved showing a true difference in mean pass rate between group A and group B is not equal to 0; (t = -10.164, df = 2435.6, p-value < 2.2e-16). This study then specifically analyzed samples that underwent microbial testing for Aspergillus, spp., Salmonella and STEC (removing samples that only underwent Total Yeast and Mold testing). We compared Group A qPCR data (n=1524, Pass=1384, Fail=140, mean pass rate of 90.8%) to Group B microarray data (n=1306, Pass=1303, Fail=3, mean pass rate of 99.8%) A Welch two sample t-test was performed to examine the relation between the microbiology platform utilized and the average rate of a passing test result. The alternative hypothesis was approved showing a true difference in means between group A and group B is not equal to 0; (t = -12.031, df = 1457.1, p-value < 2.2e-16). Results suggest the microarray platform is more accurate and operationally flexible than qPCR. The largest obstacles are the complexity of sample preparation and the initial investment.

ANAEROBIC FERMENTATION OF DIETARY HEMPSEED BY A MOUSE FECAL SLURRY GENERATES HEALTH-BENEFICIAL SHORT CHAIN FATTY ACIDS

Annette Gabaldon

The seed of industrial hemp (Cannabis sativa L.) has rich nutritional value and is increasingly being used as a dietary supplement in human and agricultural animal feeds. Hempseeds contain high-quality proteins that are easy to digest and polyunsaturated lipids with balanced fatty acid profiles, in addition to phytochemicals like tocopherols that protect against oxidation. Food processing techniques that utilize microbial fermentation can yield novel compounds that confer health benefits on the host. For example, lactic acid helps maintain the colon pH while short chain fatty acids (SCFAs) provide fuel for colonocytes and protect against colon cancer. However, few studies have investigated hempseed fermentation. Previously we found that semi-anaerobic fermentation of hempseed as a single substrate supported growth of two Lactobacillus strains (L. plantarum and L. fermentum). Here, we hypothesized that strict anaerobic fermentation of hempseed using a mouse fecal microbiome as the inoculum to ensure microbial diversity would generate high yields of SCFAs. To test this hypothesis, whole hempseed (HS) was ground and added to a basal media at concentrations of 5% HS and 10% HS (w:v). A batch culture system was developed where 100 mL bottles were fitted with a vented cap and pH sensor and incubated for 48 hrs at 37 C after inoculation. Preliminary results indicate a significant decrease in media pH by 0.36 ± 0.13 units ($p<0.05$) for fermentation of 10% HS, indicating the presence of acidic metabolites. Fermentation of 10% HS yielded relatively low concentrations of total lactic acid (<100 ug/mL), but high concentrations of SCFAs. Specifically (ug/mL): total SCFAs (6013.3 ± 319.8); butyric acid (1759.7 ± 433.7); propionic acid (1734.3 ± 238.4); and acetic acid (2256.0 ± 428.2). All values were significantly higher ($p<0.05$, One-way ANOVA) compared to control media that lacked hempseed (e.g., total SCFAs = 281.5 ± 18.2). We also performed microbiome analyses of the media and confirmed the presence of bacterial groups capable of synthesizing SCFAs. In conclusion, we demonstrated for the first time hempseed fermentation metabolites SCFAs, and notably butyrate.

ANTIMICROBIAL EFFECT OF NANOFIBERS LOADED WITH HEMP (CANNABIS SATIVA SP) EXTRACT

Aaron Dudley

Hemp (Cannabis sativa sp) is a medicinal plant that contains bioactive compounds with antimicrobial properties, the incorporation of Hemp extracts into a nanofibrous film as an active food packaging solution has yet to be widely examined. This study used electrospinning technique to prepare Polyvinyl alcohol/hemp extract nanofibrous films. The objectives of the present study were to fabricate an active nanofibrous film and evaluate its antibacterial effect on the selected foodborne pathogens. In this study, Hemp inflorescences grown at the Alabama A&M University, Winfred Thomas Research Station (Hazel Green, AL; N 34.9025-W 86.5596) were used. Polyvinyl alcohol solutions containing various concentrations of Hemp extract were electrospun with a Fluidnatek Electrospinner. The morphological characteristics of the electrospun nanofibers were characterized with scanning electron microscopy , and the in vitro and in situ antimicrobial activity were evaluated. Antibacterial activity against cocktails of enteric pathogens Listeria monocytogenes (LM) and Salmonella enterica (SE) was evaluated. All treatments were analyzed in triplicate and all statistical significance were tested at 5%. SEM images of Hemp loaded nanofibers showed uniform morphology, beadles, and smooth fibers, confirming successful incorporation of hemp extract into the nanofiber matrix and ranged in diameter from 317 ± 38.12nm (2a3) to 558.62 ± 48.72nm (2a2). The number LM in the control group was 10.72 Log CFU/mL at 37°C, while the number of LM in Hemp nanofibers decreased 8.87 Log CFU/mL after 48 h. In situ evaluation of nanofibers after four-day observation stored at 4°C and 25°C showed that the Hemp nanofibers were bacteriostatic against SE. The results suggest that packaging raw poultry in Hemp nanofibers could help improve the raw storage shelf-life of poultry meat. Therefore, Hemp-loaded nanofiber will be a good candidate for food supply chain safety.

ASSESSING THE ADAPTIVE ROLE OF CANNABINOIDS IN HERBIVORE DEFENSE IN HEMP

Jacob MacWilliams, Erika Peirce, William Jacob Pitt, Melissa Schreiner, Punya Nachappa

Plants protect themselves from threats with a multitude of toxic secondary metabolites. In response, insects are always ready to develop counter-adaptations to these metabolites. Though our understanding of plant-herbivore interactions has steadily increased, there is a lack of information on the most publicized, "new" crop, hemp (Cannabis sativa). In the United States, hemp is a multifunctional plant grown for a diversity uses, including the production of secondary metabolites known as cannabinoids. The long absence of production and research has left huge knowledge gaps in hemp – herbivore interactions including hemp responses to a key pest, cannabis aphid (Phorodon cannabis). From other studied plant – aphid interactions it is known that aphid infestation impacts plant responses and signaling pathways. To investigate the effect cannabinoids have on cannabis aphids, aphid performance was studied on high- and low-cannabinoid lines. Aphids performed better and preferred the low cannabinoid line compared to the high cannabinoid line. Tissue collection and mass spectrometry analysis of high and low cannabinoid lines identified differences in cannabinoids and in phytohormones. Aphid infestation did not have an impact on cannabinoid levels, but multiple cannabinoids were identified to be significantly different between the two lines. Aphids feeding on artificial diets supplemented with CBD had increased fecundity in early timepoints compared to aphids feeding on artificial diet alone, indicating a role in hemp – aphid interactions. Aphid infested plants did have an impact on phytohormones and led to an increase in salicylic acid, jasmonic acid, and abscisic acid levels in high-cannabinoid hemp. Taken together, our results suggest that cannabinoids and plant defense signaling pathways are involved in hemp-cannabis aphid interaction.

BIOLOGY AND MANAGEMENT OF THE HEMP RUSSET MITE (ACULOPS CANNABICOLA)

Olivia Carter, Chris Hayes, Jacob MacWilliams, Punya Nachappa

Hemp (Cannabis sativa), is quickly becoming a crop of agricultural importance worldwide. The growth of this industry has exposed hemp to more threats including several pests. Among the most serious pests of this crop is the hemp russet mite (HRM) (Aculops cannabicola), a microscopic arthropod that feeds on the leaves, stems, and petioles of developing hemp plants. Due to its minute size, HRM can go unrecognized until population numbers are so large that they have already damaged crops, and their economic impact is likely underestimated. The difficulty in eradicating this pest warrants further study into its biology and proper management. To assess the impact of CBD on HRM biology, HRM performance was evaluated on both fiber/grain and cannabidiol (CBD) varieties of hemp. Mite performance was reduced on the CBD variety of hemp compared to the fiber/grain variety in detached leaf assays. However, no differences between mites reared on an artificial high-CBD diet, suggesting the role of other cannabinoids in mite performance. Management of HRM was evaluated using sulfur treatments in field trials, and using hot water immersions with and without surfactants on hemp cuttings. Both treatments were shown to significantly reduce HRM populations with 98% suppression in plants receiving dual sulfur applications in the field and a 75% reduction of HRM population with a 15 minute 109°F hot water immersion. This research will provide hemp producers with a better understanding of this pest and approaches to properly manage HRM at various stages of hemp production.

CAN YOU RESIST ME? SCREENING HEMP LINES FOR RESISTANCE TO EMERGING VIRUSES AND VIROIDS UTILIZING THE HEMP VIROME

Laine Hackenburg, Jinlong Han, Marylee L. Kapuscinski, Mark Stenglein, Punya Nachappa

Cannabis has been an emerging industry worldwide within the past decade with a global market valued at 4.71 billion USD for hemp alone, yet the diversity and distribution of associated pathogens have yet to be adequately studied. As production increases and the crop diversifies, the emergence and spread of these pathogens are imminent. The goal of this study is to describe the diversity and distribution of viruses/viroids infecting hemp in Colorado to help prevent crop loss due to diseases. In this study, four major hemp-producing regions in Colorado were analyzed. Tissue samples were collected from two cultivars of hemp from each farm visited in these regions at three timepoints throughout the growing season. These samples were submitted for Next Generation Sequencing and upon bioinformatic analysis, candidate virus/viroid sequences were validated. With metagenomic data from previous work, 26 different lines of hemp were screened for resistance via qPCR to the top 2 predominant viruses/viroids found in the hemp virome, beet curly top virus and hop latent viroid. These 26 lines are genetically diverse which will facilitate the discovery of candidate genes involved in virus resistance. In the 2021 virome, thus far we have identified the presence of alfalfa mosaic virus, beet curly top virus, cannabis cryptic virus, among others in our samples. The beet curly top resistance screening has shown varying viral loads between lines with a significant difference in viral load between two of the lines screened, however further statistical analysis is necessary. This work aims to further integrated pest management strategies in the hemp industry to promote sustainable agriculture.

CANNABIS USE EFFECTS ON REACTION TIME IN DAILY VERSUS OCCASIONAL RECREATIONAL USERS

Alexis Krause, Samantha Bothwell, Julia Wrobel, Tim Brown, Sarah Limbacher, Ashley Brooks-Russell

Cannabis is used medically to ease symptoms caused by certain chronic conditions, but also used recreationally due to its psychoactive properties that produce feelings of euphoria. With expanded legalization, the number of people who use cannabis for recreational and medical purposes continues to rise, along with the number of people who drive following cannabis use. This may increase the risk of fatal crashes, which makes uncovering the neurocognitive effects of cannabis a priority for public health and safe driving. This study examines the effect of acute cannabis use on reaction time, and directly compares reaction time in people who use occasional versus daily, to understand the potential effect of tolerance. A total of (n=30) adults (21-55 years old) participated in a within-subjects design where reaction time was assessed, using an iPad-based assessment (CARETM by Impirica), before and after acute cannabis use. Ten participants used cannabis occasionally and smoked flower, while 20 participants used cannabis daily; 10 smoked flower, and 10 inhaled concentrates (e.g., vaped or dabbed). Participants completed the reaction time assessment task before cannabis use, as well as three times after use. Blood samples were also taken before and multiple times following cannabis use. The effect of smoking cannabis on reaction time was assessed. The analysis modeled the effect of time since smoking on reaction time using generalized additive models (GAMS). Models indicated a non-linear effect of smoking on reaction times. The change in reaction times from before to after acute cannabis use did not significantly differ between participants who used cannabis daily vs. occasionally. Both groups experienced significant declines in reaction time approximately 25 to 45 minutes after use. Identifying the period of peak impairment can improve public safety messaging around when it is most dangerous to drive after using cannabis.

CHANGING THE WORLD NATURALLY
Sergiy Kovalenkov

BLANK

CHARACTERIZING THE CANNABIS-EXERCISE RELATIONSHIP: PRELIMINARY RESULTS OF A DAILY DIARY STUDY
Vanessa Stallsmith, Hollis Karoly

Despite the "lazy stoner" stereotype, recent research has shown that frequent cannabis users actually engage in more physical activity than their non-using counterparts. However, these studies have largely been cross-sectional, and lack temporal data about the type, context, and reason to pair cannabis with exercise. Here, we report preliminary data from our ongoing naturalistic study focused on longitudinal behaviors and experiences of legal-market cannabis users who exercise. As legalization and public acceptance of cannabis grows, it is important to characterize the link between cannabis use and health behaviors, such as exercise. Preliminary data collection has recently gotten underway. This study relies on completely virtual data collection via a baseline survey, which measures substance use, cannabis use motivations, exercise motivations, and trait-level affect. Afterwards, participants are asked to complete online daily-diary surveys for the next 14 days, which capture mood, substance use, exercise patterns, temporal overlap between the two, and motivations to exercise and use cannabis. Frequent cannabis users who currently exercise at least 150 minutes each week (13 females/16 males; mean age 30.27 years) were recruited. On average, individuals completed daily-diaries on 10.88 out of 14 possible days. On average, participants used cannabis on 81% of the days they completed daily-diaries and exercised on 63% of the days they completed daily-diaries. On days which participants used both cannabis and exercised, 32.89% of the time they endorsed exercising while under the influence of cannabis or experiencing effects from using cannabis earlier in the day. The most commonly reported reason for pairing cannabis with exercise was "to help me focus/concentrate" followed closely by "it keeps me in the zone" and "enhances body awareness." A majority of our sample endorsed that they both enjoyed and met their goals in their workout. These preliminary results have expanded on prior studies and help to characterize longitudinal cannabis use and co-occurring exercise behaviors. In addition, findings point to specific motivations for combining cannabis and exercise.

COMPARING MOTIVATIONS FOR CANNABIS USE ACROSS CANNABIS USERS WHO HAVE AND HAVE NOT RECENTLY USED PSILOCYBIN

Madeline Stanger, Carillon Skrzynski, Angela Bryan

In Colorado, cannabis use prevalence has increased since legalization in 2014. With recent legislation changes, hallucinogens like psilocybin are similarly being used more commonly, with individuals potentially using both substances simultaneously (i.e., within the same time period) and/or concurrently (i.e., within the same timepoint). Subsequently, public health concerns regarding negative outcomes of combined cannabis and psilocybin use have developed. One pertinent area for research is exploring why people engage in these substances as motivations precede use, and certain motivations (e.g., use for coping purposes) are associated with greater use and negative consequences. Previous research suggests psilocybin is commonly used to alter ones' perceptions, whereas cannabis motivations are more related to enjoyment or relaxation. However, motivations for both overlap with reports of each being used for coping purposes. If individuals who use both substances are more likely to use for coping purposes than those who only use one or the other, this may help identify those at greatest risk for increased use and problems. Using data from a larger observational study on cannabis and metabolic processes, we compared regular cannabis users (use ≥7 times/month; N=97, 35.1% female, 89.7% white) who used psilocybin in the past 3 months (N=34) to those who had not (N=63) on endorsement of 12 different cannabis motives from the Comprehensive Marijuana Motives Questionnaire. A multivariate analysis of variance demonstrated that endorsement for most motives, including coping, was not different across groups (ps>0.21). However, there were differences for enjoyment ($F(1,91)=4.31$, $p=0.04$), boredom ($F(1,91)=9.10$, $p<0.01$) and availability ($F(1,91)=9.46$, $p<0.01$); recent psilocybin users reported greater endorsement (Ms=4.47, 2.86, and 2.60; SDs=0.76, 1.10 and 1.05, respectively) compared to those who had not used recently (Ms=4.12, 2.13, and 1.99, SDs=0.78, 1.05, and 0.87, respectively). While coping motives did not differ between groups, these results do indicate motives differ depending on psilocybin use and could aid in intervention and prevention efforts.

DVORCHAK L. PROPHYLACTIC USE OF CBD PRESERVES HINDLIMB SENSORIMOTOR REFLEXES IN FEMALE RATS SUBJECTED TO MILD TRAUMATIC BRAIN INJURY (2022)

Lauren Dvorchak, Bruce Bethke

A concussion is a mild traumatic brain injury that causes loss of memory, motor function, and potentially neurodegeneration. This study examined the potential of cannabidiol (CBD) to serve as a neuroprotective agent when administered prior to a concussive injury. It was hypothesized that an intraperitoneal injection of CBD would provide neuroprotective effects in rats subject to a mild traumatic brain injury as evidenced by reduced post-concussive symptomology in sensorimotor reflex, and balance tests. Further, it was expected that CBD treated animals would exhibit a decrease in phosphorylated tau protein oligomerization relative to animals not treated with CBD. While analysis of tau protein oligomerization in brain tissue was indeterminate; results of sensorimotor testing showed that administration of CBD prior to mild traumatic brain injury provided a statistically significant protection from deficits in hind limb grasping reflexes observed in rats not treated with CBD prior to concussive impact.

EFFECT OF HEMP (CANNABIS SATIVA) SUPPLEMENTATION ON VITAL AND BEHAVIORAL RESPONSES OF WEANED BEEF CATTLE

Monya Simpson, Gamal Eden Abdelrahim, Josh Herring, Martha Verghese, Felix Samuel, Nathaniel Ogunkunle, Kendra Jones, Ernst Cebert, Xiunag Kuan

Weaning induces stress to both cows and calves and hence, reduces growth performance and behavioral characteristics. The objective of this study is to evaluate the effect of industrial hemp supplementation on the vital and behavioral parameters on calves. Twelve (12) apparently healthy calves, with average body weight of 600 lb and ages 6 months were used for this studies. These calves were randomly divided into four (4) groups of three calves per each and hemp was supplemented. Group 1 (20/200mg normal concentrate for 4 weeks, CC), group 2 (14 days feeding normal concentrate pre-weaning and 14 days of feeding 20/200mg industrial hemp CH), group 3 (14 days of industrial hemp supplementation pre-weaning and 14 days of normal concentrate HC) and group 4 (4 weeks of hemp supplemented feed). Vital and behavioral parameters were measured once a week, for two weeks pre-weaning and two weeks post-weaning. Temperature was measured using thermometer, pulse rate was measured using stethoscope and respiratory rate by costo-abdominal movement. The chute score, exit score and vocalization were observed scored and recorded. The rectal temperature significantly decreased from week 1 to week 2 and thereafter increased significantly but where higher in the hemp supplemented groups. The respiratory rate significantly decreased in all the groups from week 1 to week two and there after increased significantly in all the groups but lowest in the (HH and HC) hemp supplemented groups. The heart rate also increased steadily across the hemp supplemented group with the normal range. The chute score elaborated a higher percentage of calmness, higher percentage of walking proportion and higher percentage of non-vocalizers in the hemp supplemented groups compared to the non-hemp supplemented group. It was concluded that hemp supplementation at pre and post weaning could improve the thermoregulation, respiratory efficiency and cardiac function as well as improving the behavior of the calves at weaning.

EFFECT OF INDUSTRIAL HEMP (CANNABIS SATIVA) ON RUMINATION BEHAVIOR PARAMETERS OF ANGUS CATTLE

Nathaniel Ogunkunle, Felix Samuel, Monya Simpson, Kendra Jones, Gamal Eden AbdelRahim, Xianyan Kuang, Judith Boateng

Rumination is an important behavior in cattle, maintenance of optimum rumen environment is critical to the performance and wellbeing of ruminant animals. The objective of this study was to determine the effect of industrial hemp supplementation on rumination behavior parameters of Angus cattle. Twenty black Angus heifers were completely randomized into either control (CON: n=10, receiving commercial concentrates) or hemp (HEMP: n=10, receiving 30g of hemp in 200g of commercial concentrate) in a trial that lasted for six weeks, each group was replicated twice. Hay and water were offered ad libitum, experimental diets were offered 7:00a.m daily. Rumination, ruminal pH, temperature, water intake were recorded with smaxtec bolus x2.0. Data were analyzed using GLIMMIX procedure for repeated measure in SAS 9.4 with Toeplitz as covariance structure while means were separated with Tukey. There was significant (p<0.05) difference in water intake within the experimental period. Water intake ranged from 41.24-72.96 liter/day and 44.03-64.29liter/day in CON and HEMP group respectively. No significant difference was observed in the pH and rumination of the animals. Rumination behavior ranged from 289.30 mins/day to 316.20 mins/day in CON and 200 mins/day to 318mins/day in HEMP group. Likewise, pH values of 6.59 to 6.81 for CON and 6.62 to 6.74 for HEMP were recorded. No significant (p>0.05) difference was observed in the weight gain of the heifers during the experimental period. Conclusively, industrial hemp can improve rumination behavior in cattle while conserving water and maintaining optimum rumen pH thereby improving the performance of angus cattle.

ABSTRACTS:
HEMP CULTIVATION, PROCESSES, AND USES

EFFECTS OF ORAL SUPPLEMENTATION OF CANNABIDIOL ON STALLION SPERMATOGENESIS

Payton Byars, Cheyenne Mason, Emily Purnell, Trinett Jones, Drew Cassens, Kimberly Guay

Cannabidiol (CBD) has become popular in the equine industry following the 2018 Farm Bill. Cannabidiol, a chemical derivative of the plant Cannabis Sativa L., lacks the psychoactive effects of THC, and has a longer half-life. The endocannabinoid system discovered in the 1990's has shown to have two main receptor types. Cannabinoid receptor subtype 1 (CRN1) has been identified in the male reproductive tract lining the testes, vas deferens, and prostate gland. Although it takes high amounts of the ligand, it is thought that cannabidiol may influence the CB1 receptor. This study was designed to evaluate the effects of oral CBD supplementation on stallion spermatogenesis. Quarter horse stallions (n=7) were blocked by bodyweight into a control group (n=3) and a treatment group (n=4). The treatment group was administered CBD oil (0.6 mg/kg BW), while the control group was given olive oil (0.6 mg/kg BW) over 90 days. Weight and blood were taken weekly to calculate proper dosage rates and evaluate testosterone and CBD levels of the blood. Semen samples were collected twice weekly and immediately evaluated utilizing computer assisted semen analysis to quantify motility, semen concentration, and velocity rates. Data was evaluated using Statistical Program (R Core Team, 2022) as an ANOVA with repeated measures to determine effects of treatment on static velocity, rapid velocity, and testosterone levels. Results were considered significant at $P < 0.05$ and were considered a trend at $P \leq 0.15$. Rapid velocity and static velocity were consistent in cell numbers; however, over time static velocity did trend higher in static cells in the CBD treatment group ($P \leq 0.0874$) ;(CBD = 270.7+-36.79, CON = 315.0 +-44.35). Average weekly testosterone levels did not differ among stallions yet tended to decrease by week (57.03 +-9.927 ng/dl and 46.95 +-5.151 ng/dl respectively) ;($P \leq 0.0749$). These findings indicate that cannabidiol had no effect on stallion spermatogenesis when fed at 0.6kg/mg consecutively for 90 days. Further research should evaluate cannabidiol effects over a longer period and with different ages of stallions.

EVALUATION OF HEMP AS AN ALTERNATIVE HOST PLANT FOR NOCTUID PESTS

Jeffrey Davis, Nathan Lord

Reemerging as a crop widely grown within the United States, hemp (Cannabis sativa L.) has the potential to influence population dynamics of polyphagous insect pests within agroecosystems. For herbivores, host plant impacts developmental rates, survivorship, leaf tissue consumption, and reproductive capabilities. However, current knowledge gaps in hemp-insect relationships prevent creation of sustainable integrated pest management strategies. Polyphagous members of the family Noctuidae cause both direct and indirect damage to hemp by consuming floral buds and defoliating fan leaves. However, it is unknown if consumption of hemp leaf material supports complete development. Thus, the objective of this study was to determine host plant viability and life table parameters of soybean looper, Chrysodeixis includens (Walker), fall armyworm (Spodoptera frugiperda (J.E. Smith)), and beet armyworm (Spodoptera exigua (Hübner)) on hemp. Insects were reared on hemp varieties Maverick and Pipeline and life table parameters were calculated. Larvae of all three species reared on Maverick had significantly faster preadult developmental times. Chrysodeixis includens larvae fed excised leaves of Maverick and Pipeline experienced higher intrinsic and finite rates of increase, higher net reproductive rates, and faster mean generation and doubling times. Spodoptera frugiperda larvae reared on Maverick and Pipeline had higher intrinsic and finite rates of increase, higher net reproductive rates, and faster mean generation and doubling times. Spodoptera exigua larvae had the highest survivorship on Maverick and similar, positive lifetable statistics when reared on Maverick and Pipeline'. The results of this study indicate hemp is an alternative host plant that will positively influence population dynamics of C. includens, S. frugiperda, and S. exigua in agroecosystems where they co-occur. Information collected in this study will be used to create phenological models to predict pest population dynamics on hemp and other crops within the surrounding agroecosystem.

EVALUATION OF THE EFFECT OF INDUSTRIAL HEMP SUPPLEMENTATION ON THE HEMOGRAM AND BIOCHEMICAL CHARACTERISTIC IN ANGUS HEIFERS

Felix Samuel, Nathaniel Ogunkule, Monya Simpson, Kendra Jones, Josh Herring, Gamal Abdelrahim, Martha Verghese, Ernst Cebert, Xianyan Kuang

The nutritional and physiological status of animals are indicated by changes in their hemogram and biochemical properties. The use of industrial hemp in animal nutrution is gaining importance. This study evaluated the effect of industrial hemp supplementation on the hemogram and biochemical characteristics of Angus cattle. Twenty (20) apperently healthy Angus heifers, aged 19 months with average body weight of 800 lb and body condition score of 6.5 were randomly divided into two groups of ten (10) heifers each in a completely randomised design. Group 1 (n=10) were supplemented with grounded industrial hemp at 20/200mg of the concentrate and group 2 (n=10) no industrial hemp supplementation. Hay and water were provided ad-libitum to all the groups for a period of 10 days. Three (3) ml of blood samples were collected from all the heifers at day 0 and day 10 of the experiment and used to analyse for hemogram and serum biochemistry using auto haemoanalyser and auto chemistry analyser, respectively. The total leucocyte counts, granulocyte and agranulocyte of the hemp group were significantly (P<0.05) lower than those of the control except for neutrophil and eosinophil. On the other hand, the erythrogram and erythrocytic indices were significantly (P<0.05) higher in hemp group than the control except for mean corpuscular volume. The platelet counts, platelet indices and albumin/globulin were significantly higher (P<0.05) while the blood urea nitrogen/creatinin, alkaline phosphatase and alanine amino transferase were significantly (P<0.05) lower in hemp group compare to control. However, all the haemogram and biochemical parameters were within the normal ranges for cattle. It was concluded that dietry hemp supplementation improves the erythrogram, immune status, hepatic and renal function and reduce clotting time in Angus cattle.

EXPECTANCY VS BEHAVIOR: IS OUR CONSUMPTION OF CANNABIS RELATED TO OUR EMOTIONAL EXPERIENCES AND EXPECTED EFFECTS?

Luiza Rosa

Current research indicates that individuals using cannabis have more positive expectancies about the effects of cannabis compared to non-users. Cannabis use has also been associated with increased negative affect but affect's impact on the relationship between expectation of effects and use has not been explored. This study is one of the first to measure in an international sample whether negative affect moderates the relationship between expectancy effects and frequency of use in current cannabis users. Survey participants (N=421) were recruited nationally and internationally through various online platforms and in-person clinics. Participants had an average age of 30±9 years, 49.4% were female, 53.2% were US-residents, and 47.7% were currently using cannabis products. Each participant completed online self-report questionnaires, including the Brief Marijuana Effect Expectancies Questionnaire (MEEQ-B) to measure positive (MEEQ-Bp) and negative (MEEQ-Bn) expectations about cannabis' effects and the Marijuana Consumption Questionnaire (MCQ) to measure frequency of cannabis use. In addition, four questions were asked regarding recent symptoms of anxiety and depression (negative affect). A linear model analysis showed no significant interactions between affect and positive (MEEQ-Bp) or negative (MEEQ-Bn) expectancies on frequency of use. However, there were main effects of MEEQ-Bp (t(189)=2.87, p = 0.005) and MEEQ-Bn (t(189)= -3.39, p<0.001) on frequency of use. Secondary analysis using ANOVA suggests that there were no differences in MEEQ-Bp or MEEQ-Bn by gender; however, females did have significantly greater negative affect (p=0.041). US residents had significantly greater MEEQ-BP (p=0.027) and lower negative affect (p=0.047) when compared to international participants. Comparing users to non-users, users had greater MEEQ-Bp (p<0.001) and lower MEEQ-Bn (p<0.001) than nonusers, but no difference in negative affect.These findings suggest current affective states were not associated with the interaction between cannabis expectations and use patterns. Yet, greater positive and lower negative expectancies predicted increased use. Additionally, compared to international residents, people residing within the US showed more positive expectancies for the effects of cannabis. Future research should continue to explore the expectancy of cannabis effects in a variety of populations to help better describe variations in cannabis use.

FEEDING MORE THAN 5% SPENT HEMP BIOMASS TO BROILERS DECREASES GROWTH AND NEGATIVELY AFFECTS MEAT QUALITY

Massimo Bionaz, Nathan Parker, Agung Irawan, James Hermes, Serkan Ates, Carolyn Pearce, Lydia Braiker, Maharach Matra, Gisselle Brasseur, Hunter Ford

Spent hemp biomass (SHB), a byproduct of the extraction of cannabinoids from hemp, is not yet approved by the FDA-CVM as feed ingredient, owing to the presence of cannabinoid residuals. Any meat produced from animals fed hemp by-products is considered adulterated by USDA-FSIS and ineligible for sale. Recent studies indicated that SHB can be added to the diets of ruminants without causing any detrimental effects on animal performance and health. However, there is a paucity of information whether safe feeding programs using SHB can be developed with monogastric animals. The objective of our study was to investigate the effects of varying levels of SHB on growth performance and meat quality of broilers. Two hundred Cobb 500 Cornish Cross chicks (5 day old) were randomly allocated in 20 pens (10 birds/pen; 5 pens/group). The chicks were fed isocaloric and isonitrogenous diets containing 0, 5, 10, or 20% SHB for 42 days. Feed intake, body weight, and pasty vent score were recorded weekly. After euthanasia, internal organs plus brain and breast were collected and weighted from 80 birds (4 birds for each pen, 2 per sex). The breast was analyzed for quality, including color, pH, moisture loss (both drip and cook), and tenderness. Data were analyzed using a general linear model. Statistical significance was deemed with P≤0.05. Feed intake was not affected but growth and weight of all organs (except for liver and brain, which were increased in proportion to the body weight) were decreased by feeding >5% SHB, leading to a poorer feed efficiency. Independent from the proportion of SHB, pasty vent was present only in birds fed SHB. The yellowness of the meat (b*) was increased by feeding 10 and 20% SHB with a tendency (P=0.08) for a greater drip-loss and, particularly for birds fed 20% SHB, the tenderness was decreased. The data indicated that SHB can be included to broiler diets up to 5 %without penalizing any performance and meat quality parameters; however, feeding higher levels of SHB could be detrimental. The decrease in feed efficiency might indicate some metabolic effect of SHB.

FEEDING SHEEP DIETS CONTAINING HEMP BIOMASS INCREASES DRIP LOSS BUT HAS NO EFFECTS ON OTHER MEAT QUALITY ATTRIBUTES.

Sarah Stevens

When evaluating potential new feed resources it is important to include an evaluation of the effects on animal products, especially meat. There are a number of meat quality measures that are of importance including shear force, ultimate pH, water holding capacity, drip loss, oxidation and colour. Fifteen Merino wether weaners (12 months old) were fed a pelleted rations that included hemp stubble at either 0% (Control), 28%, or 56% of the total DM, with oaten chaff as the substitute forage. Feed intake and live weight were monitored over the 56 d feeding period. Inclusion of hemp stubble had no effect (p > 0.05) on DM intake, hot carcase weight, or dressing percentage. The only difference found in the assessed meat quality attributes (of samples taken from the loin and tenderloin of the carcases) was increased drip loss (P < 0.05) when sheep were fed diets containing the hemp stubble.

HEMP AS ANIMAL FEED: A REGULATORY REVIEW AND THE RESEARCH NEEDED TO FINALLY GAIN FEDERAL APPROVAL

Hunter Buffington

Hemp seed has provided food and feed across the globe until its prohibition. Since the passage of the Hemp Farming Act in 2018, the United States has yet to federally approve hemp seed by-products for animal consumption. This presentation will review the regulatory and policy history that mandates pre-market approvals, as well as the current status of hempseed by-products for human and animal consumption. The talk will also provide a review of the states that allow it legislatively, those which have accepted recognitions of safety and the barriers that still remain and are preventing its approval by the FDA and the American Association of Feed Control Officials. Additionally, these barriers will be addressed with special attention given to understanding the research still needed to ensure analytical methods that assess the safety of these products are reasonable, repeatable and relevant. The presentation will include an update on the recent ASTM animal feed workshop that brought presenters from across the world together to discuss; gaps in analytical methods, limits of detection and across lab variation as it applies to establishing a quantitative way to meet the FDA request for 'zero tolerance' of THC in feed ingredients, and the hemp fed animal by-products entering the human food chain.

HEMP SEED CAKE DOES NOT AFFECT HEN'S PERFORMANCE, ENHANCES EGG FATTY ACIDS PROFILE, AND DOES NOT TRANSFER TETRAHYDROCANNABINOL (THC) RESIDUES.

Rajasekhar Kasula, Fausto Solis-Wenger Animal Nutrient & Technology Innovation Center, The Wenger Group, Byron Shaffer, Frank Connett, Chris Barrett, Rodney Cocker, Eric Willinghan

Hemp seed and hemp seed products have been shown to increase unsaturated fatty acids in eggs, including linoleic acid, and α-linolenic fatty acids known to increase egg weight and better human health, respectively. However, the use of hemp products like Hemp Seed Cake (HSC) in animal feed is still a concern due to potential residues of the psychoactive substance Δ-9 tetrahydrocannabinol (THC). There is not much research on the effect of HSC on the performance, fatty acids and cannabinoid profile in organs and tissues of laying hens. The objectives of these studies were to determine the effect of dietary HSC on laying hen performance, egg fatty acid, systemic organs and tissue, bone mineralization and cannabinoid residues in eggs of laying hens. Eight hundred (800) caged white hens in lay at 30 weeks of age were distributed into 4 treatments based on inclusion levels of hemp seed cake (HSC) at 0%, 10%, 20% and 30%. Each treatment group comprised of 8 cages of 25 hens that served as replicates. The observations were made over 16 weeks following a 3-week acclimation for parameters performance, egg quality, systemic and organ health, and cannabinoid residues and body tissues, and statistical analyzed by the Statistical Analysis System (SAS). There was no effect of HSC on livability, feed intake. HSC prevented a further drop of hen body weight, there was no effect on feed conversion compared to the control. HSC increased ($P<0.05$) the levels of polyunsaturated fatty acids including linoleic and linolenic acids, yolk pigmentation and lutein content in eggs and abdominal fat. A significant trend of reduction in moisture excretion with HSC feeding was noted. There was no effect on tissues and organ health parameters. The levels of THC and cannabinoids residues in eggs, blood, breast meat, body fat, liver, kidneys and spleen were below the detectable level.. The results of the study concluded that feeding HSC to laying hens up to 30% did not have negative effect on the performance, and increased deposition of polyunsaturated fatty acids with no transfer of THC or other cannabinoids in eggs, organs, or body tissues.Key words: Hens, Hemp, HSC, tetrahydrocannabinol, fat

HEMP SEED OIL SUPPLEMENTATION EFFECT ON CANNABINOIDS IN SERUM AND SYNOVIAL FLUID IN HORSES

Kristine Ely, Jessica Suagee-Bedore, Brandon Thorpe, John Fike

Horse health, longevity, and quality of life are impacted by inflammatory related diseases. Dietary polyunsaturated fatty acids (PUFA) are often targeted for their role in regulating the inflammatory response. Recent interest in hemp (Cannabis sativa) seed oil (HSO) as a PUFA source has arisen due to its unique fatty acid profile. However, restrictions regarding the use of HSO in the competitive equestrian world revolve around the potential for residual cannabinoid contamination acquired during processing. Little is known about the absorption of cannabinoids in horses; therefore, our aim was to determine if commercially available HSO fed to horses for 35 days would result in cannabinoid detection in serum and synovial fluid. Animal use was approved by Virginia Tech IACUC (22-029). Six thoroughbred geldings (11 ± 3.2 yrs, 568 ± 26 kg BW) were used in a crossover experiment with two consecutive 63d periods. Horses were offered a basal diet of hay and concentrate, or the basal diet top dressed with 166 mL HSO. Diets were designed to be isocaloric. HSO was introduced gradually over 7d, maintained for another 28d, and then removed and horses resumed basal diets for an additional 28d. Blood was collected weekly via jugular venipuncture and synovial fluid collected from the left carpus joint on d0, d35, and d63 of each period. Serum and synovial fluid were submitted to a commercial laboratory for cannabinoid analysis. Measurement of CBG, CBGA, CBD, CBDA, delta9-THC, delta8-THC, and THCA in serum and synovial fluid extracts was performed using LC-MS/MS. All horses readily consumed feed top dressed with HSO with no adverse reactions. Cannabinoids were undetectable to 50ppb at any timepoint in both serum and synovial fluid. These findings indicate that cannabinoid contamination in commercially available HSO supplemented for 35 days was not sufficient to accrue in serum or synovial fluid. Because cannabinoids are not produced within the seed, contamination in HSO is negligible, therefore, feeding HSO may not be a concern for competitive equines.

HUMAN EXPOSURE ASSESSMENT TO CANNABINOID RESIDUES PRESENT IN EDIBLE TISSUES OF BEEF CATTLE AFTER A 16-WEEK HEMPSEED CAKE FEEDING PERIOD

David J. Smith, Eric M. Serum, Thomas M. Winders, Bryan Neville, Grant R. Herges, Carl R. Dahlen, Kendall C. Swanson

A major byproduct of hemp oil production is hempseed cake. Although hempseed cake is an attractive animal feed ingredient because it contains high amounts of crude protein, neutral detergent fiber, and extractable fat, it cannot legally be utilized in animal feeds because cannabinoid residues remaining in edible tissues of recipient animals have not been characterized. As a result, hempseed cake is not a value-added byproduct of industrial hemp production but represents an economic liability for hemp oil producers. We determined the concentrations of cannabinoid residues in plasma, urine, and edible tissues of feedlot cattle (n = 16) fed hempseed cake for 16 weeks and then estimated human exposures to CBD/THC assuming consumption of beef from the cohort of test animals. Total cannabinoid concentration of hempseed cake averaged 11.3 ± 11.7 mg/kg across the feeding period with total CBD/THC concentrations of 1.3 ± 0.8 mg/kg. Neutral cannabinoids (cannabinol [CBN], CBD/THC, and cannabidivarin [CBDV]) were not detected in plasma, urine, liver, kidney, or muscle. In contrast, CBD/THC was measured in adipose tissue of all cattle fed hempseed cake (6.3 ± 2.1 to 10.1 ± 2.5 ng/g) regardless of pre-slaughter withdrawal period (0, 1, 4, and 8 d). Cannabinoid acids were depleted from liver by withdrawal day 4 but could still be measured (< 1 ng/g) in kidney of some animals harvested on withdrawal day 8. Using the conservative ARfD (1 µg/kg bw) for THC promulgated by the European Food Safety Authority, allowable daily THC intakes for humans ranged from 11.0 to 94.4 µg for male and females from 1 to 81 years of age. Quantities of THC delivered to humans consuming the 90th percentile of daily dietary fat intake consumed a fraction (0.02 to 0.1) of the allowable THC residue, even when 100% of the daily fat intake was assumed to be from beef of hempseed cake fed cattle. Thus, the probability of beef from cattle fed hempseed cake delivering an ARfD equivalent of THC is extremely remote. Consequently, hempseed cake produced from low cannabinoid hemp seed varieties appears to be a low risk, high value alternative feed source for cattle producers.

IMPACT OF VARYING INCLUSION RATES OF HEMPSEED MEAL IN THE DIET OF BOAR X SPANISH INTACT MALE GOATS ON CARCASS QUALITY VALUES

Khim Ale, Frank Abrahamsen, Jason T. Sawyer, Santosh Chaudhary, Nar Gurung

Hempseed meal (HSM) is a co-product of hemp oil production and contains valuable nutrients that make it a potential feed ingredient for animals. However, it is not approved to use in animal feed in USA due to safety concerns for animal health and consumer of animal products. Before approval of HSM as a feed ingredient, Food and Drug Administration needs enough scientific data on the effect of HSM on each species of animals at each stage of their life. Thus, to provide scientific data on the effects of HSM on goats, this study aimed to evaluate the impact of varying inclusion rates of HSM in the diet of intact male goats on their carcass quality and dressing percentage. Thirty-six Boer x Spanish intact male goats were randomly assigned to one of four experimental diets (n=9 goats/diet): 0%, 10%, 20%, and 30% HSM. Experimental diets were formulated as a total mixed ration and fed ad-libitum for 60 days. Each diet was formulated to be iso-nitrogenous and to meet or exceed the nutrient requirement of breeding male goats. At the end of the feeding trial, goats were humanely harvested at the Auburn University Lambert-Powell Meat Laboratory and their carcass weight, backfat thickness, ribeye area, and body wall thickness, dressing percentage, and cooler shrink percentage were recorded. Data were analyzed using One-way ANOVA test, and Tukey's HSD test as well Kruskal-Wallis test when needed in R version 4.2.1. There were no significant differences (p>0.05) in backfat thickness, ribeye area, body wall thickness, or cooler shrink (%) among experimental groups. However, dressing percentage of goats fed 0% HSM diet (42.8%) was significantly higher (p<0.05) than the dressing percentage of goats fed 30% HSM (40.0%). These findings suggest that HSM can be included in the diet of intact male goats up to 30% without affecting the carcass measurements and up to 20% without affecting dressing percentage. Overall, this study provided valuable results which will be useful for the approval process of HSM as a feed ingredient for use in goat diets.

INCREASED LENGTH OF EXPOSURE DOES NOT INCREASE CANNABINOID RESIDUES IN ANIMAL TISSUES

Gaye Krebs

Industrial hemp, a fast-growing summer annual, presents opportunities to the livestock industry during times when green feed may be scarce, as a supplementary feed, or as a by-product from the hemp industry. However, very little data exists on hemp biomass as a forage for ruminants. Also, to understand its safety in terms of THC exposure to humans, research is needed on the deposition and clearance of cannabinoids from tissues of animals destined for the human food market. This study investigated length (days) of dietary exposure to hemp in sheep on THC and CBD residues in various tissues. Three groups of 25 sheep were fed a full ration pellet containing 42% whole-plant hemp for either 7, 14 or 21 d (Group 1, 2 and 3 respectively) and then transferred to a feedlot with a hemp-free diet. Five sheep from each group were euthanised at 0, 14, 28, 42 and 56 d on clean feed. Tissue samples were taken from liver, kidney fat, cerebellum, loin and subcutaneous fat to analyse cannabinoid content. A tailored T Test method, assuming unequal variance, was used to compare feeding and slaughter time with significant differences recognised at p<0.05. Overall, there were very few statistically significant differences between the three exposure time groups and all differences occurred at day 0 or 14. Specifically, THCA (P=0.038) and total THC (P=0.042) were higher in Group 2 and Group 3 for faeces at day 0. Group 2 (P=0.012 T0, p<0.001 T14) and Group 3 (P=0.014 T), P=0.003) had higher D9-THC in subcutaneous fat at day 0 and 14. There were also some differences in the loin where Group 2 was higher (P=0.043) than Group 1 at day 0, and Group 3 was higher (P=0.042) than Group 1 at day 14. Cannabidiol only differed between groups in subcutaneous fat, where Group 2 was higher (P=0.045) than Group 1 at day 0 and Group 3 was higher (P<0.001) than Group 1 at day 14. Cannabidiolic acid was the same between groups for all tissues and faeces other than in the liver at day 0, where Group 3 tended to be higher (P=0.055) that Group 1. At day 42 and 56 there were no differences between groups for any of the measured cannabinoids in any of the measured tissues. The results indicate it does not matter whether sheep receive hemp for seven or 21 days, they are all equally likely to test negative (or positive) for THC after 42 days on clean feed.

INFLUENCE OF A HEMPSEED-SUPPLEMENTED DIET ON THE GUT MICROBIOME IN YOUNG GROWING FEMALE C57BL/6 MICE

Annette Gabaldon, Hailey M. Streff, Cynthia Blanton

Improvements in human and animal nutrition can be made by identifying edible plants that promote the growth and metabolism of health-beneficial gut microorganisms. As hempseed and its derivatives increasingly make their way into the food chain, we must better understand their impact on health. Previously, we found that whole hempseed was a suitable substrate (prebiotic) to support the growth and metabolism of two Lactobacillus strains. This led us to hypothesize that consumption of a hempseed diet would increase the diversity and/or relative abundances of beneficial gut bacteria. To test this hypothesis, a pre-clinical study was performed on young growing female C57BL/6 mice. From ages 5 to 30 weeks, mice were raised on either a control (0%), 50 g/kg (5%), or 150 g/kg (15%) hempseed-supplemented (HS) diet (n=8 per group). DNA was extracted for 16s RNA sequencing from fresh fecal samples collected at ages 6, 12, 20, and 28 wks and from the cecum at age 30 wks. Data are presented as preliminary results. For cecum, Firmicutes (~60%), Bacteroidetes (~25%), and Verrucomicrobia (~14%) were the most abundant phyla and were not influenced by the HS diet. Thus, the Firmicutes/Bacteroidetes (F/B) ratio for cecum was ~2.5 for all groups. The majority of cecum microbes at the genus level was also not significantly altered by the HS diet, including health-beneficial Lactobacillus, Lactococcus, Bacteroides, and Bifidobacterium. For feces collected at age 28 wks, Firmicutes, Bacteroidetes, and Verrucomicrobia were again the most abundant phyla as seen for cecum. The feces F/B ratio was ~2.9 for both control and 5% HS groups, and higher at ~4.8 for 15% HS due to a diet effect to increase Firmicutes. At the genus level the HS diet, typically both 5% and 15% concentrations, had a significant influence on the relative abundance of several bacterial groups (p<0.05). Notably, abundances of Lactobacillus and Lactococcus increased while those of Bacteroides and Bifidobacterium did not change. In conclusion, hempseed appears to be a promising dietary aide to support a healthy gut microbiome during growth and development.

INHIBITION OF ANGIOTENSIN-CONVERTING ENZYME (ACE) ACTIVITY BY CANNABINOIDS FROM CANNABIS SATIVA L.

Francisco Chacon, Joshua Kellogg

Although there is anecdotal evidence that the cannabinoids of cannabis sativa L. affect blood pressure, the mechanistic effects/interactions of these cannabinoids on blood pressure systems have yet to be described. In this study, we investigate the inhibitory characteristics of CBG, CBD, CBDA, and CBGA on angiotensin-converting enzyme-I (ACE) of the blood-regulating renin-angiotensin system. Using in silico and in vitro methods, cannabinoid activity was compared to a known ACE inhibitor, lisinopril. A molecular docking study was performed to model the interactions between the selected cannabinoids and the active site of ACE. Binding affinity, bond length, and associated receptor residues were determined and compared to lisinopril. An in vitro enzymatic assay was then performed to determine each of the selected cannabinoid's ACE inhibitory characteristics. In silico, CBG and CBGA had an affinity of -7.731 and -7.574 kcal/mol, compared to lisinopril's score of -7.526 kcal/mol. CBD and CBDA displayed an affinity of -6.714 and -5.891 kcal/mol; however, CBD was the only cannabinoid that interacted with the zinc ion within ACE, an essential component of the active site. In vitro, CBD, CBG, and CBGA inhibited ACE activity at a range of concentrations (1 – 1x10-6 mg/mL), yielding IC50 values of 21.01 μM, 7.201 μM, and 26.23 μM, respectively. CBG displayed characteristics of an uncompetitive inhibition as both the Vmax and Km were reduced at a concentration of 20.4 and 40.5 μM compared to no inhibitor (0 μM). CBGA followed a similar change with reduced Vmax and Km values at a higher concentration of 71.1 μM and 35.5 μM. It is concluded that CBG, CBD, and CBGA can inhibit ACE activity in vitro, suggesting that ACE could function as an additional receptor of cannabis cannabinoids. However, future in vivo studies are required to assess the complete ACE inhibitory activity of cannabinoids from cannabis.

LABORATORY STUDIES TO EVALUATE SWEET CORN AS A TRAP CROP TO CONTROL CORN EARWORM (HELICOVERPA ZEA) IN OUTDOOR HEMP

Dills Jera, Alejandra Velez Chavez, Katelyn Kesheimer

Hemp (Cannabis sativa L.)is a recently legalized crop in the United States that is facing many challenges in outdoor growing systems. A major obstacle growers face is the control of corn earworms (Helicoverpa zea), as the larvae feed on the inflorescence, seeds, and leaves of the plant which can lead to pathogen introduction and significant yield loss. Corn earworm infestations are especially concerning for hemp growers due to the lack of chemical control options that have been approved. This leads to the need to discover novel pest management solutions for hemp, such as trap cropping. Trap cropping has shown to be an effective solution for managing pests in various other growing systems and is especially promising when using sweet corn as it is a preferred host for female corn earworm moth oviposition. Therefore, we sought to test sweet corn as a trap crop for outdoor hemp. A laboratory choice test was used to determine the feeding preference of corn earworm larvae, given the option of hemp or corn fruit. Larvae were monitored for three days and feeding position recorded every two hours. A second no-choice test was conducted with first instar H. zea larvae reared on either hemp flowers or sweet corn kernels. Caterpillars were provided food ad libitum and weight and head capsule size were measured every 48 hours. Results were analyzed using a t-test, generalized linear mixed model with separation of means using Tukey Kramer in SAS 9.4. Results will be discussed as an applied management strategies for outdoor hemp growers. The need to find sustainable management options is crucial for growers and consumers. Hemp is being processed and sold as products that are ingested, inhaled, or used on the skin; therefore, natural solutions are paramount and trap cropping has great potential. Data from this study can influence further exploration of additional trap crops and cultural control methods for Cannabis.

OLD VIRUS, NEW HOST: EPIDEMIOLOGY AND MANAGEMENT OF BEET CURLY TOP VIRUS, AN EMERGING VECTOR BORNE VIRUS OF HEMP IN WESTERN U.S.

Punya Nachappa

Curly top disease caused by beet curly top virus (BCTV) has recently been identified as an emerging disease affecting hemp (Cannabis sativa L., THC <0.3%) in the Western United States. Curly top disease has been of economic significance and a major threat to agriculture since the early 1900's, impacting the yield and quality of multiple major western crops including sugar beet, common bean, spinach, peppers, squash, and tomato. As such, the virus appears to have found a new host in hemp, but there is currently poor understanding of its epidemiology and management in this new crop. Hence, there is a strong need to help identify the drivers of emergence of BCTV in hemp and identify disease mitigation strategies. Here we evaluated BCTV incidence and diversity of BCTV strains in hemp. We quantified the impact of BCTV on hemp yield and cannabinoid profiles. Lastly, we evaluate genetic resistance to BCTV in hemp lines and probability of seed transmission. These objectives were addressed through lab and greenhouse experiments in Colorado. We found high incidence of BCTV in the past couple of years in Colorado. The BCTV sequences from the current study had high nt identity with BCTV-Wor strains (97-99%) and lower nt identity with BCTV-CO strains (93-95%) in GenBank. The virus reduced yield but did not affect cannabinoid profiles, which is a positive result for high-CBD hemp producers. There was variability in BCTV levels among the 26 hemp lines screened suggesting potential genetic resistance that can be bred into commercial cultivars. Research is underway in our lab to test seed transmission of BCTV in hemp. Overall, the integrative approach of our study will aid in the development of disease management strategies to manage the disease in hemp and prevent the risk to other crops.

ORGANIC PESTICIDE USE: A GREENHOUSE STUDY

Chelsea Lawrence, Katelyn Kesheimer

Various management practices have been identified to control pests in hemp. With the push for more sustainable agriculture practices, organic chemical controls give the promise of greener alternatives for pest management. As there are many studies on the effectiveness of these modern pesticides, what is not as well understood is their effects on the plant themselves (phytotoxicity, NPK, marketable material). This study aims to identify the benefits of organic pesticides when used with multi-faceted IPM strategies. Since organic pesticides are marketed as the safer alternative, we aim to demystify this idea by showing that there can be deleterious effects regardless of the material used in the method of control. In this, we also underline the importance of reading the label to identify all ingredients and making accurate measurements when using pesticides. Further, this study highlights the importance of multi-faceted IPM strategies. IPM reduces damage by pests while simultaneously minimizing the damage to the environment and people. This sustainable form of pest management does include pesticide use, but only as a last resort. The treatment used was Blue Magic, all at high (every two days) and low intervals (weekly) with rates of 1oz, 2oz (recommended), and 4oz, 10oz (extreme). The mode of action for Blue Magic is supposed to prevent insects from interacting with the plant.

PARASITIZATION OF COMMERCIALLY AVAILABLE PARASITOID SPECIES AGAINST THE HEMP APHIDS, PHORODON CANNABIS (PASSERINI) (HEMIPTERA: APHIDIDAE)

Govinda Shrestha, Nora Graham, Adriana Perez, Andrea Grarfinkel

The hemp aphid (also known as the cannabis aphid or bhang aphid), Phorodon cannabis (Passerini) (Hemiptera: Aphididae) is a hemp crop-specialized aphid insect. This aphid is native to central and southeast Asia, but is spreading rapidly in the United States, including CA, CO and OR. In OR, P. cannabis was first reported in hemp in 2017 at Portland and Estacada locations, and it is continuing to spread or invade other OR hemp growing regions including Southern OR. Phorodon cannabis causes crop damage by feeding on various plant part tissues (e.g., flower buds, stems and leaves) by using their piercing and sucking mouth parts. Their feeding reduces the plant vigor resulting in stunted growth, wilting, and leaf yellowing. The control strategies for P. cannabis populations so far depend on. insecticide use, although only a few insecticides are permitted to use for hemp production in OR. There is also anecdotal evidence of insecticide resistance in P. cannabis population in OR. Thus, hemp growers are presently seeking alternative control options such as biological control agents and/or supplement the current insecticide-based control method. Among the several biological control agents, aphid parasitoids are especially regarded as effective and reliable biocontrol agents against aphid management. Currently, little documentation exists for the control efficacy of aphid parasitoids against P. cannabis. In 2022, we evaluated three commercially available parasitoid species (Aphidius colemani, Aphelinus abdominalis and Aphidius Matricaria) for their ability to parasitize hemp aphids under lab conditions. The study showed that A. Matricaria and A. abdominalis successfully parasitized 56 % and 30 % of the offered P. cannabis within 6- h and 24-h exposure periods, respectively. In contrast, none of the P. cannabis exposed to A. colemani was successfully parasitized within a 6-h exposure period. This study concludes that A. matricaria and A. abdominalis have the potential to be used against P. cannabis in hemp aphid biocontrol programs.

PI CONTROLLER DESIGN FOR HEMP-BASED PAPER ROLL-TO-ROLL (R2R) MANUFACTURING

Trung Duong

Hemp paper is a valuable alternative to conventional paper made from trees and could provide a more renewable source for much of the world's paper needs. Hemp is more suitable for paper as it has higher cellulose and lower lignin content. Hemp paper is also much eco-friendlier and more sustainable than tree paper, as hemp can be produced much quicker than trees. The purposes of this project are to investigate the characteristics of hemp-based papers in a Roll-to-Roll (R2R) process and to design adaptive control schemes for control of web tension in R2R manufacturing systems. An PI control schemes is proposed, which is based on the model reference approach where the controller gains are estimated based on matching the actual closed-loop tension control systems with an appropriately chosen reference model. The first step is studying the mechanical properties of hemp-based papers under the influence of hemp particles and temperature and the differences between papers from wood and hemp cellulose pulps. Then different designs of adaptive control schemes are investigated to select the one that satisfies: simple for practicing engineers, easy to implement in real-time, and able to auto-tune. After the controller's structure is selected, the controller gains are estimated by matching the plant performance and desired characteristics provided by a reference model. The estimates of the controller parameters are initialized by considering the stability of the nominal closed-loop tension control system. Model reference direct and indirect adaptive schemes for web tension control are investigated and implemented on an experimental platform. The experimental measurements are compared with results from the simulation of models from MATLAB/Simulink to validate the reliability of the design. An PI controller design for the hemp-based paper R2R manufacturing process using the model reference approach is proposed.

PRACTICES TO OPTIMIZE HEMP PERFORMANCE BASED ON END USE

Abdel Berrada

Hemp (Cannabis sativa L.) has been around for millenniums, but only in the last 8-10 years, has interest in growing it peaked in the U.S. Hemp uses range from fiber to hempcrete to hemp hearts to hemp proteins to hemp-derived drugs to skin lotion. Hemp cultivars vary in their plant morphology, phenology, and chemical composition. Some are used strictly to produce grain, fiber or essential oils; others have dual or triple uses. Management practices are important to maximizing cultivar performance and vary depending on end use. This presentation will detail best management practices for grain, fiber, and cannabinoids such as CBD. It will be based on replicated field trials by the author and on a review of the literature and other available information. Management practices that will be discussed include soil fertility, planting methods, dates, and rates; and water management. Various studies show significant responses to nutrient rates, irrigation amounts, and seeding dates and rates. In some experiments, plant biomass was significantly correlated to plant density, plant height, and stem diameter. As would be expected hemp cultivar had a significant impact on response variables such as seed yield, plant height, and cannabinoid concentration, which demonstrates the importance of hemp breeding in achieving a sustainable hemp industry in the U.S. More research is needed to develop best management practices that are tailored to the intended use and to the environments in which the cultivars are grown. Gaps in hemp agronomic research will be identified and solutions proposed.

PRIMING CANINE ADIPOSE-DERIVED MESENCHYMAL STEM CELLS WITH CBD-RICH CANNABIS EXTRACT MODULATES NEUROTROPHIC FACTORS EXPRESSION PROFILE

Amorim Rogerio

Mesenchymal stem cells (MSCs) are one of the most studied cell-based therapy due their properties such as homing to the injured site, immune-evasive and paracrine signaling which allow their application in immune mediated and degenerative diseases. Studies have shown that the endocannabinoid system is responsible for crucial biological functions, such as neuroprotection, pain modulation, inflammation and immunomodulation. The therapeutic use of the cannabis has experienced significant growth over the years, largely due to the beneficial effects of phytocannabinoids as cannabidiol (CBD) and other. CBD has been found to interact with the endocannabinoid system promoting modulation of cytokines and neurotrophic factors of MSCs. The aim of this in vitro study is to evaluate the gene expression of neurotrophic factors BDNF, GDNF, HGF, and cytokines IL-10, IDO, TNF-α, INF-γ, and PTGE2 after priming canine adipose-derived mesenchymal stem cells (Ad-MSCs) with CBD-rich cannabis extract. Five different samples of canine Ad-MSCs, previously isolated, immunophenotypically characterized as CD44+, CD90+, CD105+, CD34-, CD45-, MHC-II- and presenting tri-lineage cell differentiation (osteogenic, adipogenic and chondrogenic) were primed with high (2.25 µM) and low (225 nM) concentrations of CBD for 24 hours. Cell morphology, MTT assay and gene expression of neurotrophic factors BDNF, GDNF, HGF, and cytokines IDO, IL-10, TNF-α, INF-γ, and PTGES2 were evaluated. The canine Ad-MSCs primed with low and high CBD concentration did not show morphology or metabolic activity alterations. The canine Ad-MSCs primed with 2.25 µM of CBD showed increase in the HGF gene expression. However, we also observed decrease of BDNF gene expression, while the other neurotrophic factors and cytokines did not show significant differential gene expression for both doses. Previously studies have showed that CBD may have positive effects on MSCs by increasing their regenerative capacity, differentiation, colony formation, survival in hostile conditions and modulating the expression of cytokines and growth factors. The priming of canine Ad-MSCs with cannabinoids is a relatively new area of research and our findings suggesting that the neurotrophic factors expression profile of canine Ad-MSCs may be modulated by phytocannabinoids. Further studies should be performed for better understanding of MSCs priming with phytocannabinoids.

RECENT UPDATES OF THE USE OF INDUSTRIAL HEMP BYPRODUCTS IN RUMINANTS: NUTRITIONAL PROFILE, ANIMAL RESPONSE, POTENTIAL CONSTRAINTS, AND FUTURE RESEARCH DIRECTIONS

Agung Irawan, Serkan Ates

Industrial hemp (Cannabis sativa L.) is defined by the US Farm Bill 2018 as having ≤0.3% Δ9-tetrahydrocannabinol (Δ9-THC). The removal of a 50-year old federal ban on hemp by 2018 Farm Bill has prompted a sudden surge of its cultivation in the US and other countries. Consequently, byproducts derived from the processing of industrial hemp has resulted in numerous potential feed ingredients, such as hempseed cake (HSC) or meal (HSM) from seed processing, hemp hurds and hemp stalk from fiber processing, and spent hemp heart and biomass (SHB) from hemp for the extraction of cannabinoids. Interest to assess the potential use of these byproducts as feed ingredients for animals is rapidly increasing globally as testified by a growing body of research in this area. This review article provides a comprehensive view of current legal status of hemp byproducts for ruminants, their nutritional characteristics, animal responses, possible constraints, and future directions for their utilization. We quantitively summarize studies involving the use of HSC and SHB on ruminants. Overall, HSC and SHB are high in protein and polyunsaturated fatty acids, besides residuals of phytochemicals with antioxidant, anti-inflammatory, and antimicrobial properties, that can be potentially used as a partial replacement of either grain, such as soybean meal, or high-quality forages, such as alfalfa in the rations. Despite the above, it has been consistently reported that the high fiber content of HSC limits rumen fermentation and nutrient digestibility, ultimately reducing the growth performance of meat-producing ruminants. While SHB has a desirable nutritive value that is comparable to good quality alfalfa, it has probably a lower feeding value due to its poor palatability. The presence and persistence of cannabinoid residuals in meat and milk of animals fed hemp byproducts pose further challenges to design feeding programs. It is of interest for the dairy and beef industry on the potential use of SHB as nutraceutical; however, this potential need to be fully elucidated via sound scientific research.

SEASONAL ABUNDANCE OF ARTHROPODS ON HEMP (CANNABIS SATIVA L.) GROWN FOR FIBER AND CBD IN EAST-CENTRAL ALABAMA

Olufemi Ajayi, Donchel Boone, Tyson Knight, Junhuan Xu, Joseph Ayariga, Katelyn Kesheimer, Michelle Samuel-Foo

There has been a resurgence in the cultivation of industrial hemp, Cannabis sativa L., in the United States since its recent removal from the list of controlled substances by the U.S. government. Hemp can be used for several purposes including production of fiber, grain, and cannabidiol (CBD). However, there is a lack of survey on the arthropods associated with hemp in East-Central Alabama where there has been a recent increase in cultivation of the crop. Adequate knowledge of the arthropods associated with the plant is essential to achieve proper pest management and substantial yield of the crop. In this study, surveys were made weekly during hemp growing season from the year 2020 to 2022 on varieties cultivated for fiber (Henola and Bialobrezskie) at Tuskegee, and those cultivated for CBD (Lifter and Suver-Haze) at Salem. Arthropods were collected via two methodologies: "sweep-net" and "beat-into-alcohol". Collected samples were processed for identification and quantification of individuals in each species, separated by taxon, and placed in guilds. Taxonomic species allocations were made based on feeding behavior, and classifications as beneficial or pest. A randomized complete block design with arthropod guilds and hemp varieties as effects was used to evaluate the count of arthropods for all weeks of data collection using the two collection methods. Analysis of variance (ANOVA) followed by Tukey-Kramer HSD comparison test ($p < 0.05$) were performed on the arthropod counts in the two collection methods. Student's t-Test was performed on the arthropod counts between the two collection methods within each hemp variety. Herbivores were the most abundant of the guilds on fiber and CBD hemp. The sweep-net method was more effective at collecting flying arthropods, while the beat-into-alcohol method was more effective for tiny-sized arthropods. An ecological significance of the result is its usefulness for hemp growers and producers to develop sustainable integrated pest management against serious pests of the crop and encourage conservation of beneficial arthropods of the crop. Furthermore, this study provides one of the few published data sets to date reporting on the density and seasonality of arthropods on hemp grown for fiber and CBD under field settings.

STATE OF THE HEMP INDUSTRY IN THE U.S. AND FUTURE PROSPECTS—PANEL DISCUSSION

Abdel Berrada, Corbett Hefner, Rich Fletcher, Tyler Mark, Wondirad Gebru

The panel members will include hemp experts and hemp industry representatives who will give updates on hemp cultivation, processing, regulation, markets and supply chains, products, testing, and standards. It will be followed by an open discussion on successes, challenges, and prospects for the foreseeable future. It is no secret that the hemp industry in the U.S. experienced a downturn after the "boom" of 2019. The reasons for the decline in hemp cultivation are many. They include exaggerated claims and misinformation, limited processing and testing capacity, cumbersome regulation or lack of, a sharp drop in prices, underdeveloped or non-existing markets, lack of standards, limited funding for research and development, not enough adapted and productive cultivars, and competition with other crops. It is worth noting that the bust that followed the peak production of 2019 was due mostly to CBD-type hemp. Hemp cannabinoid-derived products are popular and can be profitable. However, very few have been approved by the FDA. Moreover, CBD (and other cannabinoids) hemp does not require a lot of acreage (indoor and outdoor production) to meet market demand. Currently, it is more of a niche market and may not benefit farmers much. Other hemp uses such as grain, fiber, and their derivatives are more suited to traditional farming practices and may offer environmental benefits. The challenges of the U.S. hemp industry are many, but opportunities abound. The panelists will discuss which ones show promise and what needs to be done to enhance their sustainability.

THE CHANGING ECONOMIC VIABILITY AND IMPACT OF FLORAL, GRAIN, AND FIBER HEMP PRODUCTION

Tyler Mark, Abdel Berrada

The passage of the 2014 and 2018 Farm Bills reintroduced hemp production within the United States and established the regulatory framework. Initially, hemp producers and stakeholders focused on grain and fiber hemp production. However, by 2016 floral hemp production for extraction and smokable bud started appearing in the marketplace. Two driving factors to floral hemp's rapid expansion were low commodity prices and unsubstantiated profitability claims by processors. As a result, the floral hemp segment grew rapidly as it expanded to over 150,000 acres nationwide by 2019. This completely saturated the marketplace squeezing out the profit potential at the farm level. Since the 2020 growing season the acreage of hemp production nationwide has witnessed a significant contraction. This is primarily within the floral hemp production segment while the grain and fiber segments have been experiencing a slight acreage growth as they become more economically viable. The contraction of the floral hemp sector and modest growth of the grain and fiber segments have allowed the industry to reset and develop at a more sustainable growth rate. To maintain this sustainable growth, the hemp supply chain and policymakers need to understand the economic viability and impact of each hemp sector going into the next Farm Bill discussion. This presentation will pull together information from three different studies that researchers at the Universities of Central State, Colorado State, Kentucky, and Vermont have been conducting. These studies use various methods to evaluate economic viability and impact along the hemp supply chain. Utilizing these methods, we can assess how potential policies will impact the industry's future growth.

THE EFFECT OF CANNABIDIOL ON LEARNING AND MEMORY IN ADULTS

Hanna Gebregzi, Moussa Diawara, Joanna S. Zeiger, Jeff Smith, Libby Stuyt, Luanne Cullen, Jim Carsella, Daniel Rogers, Jordan Lafebre, Jenna Knalfec, Jose Vargas

The effect of Cannabidiol (CBD) administration on learning and memory (L&M) in healthy human volunteers is unknown. To test how the administration of CBD impacts L&M in healthy human subjects. A randomized, double-blind, placebo-controlled crossover trial was conducted at Colorado State University-Pueblo. Among 57 healthy volunteers recruited from the CSU Pueblo campus and the local Pueblo community, 35 completed both trials and were included in the analyses. Participants received CBD (246 mg) or placebo ninety minutes prior to completing each of two versions of three different learning and memory tests. Learning and memory were assessed with the Montreal Cognitive Assessment (MOCA; short-term memory), the Rey Auditory Verbal Learning Task-Revised (RAVLT-R; verbal memory), and the Logical Memory Subtest of the Weschler Memory Scale (Total Prose). Several components of the RAVLT-R were examined, including The Sum of Trials (Trials I-V) score, Proactive Interference Ratio (PI ratio), and Retroactive Interference (RI ratio). Two versions of each task are available and participants completed a different version for each drug trial. This study was approved by the IRB and conducted in accordance with the Declaration of Helsinki. Linear mixed models with Bonferroni Corrections were used to compare test results between CBD and placebo with a statistical significance of $p<0.05$. Data are presented as the mean (SD) and are adjusted for non-independence of the data and for covariates. There were no significant differences between CBD and placebo for the Sum of Trials [$p = 0.42$], PI Ratio [$p = 0.20$], and RI Ratio [$p = 0.37$]. Total Prose and MOCA did not show a statistically significant difference between CBD and placebo [$p = 0.36$], and MOCA [$p = 0.64$]. There was a significant effect of the following demographic factor: coffee drinking frequency on PI Ratio ($p = 0.02$). Conclusion: CBD administration did appear not to have an effect on learning and memory in a healthy adult population.

THE EFFECTS OF CANNABIDIOL ON CAMP PRODUCTION AND STEROIDOGENESIS IN YOUNG STALLIONS.

Kimberly Guay, Emily Purnell, Payton Byars, Ashley Mason, Amber Harris-Bozer, Barbara Jones, and David Roper

Cannabinoids have been documented to have an impact on the function of aspects of spermatogenesis and folliculogenesis, which can impact fertility in the male and female. The gonadotropins follicle stimulating hormone (FSH) and luteinizing hormone (LH) are main players in gametogenesis across both sexes, and their physiological function is mediated through the function of the cyclic adenosine monophosphate (cAMP) second messenger pathway. Specifically, cAMP activates processes key for steroidogenesis, or the development of necessary sex steroids. In the male, testosterone functions not only to contribute to masculinity and sexual behavior but is essential for proper production of spermatozoa. American quarter horse stallions (n=6) were given an oral full spectrum cannabidiol (CBD) supplement, and blood was collected weekly using jugular venipuncture. Blood serum samples were evaluated for cannabinoid and testosterone concentrations by the Texas A&M University Veterinary Medical Diagnostics Lab. Statistical analyses were conducted utilizing JASP for Mac (JASP Team (2023). Pearson's r correlations were run to evaluate the relationship between cAMP, testosterone, and CBD across treatment groups from each timepoint utilized for analysis. Independent samples t tests were run to compare cyclic AMP, testosterone, and CBD levels across each timepoint utilized for analysis. All correlations were insignificant at the level ($p < .05$), except for the correlation between cAMP and testosterone seen in the CBD treated group on June 20th. All t tests were insignificant at the level ($p < .05$) except for CBD at 7/11 where a significant difference was seen between the CBD and control groups, with the CBD group having a higher blood serum concentration of CBD. More studies are needed to investigate the effect of CBD on fertility in the male before CBD can be said to be safe to consume for reproductively functional males.

THE EFFECTS OF DAILY ORAL FULL-SPECTRUM NANO-TREATED CANNABIDIOL ON GESTATING RABBITS, LITTER PARAMETERS, AND KIT GROWTH.

Madelynn Hayen, Kimberly Guay, Jacob Moorefield

The use of cannabidiols (CBD) in producing animals has the need for more research to understand the effects CBD has on fetal growth. This study investigated how nano-treated CBD affects fetal development and neonatal growth in rabbits when does were given a daily oral dose (0.6/kg) beginning a week prior to breeding through weaning. Twenty-two female meat breed rabbits were blocked by breed and assigned to either treatment (CBD, 0.6mg/kg nano-treated CBD; n = 12) or control (CON, equal volume of olive oil; n = 10). To ensure ingestion of the complete dose, animals were administered treatment via micro-pipettor. Does began treatment prior to breeding and were dosed daily throughout gestation and lactation. Does were housed individually in wire rabbit hutches with attached to a pressure flow water system and comfort pads. Does were fed a pelleted commercial rabbit ration ad-libitum. Does were weighed weekly to calculate average daily gain/loss, and to recalculate CBD dose rate. Litters were counted and weighed the morning of kindling, and conception rate, birth weight, litter morbidity, litter size, and litter weight were recorded. Kits were weighed weekly for rate of gain through weaning. The average days on trial for the does was 77 days and conception rates were 50% for both CBD and CON rabbits. During gestation, CBD does lost an average of 0.61g while CON does gained 5.4g, however this was not significantly different. There was no difference in litter size (CBD = 6 and CON = 5). The average number of kits born alive was 4 and 5 for CBD and CON respectively, while the average number of litter morbidity was 2 for CBD does and 1 in CON does. Litter weight was lower for CBD treated does compared to CON does with respective means of 234g, and 263g. Average daily gain for kits whose mother was treated with CBD was and average of 8g lower than CON kits (50g vs 58g).

THE EFFECTS OF FULL SPECTRUM HEMP OIL ON EXTINCTION OF STRESS ENHANCED FEAR LEARNING IN A RODENT MODEL OF PTSD

Tiphanie Chanel, Nicholas Glowinski, Carlos Maestas-Olguin, Jacob Vigil, Nathan Pentkowski

There are only 2 FDA-approved treatments for Post-Traumatic Stress Disorder (PTSD) despite the overwhelming evidence for the need of more effective treatments. For example, roughly half of people with PTSD that seek treatment experience relief from conventional pharmaceutical medications and only one third experience full remission. The Cannabis plant is a promising novel treatment for PTSD for several reasons. The endocannabinoid system plays a role in stress, emotion, cognition, and learning processes. Cannabidiol, one of the most widely studied phytocannabinoids found in the Cannabis plant, has both anxiolytic and antidepressant qualities. The present study examines the effects of full spectrum hemp oil on the extinction of stress enhanced fear learning in a rodent model of PTSD. During trauma exposure, rats were assigned to either a control (no-shock) or trauma (shock) group. In the days following the trauma exposure, rats were assessed for fear memory, fear generalization, exaggerated fear learning and new fear learning. Rats were then assigned to either a control (peanut butter) or hemp (hemp oil using a peanut butter vehicle) group and tested for rates of fear extinction. The trauma group spent significantly more time freezing than the non-trauma group on day 2. Either group did not show a significant difference in the baseline to the new context showing no signs of fear generalization between the two contexts however, the trauma group froze significantly more following a single shock showing an exaggerated fear on day 3. The trauma group also froze significantly more on day 4 reflecting stress enhanced fear learning. Results suggest cannabidiol was ineffective at the given dose as there was no difference between the two groups during extinction trials.

UNDERSTANDING AND MANAGING HOP LATENT VIROID IN CANNABIS

Zamir Punja, Cameron Scott, Janesse Homes, Liam Buirs

Hop Latent viroid (HpLVd) is an infectious pathogen on cannabis (Cannabis sativa L.) that has severe economic impact through reduction in growth of affected plants and reduced cannabinoid production. Surveys in cannabis production regions in North America indicate that up to 50% of production facilities have HpLVd. The objective of this research was to demonstrate the impact of HpLVd on growth of different genotypes of cannabis, and on trichome development and THC production. Studies on transmission and spread of the viroid were also conducted. Infected mother plants may show stunted growth, with smaller leaves; cuttings from affected plants showed reduced rooting; plants in flower showed stunted and reduced growth of inflorescences. Five genotypes showed a 12-48% reduction in development of inflorescences, a 28-39% reduction in THC production, and a 10% reduction in terpenes at harvest. There were significant ($p=0.05$) differences in viroid infections among 25 genotypes assessed, suggesting that genetic selection for resistance has potential. Affected genotypes showed similar trichome densities, but trichome stalk length and head gland diameter were significantly ($p=0.05$) reduced, leading to lower cannabinoid accumulation. The viroid was readily spread through vegetative propagation, and cut surfaces of stems were especially vulnerable to infection. Following introduction of the viroid by artificial inoculation, it was first detected in the roots of affected plants (within 2 wk), and spread to young developing leaves, followed by older leaves (within 4 wk). Plants in a 12:12 hr photoperiod showed more rapid spread of HpLVd into roots and flowers compared to constant 24 hr. Viroid concentrations were significantly higher in flower tissues compared to the rest of the plant. Infection through roots was also observed in hydroponic cultivation, suggesting potential movement of the viroid through water. Root sampling is a highly sensitive and reliable method for HpLVd detection. Rigorous testing, destroying infected plants, and preventing spread on cut stem surfaces and tools, as well as root contact, can reduce spread. Heating to 70 C did not affect HpLV stability.

USING GREEN LACEWINGS FOR BIOLOGICAL CONTROL OF TWO SPOTTED SPIDER MITES IN CANNABIS: POTENTIAL INTERFERENCE WITH INTRAGUILD PREDATION

Anna Williams, Ivy Thweatt, Katelyn Kesheimer

Two-spotted spider mites, Tetranychus urticae, are a prevalent pest in hemp, Cannabis sativa L., and are found on hemp grown in both the field and greenhouse. Two-spotted spider mites feed on the underside of the leaves; feeding damage results in the stippling of leaves and, in high numbers, can cause damage that mimics drought stress. Lacewings, Chrysoperla sp., will feed on two-spotted spider mites and can potentially be used as an integrated pest management strategy for control in hemp. However, lacewing larvae are susceptible to intraguild predation (IGP), which can interfere with successful biological control. Therefore, we sought to quantify the level of intraguild predation between lacewing larvae at different ratios of predatory lacewings to pestiferous spider mites in an attempt to identify an effective biological control strategy. Lacewings were tested at a rate of 0, 1, 2, 4, and 8 larvae per arena with high (n=40) and low (n=20) populations of two-spotted spider mites. In a laboratory study, we assessed different numbers and instars of lacewing larvae and measured mortality caused by IGP. We also assessed population suppression of two-spotted spider mites. Results were analyzed using a generalized linear mixed model in SAS 9.4. Data on the most effective lacewing larvae to two-spotted spider mites population ratio will be discussed as a greenhouse management strategy for hemp growers. This study aids in understanding the relationships between predator and prey and predator and predator in a greenhouse system. Information can be used to further explore pest management questions in Cannabis including predator and pest behavior, predator identity and number, and the biological control release strategies.

WHAT RESEARCH IS NEEDED TO PROCEED WITH THE LEGALIZATION OF HEMP BYPRODUCTS AS FEED INGREDIENT IN UNITED STATES?

Massimo Bionaz, Morgan Tweet, Jeffrey Steiner

With the production of hemp grown for grain and cannabinoids, significant amounts of byproducts are generated after extracting the oil from seeds and cannabinoids from the biomass. Research has shown that these co-products from processed hemp materials offer highly nutritious options as feed ingredients for animals. Utilization of by-products presents a great opportunity because feed ingredients are a major cost to the livestock and poultry industry, as well as for pets. However, these are not yet approved by the Food Drug Administration-Center for Veterinary Medicine. The Association of American Feed Control Officials published a letter emphasizing the need for more research to assure that hemp byproducts are safe to be fed to animals. To address this need, a workshop was held in October 2022 to identify the research needed to proceed with the legalization of hemp byproducts as feed ingredients. Eighty-one participants met in a hybrid format for a workshop funded by the USDA National Institute of Food and Agriculture and organized by the Oregon State University and the Hemp Feed Coalition. A total of 19 speakers, four from the industry, three from regulatory agencies, and 12 researchers, provided an update on the status of the hemp used as feed ingredients. The workshop also featured two PANEL DISCUSSIONs - one about analytical standards and one about regulation. A white paper summarizing the workshop is being completed to be publicly available. In summary, the hemp industry recognizes the need for continued collaboration between regulators, researchers. The regulators highlighted the need for a data-driven argument to support the safety of products produced from animals fed hemp by-products and the need to determine a tolerable dose intake (TDI) for the various cannabinoids to determine the safety of the products from animals fed with hemp byproducts. According to FDA representatives, animal models would be acceptable to support safety. The researchers highlighted the lack of research on monogastric species, the need to determine the proper amounts for each hemp byproduct that can be fed to animals, and the need to determine the metabolites of cannabinoids.

THE PROTECTIVE ROLE OF ENDOCANNABINOIDS IN TRAUMATIC BRAIN INJURY

Esther Shohami

This presentation is dedicated to the memory of Prof. Rafi Mechoulam, the pioneer and founding father of cannabis as a novel research field in basic and clinical science. Traumatic brain injury (TBI), a major health problem with significant, worldwide socioeconomic burden affecting millions of people, is a complex, dynamic and heterogeneous pathology. To date, there is no effective treatment to this "silent epidemic". TBI triggers the accumulation of harmful mediators and results in injury cascades that evolve into chronic brain damage. However, endogenous, protective mechanisms to attenuate damage are also set in motion. In this presentation we will discuss the role the cannabinoids play to improve the outcome of TBI, in a mouse model of closed head injury. Three types of cannabinoid-related compounds that act to reduce brain damage after TBI will be discussed: 1. The endocannabinoids (eCB) that are produced by the brain. 2. The plant-derived, non-psychotropic compound, cannabidiol (CBD) 3. Synthetic compounds, that target the CB2 receptor. The endocannabinoids (eCB) 2-arachidonoylglycerol (2AG) is the main brain constituent of the endocannabinoid (eCB) system and is an agonist of the both CB 1 and CB2 receptors. The levels of 2-AG are significantly elevated in a mouse model after TBI, and the mechanisms by which it affords neuroprotection will be discussed. N-arachidonoyl-L-serine (AraS), was also identified as another endogenous brain constituent structurally-related to the eCBs family. However, as they do not bind to known CB receptors they are referred to as eCB-like compounds. Despite its lack of affinity to CB 1 or CB 2 receptors, some of the effects of AraS are similar to those of the classical eCBs, and its mechanism of action after TBI will be discussed. Cannabidiol (CBD) CBD which is nowadays being successfully implemented in various disease therapies and will be discussed as potential tool to treat TBI. While exhibiting low activity via the CB1 and CB2 receptors, this phytocannabinoid binds to a broad spectrum of targets. When given after TBI it significantly improves short-and long-term motor and cognitive functions, accompanied by reduction of lesion volume. The diverse pathology of TBI was found to be well addressed by the multi-target cannabinoid compound, CBD. Synthetic CB2 agonists In view of the increasing evidence that the CB 2 Receptor plays a role in the brain during neuroinflammation we tested whether selective CB 2 agonists have a beneficial effect after TBI. In mice and rats, subjected to TBI and treated with these novel synthetic compounds, we showed enhanced neurobehavioral recovery and inhibition of inflammatory mediators. We propose these CB 2 agonists as potential drugs for development of novel therapeutic modality to TBI.

A METHOD TO MEASURE URINARY CANNABINOIDS WITH ADEQUATE SENSITIVITY TO DETECT EXPOSURE TO SECONDHAND CANNABIS SMOKE

Kevin Caron, Connie S. Sosnoff, Benjamin C. Blount, Lanqing Wang

Smoking and/or vaping cannabis has been associated with adverse health effects from exposure to cannabinoids and toxic chemicals found in cannabis smoke/aerosols. Cannabis use in group settings and public spaces may lead to secondhand exposure to cannabis smoke. We present here an improved, semi-automated, high-throughput assay that is sensitive enough to measure five cannabinoids in urine across the range of concentrations expected from secondhand cannabis smoke exposure as well as from active use. We used isotope dilution and ultrahigh performance liquid chromatography coupled with electrospray ionization tandem mass spectrometry (UHPLC-ESI-MS/MS) to measure Δ9-tetrahydrocannabinol (THC), cannabidiol (CBD), cannabinol (CBN), and two major metabolites of THC, 11-hydroxy-THC (OH-THC) and 11-nor-9-carboxy-THC (COOH-THC) in urine. A pool of anonymized human urine obtained from commercial sources was used for method validation. To measure the total concentrations of each analyte, urine samples were spiked with internal standard solution containing stable isotopically labeled versions of the analytes, followed by enzymatic hydrolysis with β-glucuronidase. The sample was cleaned on a C18 solid phase extraction (SPE) plate, concentrated, and the residual was injected into the UHPLC-ESI-MS/MS system. All aliquots of sample, internal standard, and enzyme as well as the transfer of mixtures and cleaning on the SPE were completed using an automated liquid handler. The limit of detection (LOD) for this assay using 0.5 mL of urine was 0.005 ng/mL for all 5 analytes. The accuracy of our method ranged from 89.6% to 102.0% with a within-day precision coefficient of variance (CV) from 2.5% to 8.6% and a between-day precision CV from 1.4% to 9.3%. Recoveries ranged from 71.8% to 89.6%. Our semi-automated, high-throughput method is sensitive, accurate, precise, and has high recoveries. Our LOD for COOH-THC is well below the 15 ng/mL threshold used to confirm active cannabis use in federally regulated testing. This method can be used to detect exposure to secondhand cannabis smoke as well as active use.

AN LCMS-MS ASSAY OF CANNABIDIVARIN & METABOLITES IN PHASE TRIAL FOR TREATMENT OF EPILEPSY IN GIRLS WITH RETT SYNDROME

Gordan Rebecca, Ellen N Hurley, Carolyn J Ellaway, Alexandra M Johnson, Linda Truong, Peter Galettis, Jennifer H Martin, John A Lawson

Cannabivarin (CBDV) is a propyl analogue of Cannabidiol and expresses efficacy in seizure-reduction in pre-clinical models of epilepsy. To investigate the pharmacokinetics of CBDV in a trial of RETT syndrome, an assay needs to be developed. Aims. To develop and validate an LC-MSMS assay of CBDV and metabolites: 6-hydroxy-CBDV, 7-hydroxy-CBDV, 7-carboxy-CBDV in human plasma. CBDV and metabolites were extracted from plasma by addition of 0.1% formic acid in acetonitrile and deuterated standards and injected onto a Shimadzu 8060 Triple quadrupole LCMSMS using a Restek Raptor ARC-18 column and binary gradient with mobile phases 0.1% formic acid in H2O, and acetonitrile. Results. Method validation followed FDA bioanalytical method guidelines. The analytical range was validated from the limit of quantitation of 0.5ng/mL to 50ng/mL for 6-hydroxy-CBDV, 7-hydroxy-CBDV, and CBDV, and 50ng/mL to 5000ng/mL for 7-COOH-CBDV. Intra-batch imprecision for all compounds was 6.7-11.4% and inter-batch was 6.9-13.8%. Accuracy for all compounds was between 86 – 113 % and matrix effects were accounted for by internal standards. PK was analysed for five children to generate AUC's and demonstrate a C-max at approximately 2 hours. All values were within analytical range, except one 7-Carboxy-CBDV trough value at 15 months which was 11,109ng/mL. A method was successfully developed and validated to assay patient samples to ascertain PK of CBDV and metabolites in human plasma. CBDV was safe and tolerated over 15 months, and demonstrated an average monthly seizure reduction of 79% with the highest recorded average reduction of 98% across patients over 15 months. The patients were on between 2-5 other anti-seizure medications, and potential drug-drug interactions may be a focus of future research. Hurley E et al(2022) Epilepsia, 63:7 pp 1736-1747

ANTI-TUMORAL EFFECT OF CANNABIS SATIVA OIL IN HUMAN AND CANINE PROSTATIC CARCINOMA CELL LINES

Renee Laufer-Amorim, Luís Gustavo Ramos de Moraes Calheiros, Paulo César Leão Eliam, Thayná Oliveira da Silva

Prostate cancer (PC) is the most frequent type in men in occidental world and the second cause of death, showing a significant increase in cases in the last years. Dogs are considered a good natural model for the study of some types of cancer, since they share the same environment as humans, and have a shorter life span. In dogs, the incidence of PC is low, but the prognosis is poor, with high metastatic rates, to the same organs as humans. Most of canine PC are androgen receptor negative. Cannabinoid receptors have been reported in human PC related to cellular proliferation. We aimed to investigate the anti-tumoral effect of two full spectrum Cannabis sativa oils, one CBD rich (28,12CBD:0,80THC) and the other THC rich (34,07THC:0,11CBD) in two canine PC cell lines (Unesp-PC1 and Unesp PC-2) and LnCap (human cell line). We tested both oils in a concentration of 2,5μM, 5μM, 7,5μM, 10μM for the canine cell lines and 10μM, 20μM, 30μM ,40μM for LnCap. After the cells reached confluence, the cells were plated in 96 well plates, each test in triplicate. The cells were treated with the different concentration of the oils for 24 hours and MTT test was done to determine the IC50. Both oil extracts, rich in CBD and rich in THC showed an anti-tumoral effect in all three cell lines. For canine Unesp-PC1 the IC50 concentration was 3.437μM for the CBD rich oil and 4.909μM for the THC rich oil. For the Unesp PC-2 cell line the IC50 were: 3.577μM and 4.486μM. For LnCap the concentration was higher: 12.77μM and 29.00μM. This is the first report of in vitro anti-tumoral effect of CBD an THC in canine prostatic cell lines, and as in the human cell line, LnCap, there was an anti-proliferative effect.

ANTINEOPLASTIC PROPERTIES OF THCV, HHC, HHCV AND THEIR ANTI-PROLIFERATIVE EFFECTS ON HPAF-II, MIA-PACA2, ASPC-1, AND PANC-1 PANCREATIC DUCTAL ADENOCARCINOMA CELL LINES

Giovanni Ramirez, Tesfay T. Tesfatsion, Arianna C. Collins, Giovanni A. Ramirez, Yousef Mzannar, Husain Yar Khan, Omar Aboukameel, Asfar S. Azmi, Prakash G. Jagtap, Kyle P. Ray, Westley Cruces

Cannabinoid receptors CB1 and CB2 are the primary endogenous receptors with which cannabinoids interact, inducing physiological and psychological effects. Although interactions with other receptors including TRPV1 and GPCR55 have been recognized in earlier studies, these interactions may play a significant role in cancer remediation through the unspecified upregulation or downregulation of specific pathways. The main active constituents within the cannabis plant are cannabidiol (CBD) and tetrahydrocannabinol (THC), which have been categorized as either non-intoxicating with benefit or intoxicating with no benefit. These categories are constantly ignored, as cannabinoids have shown efficacy in the treatment of certain diseases and ailments as single-agent compounds. Tetrahydrocannabivarin (THCV), a rare cannabinoid, is a homologue of THC, with the C5 alkyl chain having three carbons rather than the standard five-carbon length. THCV has garnered attention in a clinical setting as an anti-obesity drug treating glucose issues. Hexahydrocannabinol (HHC), a hydrogenated analogue of THC, is a rare cannabinoid like THCV. These cyclic cannabinoids are considered rare because they are typically found in minimal to trace amounts within cannabis sativa and their given C. indica, and C. ruderalis subspecies. Increased popularity of these rare cannabinoids has led to proposed experimentation leading to assessing the cytotoxicity of these cannabinoids toward, cancer cells of the pancreas (MIA-PaCa2, HPAF-II, and PANC1). The data evaluated through such studies led to the proposed idea of these rare cyclic cannabinoids for the treatment of pancreatic cancer due to their modest efficacy as single-agent antineoplastics compared to common single-agent antineoplastics on the market, with evidence being strongly presented when compared to commercially available anticancer agents poly(ADP-ribose) polymerase (PARP) inhibitors.

CANNABIDIOL AND YOUR IMMUNE HEALTH

Laura Stewart

While acute inflammation can be beneficial and acts as an essential defense and repair mechanism for the body, chronic inflammation, which is defined as inflammation that persists for weeks, months, or years, is associated with the development and progression of many of the chronic diseases present in society today. Cannabidiol (CBD) has been proposed by many as a health promoting, anti-inflammatory agent; however, the research supporting these claims is limited. This talk will provide an overview of the research emerging from our lab. It will provide evidence both for and against the use of CBD to improve health and regulate inflammation in the body.

CANNABIDIOL REDUCED ALCOHOL CRAVING AND DRINKING BEHAVIOR IN INDIVIDUALS WITH ALCOHOL USE DISORDER

Raeghan Mueller

Alcohol use disorder (AUD) carries enormous personal and socioeconomic costs, and current treatments are modestly successful. Cannabidiol (CBD) is a proposed candidate for AUD due to evidence demonstrating that CBD mitigates AUD symptoms and other addictive disorders. CBD diminishes the reinforcing properties of alcohol, decreases drinking motivation and consumption in mice, and attenuates cue- and stress-induced alcohol-seeking, reinstatement, and impulsivity in a rat model of AUD. However, human research is limited, with only three studies conducted 40 years ago and, currently, no published empirical trials of the effect of CBD on AUD patients. Notably, CBD products are widely available to consumers, and some products have a small amount of THC, further supporting an investigation into the efficacy of CBD (with and without THC) in reducing drinking in AUD patients. To that end, participants with moderate to severe AUD enrolled in a 7-week double-blind RCT (N=28) were randomized into one of three treatment conditions: full-spectrum CBD [fsCBD, <.3% THC; n=10; mean age (M)=33, standard deviation (SD)=8.34; 90% female], broad-spectrum CBD [bsCBD, no THC; n=8; M=36.88, SD=8.87; 50% female], or placebo [n=10; M=38.4, SD=5.66; 80% female]. Participants ingested 150mg daily doses of their assigned condition and were assessed at three in-person visits on measures of alcohol craving and consumption. A repeated measures ANOVA assessed group differences across the trial period. There was a linear effect of time (p=.001) and condition-by-time interaction on AUDIT scores (p=.034) and a simple effect of time within the bsCBD condition such that scores decreased from baseline to endpoint (p=.001). Further, there was a linear effect of time (p=.006) and a quadratic condition-by-time interaction (p=.045) on alcohol craving scores. A simple effect of time within the bsCBD condition revealed that craving decreased from baseline to endpoint (p=.049) and decreased from midpoint to endpoint within the fsCBD condition (p=.001). Although a preliminary pilot study, our findings demonstrate the potential influence of CBD to modulate reward networks implicated in downstream incentive salience cues related to craving and motivated behaviors in AUD patients.

CANNABINOIDS AND CARDIOMETABOLIC PHYSIOLOGY AT REST AND DURING EXERCISE

Christopher Bell

There is considerable interest in the potential benefits of cannabinoids as they pertain to cardiometabolic physiology at rest and during exercise. This presentation will comprise review and discussion of recent studies from our lab examining the influence of edible marijuana and cannabidiol on glucose control, autonomic regulation of heart rate, physiological responses to standardized exercise, and exercise performance. The importance of timing of measurements with respect to cannabinoid ingestion will also be addressed.

CANNABIS USE AND POSTOPERATIVE OUTCOMES IN PATIENTS UNDERGOING HEPATECTOMY

Michael Kirsch, Helen Paglia, Thiago Araujo, Helen Madsen, Salvador Rodriguez Franco, Mona Hamermesh, Reed Weiss, Ana Gleisner, Richard Schulick, Marco Del Chiaro, Camille Stewart

Use of cannabis and its derivative products (cannabinoids) has increased nationally. The cannabinoid cannabidiol (CBD) has been found to increase liver transaminases. We therefore sought to better understand the impacts of cannabinoid use on outcomes after liver surgery. We performed a single-center, retrospective review of prospectively collected clinical data from patients undergoing hepatectomy between 2019-2021. The outcomes of interest were pre- and postoperative liver transaminase levels and any complications within 90 days of surgery, classified using the Clavien-Dindo grading system. Multivariate linear and logistic regression were used to adjust for the influence of confounding variables, as appropriate. There were 247 consecutive patients included who underwent hepatectomy. Most patients were female (55.5%), most had an Eastern Cooperative Oncology Group performance status (ECOG) of 0 (n = 179, 72.5%) with a median age of 60.1 [IQR 50 – 70.2]. Forty patients (16.2%) reported cannabinoid use, most recreational (n = 29/40, 72.5%). Cannabinoid users were younger (median 61.1 IQR (52.1, 70.1) vs 52.1 (37.5, 66.7) years, p=0.002), but were otherwise demographically similar to non-users. There were 17/40 (42.5%) patients who reported cannabinoid use without use of tobacco and or abuse of alcohol. In unadjusted analysis, cannabinoid use was associated with higher alanine transferase (ALT) preoperatively and on post-operative day (POD1) (36.2 vs 61.8, p=0.03, and 264.7 vs 384.4, p=0.015 respectively). On multivariate analysis, cannabinoid use remained associated with increased ALT on POD1 (β = 161.26, 95% CI (59.29, 263.23), p = 0.002). There were 106/247 (42.9%) patients with complications within 90 days of surgery (grade 1-2, n=47/106 (44.3%), grade 3-5, n=59/106 (55.7%)). In unadjusted and multivariate analysis, there were no differences in complication rates between cannabinoid users and non-users identified. Cannabinoid use is self-reported by a non-trivial proportion of patients undergoing liver resection. Cannabinoid use may increase pre- and postoperative liver transaminase levels, but may not increase complications.

CANNABIS USE AND SUICIDALITY: A MULTI-SITE, CO-TWIN CONTROL STUDY FROM ADOLESCENCE THROUGH MIDDLE ADULTHOOD

Jarrod Ellingson, Jonathan Schaefer, Elisa Stern, Stephanie Zellers, J. Megan Ross, Matthew McGue, Sylia Wilson, Scott Vrieze, Soo H. Rhee, Christian J. Hopfer

Cannabis use is broadly associated with adverse mental health outcomes, including suicidality. Often, this relationship is assumed to indicate a causal effect of cannabis use on suicidality. However, a causal relationship cannot be established without addressing plausible alternative explanations. Two important alternative explanations are often unexamined in empirical studies of cannabis use – familial confounders and past behavior. Regarding familial confounders, cannabis use co-occurs with several shared risk factors for suicidality including genetic factors, lower socioeconomic status, parental psychopathology, parental substance use, and parental marital instability. This study used the co-twin control design, which leverages co-twins from the same family as matched controls, to test the effects of cannabis use on suicidality while controlling familial confounders. Within this design, we also used longitudinal data to examine the prospective effects (i.e., indicating directionality) across adolescence, young adulthood, and middle adulthood (assessments occurring in five-year increments). We found consistent cross-sectional associations between cannabis use and suicidality at ages. Importantly, familial confounders did not explain cross-sectional effects. Notably, prospective analyses found significant effects of earlier cannabis use on later suicidality and earlier suicidality on later cannabis use. However, in our most stringent test, co-twin control analyses of prospective effects failed to find within-twin-pair differences that would support a clear, causal relationship. While the results suggest that familial confounders cannot explain associations between cannabis use and suicidality, prospective analyses suggested bidirectional effects that were at least partially explained by confounders. The presence of robust cross-sectional effects but nuanced prospective effects may be due to the broad temporal scale (five years) with which assessments occurred. That is, any causal effects between cannabis use and suicidality (in either direction) may occur on a shorter time frame, which we recommend as the focus for future work.

CANNABIS USE IN PHYSICALLY ACTIVE INDIVIDUALS IS ASSOCIATED WITH ALTERED MONOCYTE PHENOTYPE BUT NOT ACUTE IMMUNE RESPONSE

Jonathon Lisano, Jacob Kisiolek, Victoria Flores, Peter Smoak, Nicholas A. Pullen, Laura K. Stewart

Monocytes and their three subtypes (classical, non-classical, and intermediate) are an immune cell population that is commonly associated with exercise recovery. Particularly the NC sub-type for their release of pro-inflammatory cytokines like interleukin-6 (IL-6) and tumor necrosis factor-α (TNFα). In cultured cells, cannabis has been observed to exert an acute anti-inflammatory effect, but it is still unknown if the chronic use of cannabis in physically active individuals produces a similar anti-inflammatory effect on immune cell function that is associated with alterations in monocyte phenotype. A total of N=22 participants were recruited for this study, and classified as either cannabis users (CU, n=11) or non-users (NU, n=11) based on their cannabis use habits over the previous 6 months. White blood cells were isolated from venous blood samples and costained for cluster of differentiation 14 (CD14) and 16 (CD16) to assess monocyte phenotype via flow cytometry. Venous whole blood was also used to determine immune response via IL-6 and TNFα release in response to 24-hour lipopolysaccharide (LPS) stimulations. All participants met the American College of Sports Medicines guidelines for weekly exercise requirements. The total number of monocytes per milliliter of blood was significantly greater (p<0.01) in CU ($5.1 \times 10^5 \pm 1.6 \times 10^5$ cells/mL) compared to NU ($3.2 \times 10^5 \pm 1.2 \times 10^5$ cells/mL). Despite CU having significantly greater numbers of monocytes classified as classical and intermediate, there was no difference in the number of non-classical monocytes between CU ($5.7 \times 10^4 \pm 4.4 \times 10^4$ cells/mL) and NU ($4.3 \times 10^4 \pm 2.4 \times 10^4$ cells/mL) groups (p=0.50). Total LPS-stimulated concentrations of IL-6 and TNFα were not different between groups with this lack of difference persisting when standardized to the number of non-classical monocytes in the blood. Based on these data, the chronic use of cannabis does not appear to alter the acute immune response in physically active individuals. This is despite observed alterations in monocyte number and phenotype and is likely the result of no alterations being observed in the non-classical mono

CANNIBIDIOL STUDY IN AUTISM SPECTRUM DISORDERS (CASCADE): PROGRESS TO DATE AND ADVERSE EVENTS OF CBD IN CHILDREN WITH ASD

Steffany Contreras, Rebecca Rochowiak, Elise Sannar, Ronda Franke, Emily Werner, Talia Thompson, Owen Miller, Jacquelyn Bainbridge, Crystal Natvig, Susan Mikulich, Nicole Tartaglia

Autism spectrum disorder (ASD) frequently presents with behavioral comorbidities such as irritability and aggressive behaviors which can cause significant adaptive impairment. Medications approved by the FDA for irritability in ASD have the potential for side effects and are not preferred by many families. Preliminary studies suggest that cannabidiol (CBD) may lead to improvements of behavioral symptoms in ASD. There is a need for studies of efficacy of CBD in ASD in blinded, randomized trials, as well as information related to adverse effects of CBD treatment. The CASCADE study is an ongoing randomized, placebo-controlled crossover trial designed to evaluate the efficacy of oral CBD (10mg/kg/day; 100mg/mL Jazz Pharmaceuticals) for 12 weeks in ASD patients 5 to 17 years of age for the primary outcome of irritability and aggressive behaviors. Randomization goal for statistical power for the primary outcome is 70. The study is funded by the Colorado Department of Public Health (clinicaltrials.gov nct04520685). Here we report progress to date and adverse events (AEs) seen in completed participants of the trial. At each study visit, the caregiver completes questionnaires to assess their child's irritability and aggressive behavior using the Aberrant Behavior Checklist–2, along with other measures of behavior, anxiety, and attention. Adverse events are recorded at each study visit. As of June 2023, 81 participants have consented, including 11 screen fails, 12 active participants, 40 study completions, 16 early withdrawals, and 2 participants terminated by PI. Of the 70 randomized, the mean age is 10.1 (sd 3.2), 83% male. Mean ABC-Irritability score at baseline was 22.7 (sd 8.37). Out of the 58 participants who have completed or withdrawn from, the most common study AEs include URI (39.6%), increased irritability (37.9%) and loose stools/diarrhea (17.2%), although results remain blinded to treatment of drug or placebo at the time of AE. Cohort demographics, baseline ASD characteristics, and AEs will be updated. Unblinded comparison of AEs during CBD treatment versus placebo will be presented

CO-USE OF CANNABIS AND PSYCHEDELIC COMPOUNDS: EVIDENCE FROM FIELD DATA COLLECTION IN COLORADO

Cianna Piercey, Devin Henry, Wes MacLean, Maia Bransom, Joseph Cameron, Bradley Conner, Jeffrey Snodgrass, Hollis Karoly

Over 90% of people who use cannabis also report use of other drugs. To date, most cannabis drug interaction studies have focused on the co-use of cannabis and alcohol, with few studies examining co-use of cannabis with other substances. Recently, Colorado decriminalized psilocybin (i.e., magic mushrooms), N, N-Dimethyltryptamine (i.e., DMT), and several other psychedelic compounds. Given this change in legislation, we might expect to see an increase in the co-use of cannabis and psychedelics, underscoring the growing need to understand how Tetrahydrocannabinol (THC) interacts with hallucinogenic compounds to impact outcomes. Some emerging evidence suggests that THC may intensify the intoxicating effects of psychedelics in a dose-dependent manner, potentially increasing risk of harm to self and others. However, it is also important to consider how psychedelics might be used by some individuals to mitigate adverse outcomes. For example, cannabis may be used to decrease the dose of psychedelics needed to produce desired effects, aid in sleep or stimulate appetite following a psychedelic experience, and/or reduce negative affect during a challenging psychedelic experience. I will discuss the current state of the literature on interactions between cannabis and psychedelic compounds, as well as preliminary findings from an ongoing study of cannabis and psychedelic co-users in Colorado. Specifically, our team is currently collecting field data at concerts and music festivals in Colorado on a variety of cannabis and psychedelic consumption variables (e.g., frequency and quantity of use, potency, doing patterns, drug acquisition) and outcomes of use (Current N=81, AFAB=50.6%, Mean Age=27.16). Preliminary findings suggests that 78.1% of participants used cannabis in the past 30 days and 55.6% of participants intended to use cannabis at the event they were entering. Among participants who planned to use cannabis during the event they were entering, most (93.3%) indicated plans to co-use with at least one other substance, including drugs such as MDMA, psilocybin, and LSD. Future analyses will test for associations between co-use and outcomes.

COMPARING THE EFFECTIVENESS OF CANNABIS TO TREAT SLEEP IMPAIRMENTS BETWEEN THOSE WITH AND WITHOUT SLEEP DISORDERS

Allison Herens, Brooke Worster, Emily Hajjar, Gregory Garber, Erin Kelly

People are increasingly turning to cannabis to treat sleep disorders and sleep-related symptoms. Despite mixed results in prior research, there is a small body of research indicating that cannabis could have a positive impact on sleep disorders, as well as people who have sleep issues that haven't arisen to a clinical level warranting diagnosis. It's important to understand if there are differences in the effectiveness of these therapies between those who have a sleep disorder diagnosis versus those who do not. Using an online cross-sectional survey, individuals across the United States self-reported how they used cannabis to treat sleep disturbances (N=528). To determine if a formal sleep diagnosis is associated with insomnia severity while using cannabis, a one-way ANCOVA was used to compare the difference between those with and without sleep diagnoses on the ISI on days that cannabis was used. Analyses controlled for age, gender, race, number of mental health diagnoses, employment status, and job shifts that may negatively impact sleep like third shift and swing shifts. While using cannabis, both those with a diagnosis (M=9.60, SD=4.68) and without a diagnosis (M=8.45, SD=3.92) reported scores well below the clinical cutoff of 15 on the ISI. There was a significant effect of formal sleep disorders on ISI scores after controlling for stated covariates [$F(1, 441)=5.66, p=.018$]. While most participants used cannabis for sleep daily, a subset of the sample did not (n =112). Using a paired t-test, we compared if insomnia severity was significantly reduced on days when using cannabis compared to when not using. There was a significant improvement in ISI scores on days that individuals did not use cannabis (M=13.84, SD=4.80) compared to days they used cannabis (M=9.04, SD=4.44), $t(111)=11.56, p<.001$. While patients with formal sleep disorder diagnoses still report greater sleep issues than those who do not have a formal diagnosis, both groups showed significant improvement in their levels of impairment related to sleep while using cannabis.

COMPARISON OF KNOWLEDGE, ATTITUDES, AND PRACTICE (KAP) IN ALLERGISTS AND ALLERGIC AND ASTHMATIC PATIENTS

Joanna Zeiger, William S. Silvers, Robert S. Zeiger

Dissemination of knowledge about cannabis in the medical setting has lagged behind increasing legalization and cannabis use. Allergists should be educating their patients about cannabis allergy and potential harms of cannabis inhalation, particularly among asthmatics. This analysis compared KAP among allergists and allergic/asthmatic patients. Allergists from the American College of Allergy, Asthma, and Immunology (ACAAI; n=207) and allergic/asthmatic patients from the Allergy and Asthma Network (AAN; n=489) completed an anonymous online survey. SPSS Two-Step cluster analysis was performed separately for allergists and patients to create attitude groups based on 10 attitudes questions. Four knowledge questions were used to generate a knowledge score by adding together the number of correct answers (range 0-4). Chi-square and ANOVA were used to determine whether there were significant differences in knowledge and attitudes between groups and practice within groups. Practice in allergists was defined as how comfortable they were speaking to patients about cannabis; practice among patients was whether they used cannabis in the past two weeks. Mean knowledge scores were 2.2 (SD=1.1) for allergists and 1.9 (SD=1.1) for patients (p<0.001). Two cannabis attitudes clusters were identified in both groups, entitled Progressive (allergists: n=124,59.9%; patients: n=211,43.1%) and Traditional (allergists: n=83,40.3%; patients: n=278, 56.9%) (group difference for attitudes: p<0.001). 140 (67.6%) allergists were comfortable speaking to patients about cannabis; however, 23% never asked about cannabis during patient visits (39% only queried in 1-25% of visits). Past 2-week cannabis use was reported by 88 (18%) patients of whom 67% smoked and/or vaped (routes of administration that can exacerbate asthma). Being in the progressive attitudes cluster was associated with having a higher knowledge score in allergists and patients (both p<0.01) and also with past two-week cannabis use in patients and comfort speaking to patients about cannabis among allergists (both p<0.001). Patients with allergy/asthma are less knowledgeable and less progressive about cannabis than allergists.

ABSTRACTS:
MEDICAL AND CLINICAL RESEARCH

CONGRATS ON THE AUTISM: A VISUAL PROJECT ON THE USE OF CANNABIS TO IMPROVE MOVEMENT EXPERIENCES IN AUTISM

Jersey Noah Deutsch

Physical activity rates are shown to be lower in autistic people. Current research on exercise interventions for this population focus on correcting movements or decreasing repetitive self-regulatory behaviors (stimming), leading to autistic masking. Autistic adults are reclaiming stimming behaviors as exercise by sharing experiences with cannabis use to unmask and facilitate physical activity participation. This project illustrates the role of cannabis in exercise and unmasking through memes. Studies show that autistic people often experience "a propensity for visual information and recall of subject details." The project is designed through memes and online visual content. Thirty memes are included, annotated, and summarized with current best evidence on autism and physical activity, body politics, unmasking, stimming and cannabis. Research on autism and physical activity highlights exercise interventions for the autistics in a way that encourages masking by categorizing "stimming" as a behavior that needs to be corrected. Meanwhile, stimming itself can be categorized as exercise and should not be discouraged. Reviewing research on autism and physical activity through an autistic lens, it is clear that researchers have not centered the perspectives of autistic people. The way that people in the autistic community have reclaimed stimming is worthwhile to consider for future research. Research has shown that cannabis can improve the exercise experience for neurotypical adults. Similarly, autistic communities are highlighting that cannabis can aid in unmasking, allowing autistics to "stim" more freely. When autistic people are able to embrace "stimming," our overall health is benefitted. Future research on autism and exercise should consider the role that cannabis may play in facilitating movement. We also encourage future investigations in cannabis and autism to center the experiences of autistic people in order to reflect another component of body autonomy.

CONNECTING THE PHARMACOKINETICS AND PHARMACODYNAMICS OF CANNABIS IN HUMANS BASED ON THE METHOD OF DELIVERY

Gary Milavetz, Gary G. Gaffney, Timothy L. Brown, Rose Schmidt

The psychoactive components of cannabis may be administered by inhalation, orally, or topical absorption. Tetrahydrocannabinol (THC) is the primary psychoactive agent from the cannabis plant. The perception of impairment is consistent with the psychoactive effects caused by THC taking up binding sites at the cannabis receptors (CB-1) found in the central nervous system (CNS). Methods: Data is taken from several published studies to compare the blood levels and the perception of impairment related to the method of delivery. Results and Discussion: THC appears in blood almost immediately after inhalation and is consistent with the perception of psychoactive effects but leads observed performance impairment. Over time blood levels of THC drop much more quickly than perceived and observed effects. In contrast, THC appears in blood at a lower amount associated with metabolism in the gastrointestinal (GI) track and is somewhat delayed relative to inhalation. Minimal THC is absorbed through the skin. Conclusions: The perception of impairment is produced almost immediately. Subjective effects continue to decline following vaporized cannabis administration in relation to THC blood levels as they approach a steady state asymptote. Over time there can be discontinuities between perceived effects and observed effects that can result in greater risk in activities requiring mental acuity to respond to emerging situations following use of vaporized cannabis Whereas impairment is delayed from GI absorption and negligible from topical absorption through the skin. The biggest risk is associated with the delayed GI absorption. Users continue to administer oral cannabis products to feel the psychoactive effects, but because of the delay they may have administered excessive amounts and experience troublesome side effects such as paranoia and anxiety.

ABSTRACTS:
MEDICAL AND CLINICAL RESEARCH

DON'T HIT SNOOZE ON CANNABIS: INFLAMMATORY MEDIATED EFFECTS ON SLEEP QUALITY IN MILD TO MODERATELY ANXIOUS INDIVIDUALS

Jonathon Lisano, Carillon Skrzynski, Greg Giordano, Angela Bryan, Cinnamon Bidwell

Effects of cannabis on sleep are mixed and may depend on the amount of THC vs CBD in the product or individual differences in anxiety and inflammation. This study aims to assess if changes in subjective sleep quality following ad libitum use of one of three cannabis chemovars over a 4-week period are dependent on pro-inflammatory cytokine levels in mild to moderately anxious individuals. A total of 171 participants (55% female), with a mean age of 31±12 years, who had General Anxiety Disorder-7 (GAD-7) scores of ≥ 5 were assigned to a CBD dominant (CBD: n=52), THC dominant (THC: n=44), equal parts THC to CBD (THC+CBD: n=51), or non-user (NU: n=24) group. Participants in cannabis use groups were instructed to use their flower products ad libitum over the 4-week study period and used their products an average of 12.0±8.1 times. Pittsburgh Sleep Quality Index (PSQI) scores were collected at baseline (pre-intervention) and at 4-weeks. Intravenous blood was collected at baseline to assess inflammatory state via circulating cytokines. Group differences in PSQI scores were assessed using analysis of variance (ANOVA). Exploratory generalized estimating equation (GEE) models assessed main effects and interactions of group by time and baseline inflammatory state. Participants in the CBD and THC+CBD groups had significantly higher PSQI scores at baseline compared to NU (p<0.01). The ANOVA model assessing change from baseline to 4-weeks showed improved sleep in only the CBD group (p<0.01). Moderator GEE analysis revealed a significant three-way group by time by baseline inflammation interaction (p<0.01). Significant improvements in sleep quality were observed in the THC group at moderate levels of inflammation, but in the CBD and THC+CBD groups improvements were observed at moderate and high levels of inflammation. Cannabis chemovars, particularly those containing higher amounts of CBD, were associated with improvements in subjective sleep quality in mild to moderately anxious cannabis users and were dependent on baseline inflammatory status. These results indicate that individuals with moderate to high levels of inflammation looking to use cannabis to improve sleep quality may experience the best effects by selecting products containing higher amounts of CBD.

ENDOCANNABINOID SYSTEM AND LONG COVID

Michael Stewart, Leonard Wisneski

Post-acute sequalae COVID-19 syndrome (PASC or Long Covid) is COVID symptoms lasting more than 30 days. PASC occurs in both hospitalized and patients with mild symptoms. PASC symptoms exceed 200, and include fever, fatigue, neurocognitive dysfunction (brain fog), dyspnea, chest pain, and depression, many of which are waxing and waning over time. The endocannabinoid system (ECS) contains the body's largest collection of neurotransmitters and receptors and regulates functions impacted by PASC across many systems, including inflammatory and immune responses. Could fortifying a compromised ECS reduce PASC symptoms in multiple physiologic systems? To test this single-system hypothesis, a phase 4 post marketing clinical trial in humans was performed using a full-spectrum hemp-derived formulation. Full IRB approval was obtained for a randomized, placebo-controlled, single-blind, open-label crossover study. Informed participants were randomized to two treatment groups. Group 1 received blinded active product for 28 days, and Group 2 received blinded placebo for 28 days. Both groups crossed over to open-label active product at 28 days with a safety assessment at day 70. Patient-Reported Outcomes Measurement Information System (PROMIS) scores and Patient Global Impression of Change (PGIC) score assessed primary and secondary objectives. Safety was assessed at each visit. Formula C improved 8 of 9 symptoms. Patient's PGIC improved 3X. Twenty-four participants completed the study. No adverse safety events occurred. Curiously, PGIC and PROMIS scores improved across both groups at day 28. A reanalysis of the placebo confirmed unexpected medical concentration of terpenes. Loss of a true placebo was mitigated by the cross-over arm and baseline design. Improved scores on outcome measures were maintained across the open-label treatment period. Formula C improved Patient outcomes without significant adverse events. Results support the hypothesis that modulation of the ECS with a hemp-derived formulation can safely attenuate PASC symptoms. Formula C is commercially available. Extended research has been IRB approved.

EVIDENCE-BASED CUSTOMER DISCOVERY CONFIRMS VALUE OF MEDICAL CANNABIS RESEARCH PLATFORM

Cheryl Fitzer-Attas, Shrey Joshi, Connie Pascal

The National Science Foundation's I-Corps™ program trains scientists & engineers in innovation skills, providing a framework for transforming ideas into commercial successes. Evidence-based customer discovery (EBCD) is a qualitative research methodology that focuses on understanding problems potential customers face and what they value. Despite the global tidal wave of medical cannabis usage, the industry is highly-regulated, leading to significant research hurdles and under-funding. Through a Rutgers University I-Corps™ cohort, we used EBCD to assess potential customer value for an on-demand decentralized research platform for medical cannabis. After defining potential customer segments and corresponding value proposition hypotheses, we conducted semi-structured interviews with a diverse group of stakeholders (purposeful and snowball sampling) to test hypotheses and generate insights. We required >80% aligned insights for hypothesis 'validation'. Interviews took place over 15 weeks via online video calls that were recorded and transcribed to track insights using the software Innovation Within™. We conducted 47 interviews with 15 researchers (academic/hospital), 14 medical cannabis producers, 9 health-care providers (HCP) who actively recommend/prescribe cannabis, 6 regulators/policymakers, and 2 healthcare consumers. Interviewees resided mostly in North America (72%), with representation from EU/UK (15%) and Israel (13%). Value propositions hypotheses were 'validated' for researchers, producers, and HCPs, with >80% alignment of insights. Important customer obstacles and potential platform solutions were extracted. Based on lean startup methodologies, EBCD is a crucial first step in determining potential success of a product or service. We used direct dialog with key stakeholders to 'validate' value proposition hypotheses and characterize customer segments for a decentralized clinical research platform. We gained evidence for product-market fit and learned about features of interest. This research platform will provide valuable data to better understand benefits and risks of medical cannabis for individuals, disease states, and public health.

EXPLORING THE EFFICACY OF CANNABIS IN PAIN MANAGEMENT AND OPIOID REDUCTION

Alan Morris

Back and neck pain are highly prevalent and disabling musculoskeletal conditions that significantly affect the quality of life of those affected. Opioids are commonly prescribed for pain management, but they are often ineffective, and can result in dependency and lethal overdose. Cannabis has emerged as a promising alternative analgesic treatment, gaining increasing recognition for its potential benefits in reducing pain and opioid use. While preclinical and clinical studies have shown potential benefits for cannabis in pain management and opioid use reduction, the evidence regarding the efficacy and safety of cannabis-based therapies is still evolving. This talk will provide a comprehensive update on the current state of knowledge regarding the potential of cannabis to decrease and/or replace opioids. The presentation will cover recent findings from preclinical and clinical studies, insights into the mechanisms of action, and implications for future research, clinical practice, and policy development. Additionally, emerging data from our lab and two new trials that we began in 2023 will be discussed. In a double-blind crossover trial, we compared the efficacy of acute cannabis exposure to the commonly prescribed opioid oxycodone for spontaneous pain relief. To date, 38 participants have been enrolled. Each participant has attended 3 study visits that included neurocognitive assessments, field sobriety tests, drug effect ratings, and pain threshold measurements using a computer-controlled pressure algometer. The data remain blinded and are referred to as drugs A, B, and C (cannabis, oxycodone, and placebo). Drug A slightly decreased pain threshold and impaired the one leg stand portion of the field sobriety test. Drug B had minimal effect on pain threshold and field sobriety testing. Drug C increased pain threshold and caused Horizontal Gaze Nystagmus. No effect was seen on the walk and turn test after administration of any drug. Subjective drug effects varied across the 3 treatments. Drug A had a rapid onset of effects, Drug C had a delayed onset, and Drug B had little effect. Pain threshold changes were mixed across genders and drug conditions. Final statistical analysis will account for between-participants differences in pain sensitivity. The study is expected to be completed by early 2024.

FEASABILITY OF HEMP-DERIVED MINOR CANNABINOIDS AND TERPENES FOR SKIN REPAIR AND WOUND HEALING

Traci Kimball

We conducted a comprehensive a literature review and Clinical Trials search on the use of major and minor cannabinoids, i.e., compounds found in the cannabis plant, for the treatment of skin conditions and diseases, with special focus on wound healing. Part one focuses on scientific publications retrieved from the PubMed database of the U.S. National Institutes of Health's National Library of Medicine (NIH/NLM), and part two on clinical trials registered at the clinicaltrials.com website, run by the United States National Library of Medicine at the National Institutes of Health. Publications for potential inclusion were retrieved via a systematic search of the PubMed database. Citations were limited to papers published in the past 5 years in the English,Portuguese, Spanish, Italian, French and German languages. The literature search was completed on October, 2022. A total of 335 scientific publications were retrieved with 52 publications of relevance found linking to our research aims: feasibility and mechanism of action of cannabinoids and terpenes working in synergy (i.e.ENTROURAGE) for skin inflammation, pain and biofilm in wounds. Although many of the studies presented in this review do not meet the highest standards of scientific research (randomized, double-blinded, placebo-controlled, large sample size), many were well-designed and reached statistically significant results stating to the benefits of cannabinoids for wound healing. The clinical trials retrieved are a good indication of the growing interest in the use of cannabinoids for the treatment of skin diseases.

FETAL CANNABIDIOL (CBD) EXPOSURE INDUCES GLUCOSE INTOLERANCE AND INSULIN RESISTANCE IN A SEX- AND DOSE-DEPENDENT MANNER

Karli Swenson, D. Sarbaugh, L. Folts, C. Minne, E.A. Bates

Pregnant people consume cannabidiol (CBD), a non-psychoactive component of marijuana, because it can help with morning sickness and public perception is that it is safe. CBD diffuses across the placenta and accumulates in the fetal brain, liver, and other fatty tissues. Children exposed to marijuana in-utero show increased fasting blood glucose and adiposity at 5 years old. However, the specific impact of CBD within marijuana products is unknown. Furthermore, CBD activates receptors that regulate important developmental and metabolic processes. Thus, we hypothesized that fetal CBD exposure impacts postnatal diabetes risk and metabolism in mice. We administered 50mg/kg CBD or vehicle to pregnant mice throughout gestation from embryonic day (E)5.5 to birth. We found that male, but not female, offspring are glucose intolerant at 22 weeks old. We find no differences in pancreatic morphology, though CBD-exposed male offspring release insufficient insulin upon glucose stimulation, a marker of pre-diabetes. However, we show that CBD exposed offspring show no differences in body composition or calorimetry, including caloric intake, activity, or calories burned. We find that female, but not male, offspring are insulin resistant at 22 weeks old. We show that lower, more clinically relevant doses of CBD, including 10mg/kg and 25mg/kg are sufficient to induce glucose intolerance and insulin resistance as well. Together, this data highlights the risk to offspring of gestational CBD consumption, including development of prediabetes in a sex- and dose-dependent manner.

GESTATIONAL CANNABIDIOL (CBD) CONSUMPTION IMPACTS OFFSPRING BRAIN DEVELOPMENT AND POSTNATAL BEHAVIOR

Lillian Folts, Karli Swenson, Louis Wulschner-Gomez, Won Chan Oh, Emily Bates

Cannabidiol (CBD), a non-psychoactive component of cannabis, is marketed to pregnant people as a safe and natural alternative to traditional pharmaceuticals to alleviate morning sickness. Consumption of CBD during pregnancy is increasing in the U.S., with up to 19% of pregnant people reporting taking CBD at least once during their pregnancy Currently, there is little known about how fetal CBD exposure affects offspring brain development and behavior. CBD activates Transient Potential Villanoid 1 Receptor (TRPV1), Kv7 potassium channels, and Serotonin 1A Receptor (5HT1AR) which are critical for brain development. To determine if fetal CBD exposure alters offspring brain development and behavior, we administered 50 mg/kg of CBD or vehicle daily to pregnant mice from embryonic day (E) 5 until birth. We conducted single cell RNA sequencing on the hypothalamuses from postnatal day (P)1.5 pups to elucidate the impact of CBD exposure on development of the hypothalamus. These data revealed differences in gene expression within the hypothalamus based on CBD exposure and offspring sex that predicted changes in neurodevelopment. To determine if CBD affects postnatal behavior, we measured thermal pain sensitivity, anxiety, memory, and cognition in female and male mice exposed to CBD or vehicle during fetal development. Fetal CBD exposure led to heightened thermal pain sensitivity in male offspring but not female offspring, regardless of stage in the estrous cycle. We found that heightened thermal pain sensitivity in CBD-exposed males is dependent on TRPV1. Fetal CBD exposure did not affect anxiety or memory in mice. We show that fetal CBD exposure reduces cognition in female, but not male offspring. Ex vivo electrophysiology recordings demonstrate that fetal CBD exposure renders layer 2/3 pyramidal neurons in the prefrontal cortex of female offspring less excitable, although they have a similar resting membrane potential compared to males and vehicle control females. Combined, these data suggest that fetal CBD exposure could be harmful to fetal brain development, highlighting the need for increased awareness and education surrounding CBD use during pregnancy.

IDENTIFICATION OF VAPED VITAMIN E ACETATE AS THE PRIMARY CAUSE OF E-CIGARETTE, OR VAPING, PRODUCT ASSOCIATED LUNG INJURY (EVALI)

Benjamin Blount

E-cigarette, or vaping, product associated lung injury (EVALI) resulted in the death of 68 people and hospitalization of 2,807 from all 50 states, the District of Columbia, and several U.S. territories and other countries. Early epidemiological data indicated a non-infectious cause of the outbreak. This presentation will describe the development and application of new analytical methods to measure potentially causal chemicals in e-liquids, vaped aerosols, and bronchoalveolar lavage fluid collected from EVALI cases. Bronchoalveolar lavage (BAL) fluids were obtained by clinical teams caring for hospitalized EVALI patients. Residual specimen was stored frozen for subsequent analyses for potential EVALI toxicants. Vitamin E acetate (VEA) was detected in BAL fluid samples from 48 of 51 (94%) EVALI cases. Of the other excipient measured (plant oils, medium-chain triglyceride oil, coconut oil, petroleum distillates, and diluent terpenes) only coconut oil and limonene were detected in case patient BAL fluid. No VEA was detected in BAL fluids collected from 99 non-EVALI comparators (including 18 comparators who used nicotine e-cigarettes). VEA may injure the lung through ketene formation during vaping and also through disruption of alveolar surface tension. These measurements implicate vaped VEA as a likely cause of lung injury. Further data will be presented to demonstrate that mice exposed to vaped vitamin E acetate develop lung injury. In conclusion, vaped vitamin E acetate is the primary cause of the EVALI outbreak based on accumulation of VEA in BAL fluid. BAL fluid analysis is unique in that it provides direct linkage of product constituents to inhaled chemicals reaching the lungs. This approach may be useful for assessing future causes of lung injury related to vaping.

IMPACT OF PRENATAL EXPOSURE TO DELTA 9-TETRAHYDROCANNABINOL AND CANNABIDIOL ON NEONATAL ADIPOSITY AND POSTNATAL GROWTH TRAJECTORIES: THE HEALTHY START STUDY

Brianna Moore, Wei Perng, Katherine A. Sauder, Emily T. Hébert, Adrienne T. Hoyt, Erica M. Wymore, Kristen E. Boyle, Allison L. B. Shapiro, Gregory Kinney, Dana Dabelea

Cannabis use during pregnancy is associated with lower birth weight. Less is known about whether prenatal exposure to individual cannabinoids influences offspring growth, or whether breastfeeding modifies this association. We followed 128 mother-child pairs from Colorado through age 3 years. We measured delta 9-tetrahydrocannabinol (Δ9-THC) and cannabidiol (CBD) in maternal urine collected mid-gestation. Generalized linear models estimated the associations between Δ9-THC (with/without CBD) and neonatal body composition. A mixed-effects model estimated the association between Δ9-THC and BMI trajectories. Interaction was assessed by a three-way product term (Δ9-THC x breastmilk-months x age). In this Colorado-based cohort, 12% (n=15) of children had Δ9-THC exposure, with three having concomitant CBD exposure. Offspring exposed to Δ9-THC alone had lower weights (-216 g, 95% CI: -458, 27) and adiposity (-2.1%; 95% CI: -4.2, -0.04) at birth, and grew more rapidly in childhood (0.57 kg/m2 increase in BMI per year; 95% CI: 0.04, 1.72). Breastfeeding modified this association, such that Δ9-THC exposure had no effect on growth among those breastfed for ~9 months but was associated with a 2.02 kg/m2 higher BMI at three years among never breastfed offspring (95% CI: 0.67, 3.35). Prenatal exposure to Δ9-THC, in the absence of CBD, influenced early-life growth. Breastfeeding may reduce accelerated postnatal growth among Δ9-THC-exposed offspring, but the impact of lactational exposure requires further investigation.

LC - MS/MS QUANTIFICATION OF Δ8-THC, Δ9-THC, THCV ISOMERS AND THEIR MAIN METABOLITES IN HUMAN PLASMA

Cristina Sempio, Jorge Campos-Palomino, Jelena Klawitter, Amy Harrison, Erica Peters, Laura MacNair, Marcel Bonn-Miller, Marilyn A. Huestis, Uwe Christians, Jost Klawitter

In recent years, isomers of tetrahydrocannabinol (THC) and tetrahydrocannabivarin (THCV) gained popularity for recreational and therapeutic applications, but little is known about their pharmacokinetics and metabolism. Cannabis consumption is generally monitored by detection of Δ9-THC and its metabolites, 11-hydroxy-Δ9-THC (Δ9-11-OH-THC) and 11-nor-9-carboxy-Δ9-THC (Δ9-THCCOOH), in blood, plasma or urine. Recently, the surge of preclinical, clinical and observational trials involving Δ8-THC and Δ8-THCV increased the need for sensitive and specific analytical assays to establish dose-effect relationships. We developed and validated an online extraction high-performance liquid chromatography coupled to tandem mass spectrometry (LC/LC-MS/MS) assay for simultaneous quantification of 13 cannabinoids and metabolites including Δ9-THC, 11-OH-Δ9-THC, Δ9-THCCOOH, Δ8-THC, 11-OH- Δ8-THC, Δ8-THCCOOH, (6aR,9R)-Δ10-THC, (6aR,9S)-Δ10-THC, Δ9-THCV, 11-nor-9-carboxy-Δ9-THCV (Δ9-THCV-COOH), Δ8-THCV, 11-hydroxy-Δ8-THCV and Δ8-THCV-COOH in human plasma. The novelty of this approach is the simultaneous quantitative analysis of the isomers of THC, THCV and their main metabolites. Human plasma was fortified with cannabinoids at varying concentrations within the working range of the respective compound and 200 μL extracted using a simple one-step protein precipitation procedure. Two-hundred and fifty μL sample supernatant was injected onto the extraction column (3.0x5.0 mm, 2.7 μm particle size, C8) then the analytes were back-flushed onto the analytical column (3.0x150 mm, 2.7 μm particle size, RP-Amide). Analysis was performed on an API5000 MS/MS that ran in the positive multiple reaction monitoring (MRM) mode. The method was validated according to FDA guidelines. Linear ranges were 0.5-400 ng/mL or 1-400 ng/mL for all analytes except Δ8-11-OH-THC. Acceptance criteria for intra- and inter-batch accuracy (85-115%) and precision (<15%) were met for all compounds in human plasma. Mean extraction efficiency was 68.8-106.2% and mean absolute matrix effect ranged 4.2-25.9% in plasma. No carry over was detected. The assay was used to quantify Δ8-THC

LOCATION, LOCATION, LOCATION: VARIABILITY IN EXPERIENCE OF EXERCISE DURING CANNABIS USE IN THE NATURAL ENVIRONMENT VERSUS THE LAB

Angela Bryan, Laurel Gibson, Gregory Giordano, Luyi Gao

Cannabis users are more likely to meet exercise recommendations than non-users, and those who use cannabis during exercise report that it increases their enjoyment of and motivation for exercise. Given the legal landscape affecting cannabis research, studies of cannabis use during actual exercise is challenging and there are a range of possible approaches. This study compares two methodologies for studying exercise during cannabis use. The first uses a remote observational design in which participants (n = 49) completed their typical running route once after using their preferred cannabis product and once without using cannabis (order counterbalanced). The second used a laboratory-based design in which participants (n = 44) completed a bout of treadmill exercise of prescribed intensity and duration once after using a study-directed cannabis product (THC-dominant versus CBD-dominant flower) and once without using cannabis (order counterbalanced). In the remote study, participants ran an average of 3.88 miles (SD = 2.28) and ran an average of 31 seconds/mile slower during their cannabis run. They reported experiencing less negative affect, greater positive affect, tranquility, and enjoyment, less pain and more runner's high symptoms during their cannabis (vs. non-cannabis) runs. There were no differences in perceived exertion and cannabis type/cannabinoid ratio did not affect outcomes. In the laboratory , participants also reported more positive affect, enjoyment, and runner's high symptoms during their cannabis (vs. non-cannabis) exercise, but also reported more exertion and breathlessness. Pain levels did not differ. There was a larger difference in enjoyment and a smaller difference in exertion in the CBD (vs. THC) condition. Results suggest that while some of the subjective outcomes of exercise during cannabis use are relatively robust (e.g., enjoyment, runner's high) others depend in part on the context (lab versus natural environment) and/or parameters (self-selected versus imposed intensity) of exercise. Both studies were pre-registered on OSF (https://osf.io/tx97g; remote and https://osf.io/sptzb; laboratory).

QUANTITATIVE ANALYSIS OF E-CIGARETTES/VAPE PRODUCTS RELATED TO A LUNG INJURY OUTBREAK

Clifford Watson, Liza Valentin-Blasini, Benjamin Blount

Analyzing emissions from e-cigarette/vape products (EVPs) is complicated, in part, by chemical and physical differences in the devices and liquid contents. For example, nicotine is relatively polar and the corresponding solvent systems used are relatively polar propylene glycol and glycerol. In contrast, devices containing cannabinoids often use less polar solvent such as medium chain triglycerides (MCTs). The chemical and physical differences in active ingredients in EVPs lead to use of additives/solvent of different polarity; of relevance, vitamin e-acetate additive in EVPs was the primary cause of the 2019-2020 outbreak of e-cigarette, or vaping, product associated lung injury (EVALI). During the EVALI response, we developed and validated multiple quantitative analytical methods to characterize potentially causal chemicals. We conducted analyses for tocopherols, squalene, squalene, terpenes, nicotine, humectants, cannabinoids, volatile organic compounds, hydrogen cyanide, carbonyls, metals, and triglycerides in aerosols from EVPs obtained from cases (total of 175 case-related and 19 non-case-related devices or liquids). The differences in the devices, their chemistries, and lack of reference products provided many analytical challenges for optimizing aerosol generation, sample preparation, and quantification. For example, some devices had non-circular mouthpiece geometries so connection to testing apparatus required novel adapters. Per puff aerosol deliveries between some devices yielded 10-fold differences in emissions. Differences in the polar and non-polar liquid contents required modifications in sample preparation procedures to optimize analyses. This presentation addresses how we optimized analyses to resolve these challenges while operating in a strict quality assurance/control environment.

RATES OF CANNABIS USE VERSUS OTHER ILLICIT SUBSTANCES IN SURGICAL ONCOLOGY PATIENTS

Salvador Rodriguez Franco, Helen Madsen, Ana Gleisner, Marco Del Chiaro, Richard D Schulick, Martin McCarter, Camille Stewart

Many states have comprehensive medical cannabis programs. Reported therapeutic benefits of cannabis include decreased symptoms of pain, nausea, and anorexia- uses that may be applicable to surgical oncology patients. Despite this, there is a paucity of data on the use of cannabis in these patients. We aim to compare the rate of cannabis use to other substances in surgical oncology patients. This is a single center retrospective review from 2010-2020 of all patients who underwent an oncologic operation and were included in the prospectively maintained surgical oncology database (breast, gastric and esophageal, skin and melanoma, pancreatic, colorectal, and hepatic cancer). The primary outcome was self-reported use of patient-reported alcohol, tobacco, cannabis/derivative products (cannabinoids), and other illicit substances (heroin, intravenous (IV) drugs, methamphetamines, cocaine). A total of 4,354 patients were included for analysis. Cannabis use was self-reported in 14.7% of patients and was more common in pancreatic and breast cancer. Medical use was more common than recreational use for all types of patients with cancer, reported at a rate of 60.5%, however this information was not available for all patients. Among cannabis users, combined use of tobacco was common, with an average rate of 54.7%. Tobacco use was reported in 41.1% of surgical oncology patients, reported tobacco use was highest in patients with pancreatic and gastric/esophageal cancer. The rate of reported current alcohol use was 57.6%, with patients with skin and breast cancer reporting the most frequent use. For all surgical oncology patients, the reported rate of illicit drug use was <1%. Conclusion: Cannabis and cannabinoid use was commonly reported in our surgical patients, with an average use rate of 14.5%. Limitations of the data include reliance on patient self-report of substance use. It is critical for providers to recognize that cannabis is of particular interest to the surgical oncologic population and is distinct from other reported illicit substance use. This indicates a need for future-focused studies on the impact of cannabis use.

ROLE OF CANNABIGEROL IN ALLEVIATING THE HIGH-FAT-DIET INDUCED NON-ALCOHOLIC FATTY LIVER DISEASE IN MICE MODEL

Yutan Han

Non-alcoholic fatty liver disease (NAFLD) is one of the leading causes of chronic liver disease that can progress into a more advanced form- non-alcoholic steatohepatitis (NASH) featuring inflammation and fibrosis. There is no specific medicine for advanced NASH patients, making it critical to find supplements to mitigate liver damage. Non-psychoactive cannabinoids cannabidiol (CBD) and cannabigerol (CBG) has shown anti-inflammatory effect in other diseases, but their therapeutic effect in NAFLD/NASH is unknown. We aim to evaluate the efficacy of CBG intervention to reduce NAFLD/NASH. C57BL/6 mice were utilized at 8 weeks of age and separated into different diet regimens of either normal chow or high fat diet. At 16 weeks the mice were then separated into different treatment regimens of control or CBG fed ad-libitum through drinking water at a concentration of 136mg/liter. At 24 weeks mice were euthanized and dissected with body and organ weights recorded. Liver steatosis, morphology, oxidative stress, bile duct proliferation and inflammation were examined using Oil Red O, H&E, 8-OH-dG (markers for oxidative stress), CK-19 (markers for cholangiocytes)and CD45 (marker for white blood cells) staining, respectively. T cell population were examined in isolated splenocyes using flow cytometry. We have found that administration of CBG in diet-induced NAFLD/NASH leads to decreases in hepatic steatosis, oxidative stress, immune cell infiltration, and bile duct proliferation in the liver. T cell population (CD3+CD45+), Tc cell population (CD45+ CD8+) and Th cell population (CD45+ CD4+) were diminished with CBG treatment when compared to diet-induced NAFLD/NASH group. This research will provide therapeutic efficacy data about CBG for NAFLD/NASH for the first time in mice, which will benefit future cannabinoid-related animal and human studies. Further, we will provide in-depth information about molecular mechanisms in which CBG diminishes NAFLD/NASH progression.

STEM: SYSTEMATICALLY TESTING THE EVIDENCE ON MARIJUANA

Beth Shaw, Chelsea Ayers, Jamie Lo, Snehapriya Yeddala, Shannon Robalino, Devan Kansagara

With continuing legalization, cannabis use has been increasing in the US. Meanwhile, many healthcare providers are not counseling patients on the health effects of cannabis and most patients source this information from elsewhere (e.g., internet, cannabis dispensaries). Limited evidence regarding cannabis health effects, and a rapidly-changing research landscape, leave providers without guidance on how to counsel patients. As more patients are using or showing interest in using cannabis, healthcare providers should be prepared to have evidence-informed discussions about cannabis use. Additionally, high-quality research is needed to improve knowledge regarding cannabis health effects. STEM is a collaboration between the Veterans Health Administration (VHA) and the Center for Evidence-based Policy at Oregon Health & Science University, and is funded by the VHA Office of Rural Health. Using best-practice approaches to living systematic reviews, and guided by a technical expert panel comprised of individuals with cannabis-related clinical and research expertise, we aim to: 1. Empower healthcare providers to have evidence-based discussions about cannabis use with patients 2. Identify research gaps and highlight ongoing research to help researchers design high-yield studies that advance the field of clinical cannabis research Since the launch of the website in January 2022 we have: Completed 6 living systematic reviews, including cannabis use in pregnancy and cannabis for PTSD, Provided an overview of cannabis basics, Developed 12 clinical briefs, on topics ranging from "patient experiences when visiting dispensaries" to "cannabis and sleep." We also provide a searchable database of ongoing studies of cannabis-related research, guidance on the conduct of cannabis-related research, and an interactive policy map on legal status and key cannabis use statistics by US state. STEM is an independent, methodologically rigorous, and updated cannabis evidence resource for the healthcare sector that synthesizes what is known from research and what is left to learn about health effects of cannabis.

THE INFLUENCE OF CANNABIS INHALATION ON EXERCISE PHYSIOLOGY AND CARDIOVASCULAR FUNCTION: EXPLORING THE EFFECTS OF CANNABINOIDS AND MODE OF ADMINISTRATION

Christian Cheung, Massimo Nardone, Ryleigh E. Baker, Alex M. Coates, Jordan B. Lee, Kathryn Pfundt, Philip J. Millar, Jamie F. Burr

Cannabis inhalation exerts acute hemodynamic effects in humans, both at rest and during exercise. Despite the long-standing knowledge that cannabis inhalation acutely increases heart rate, investigations examining more specific indices of cardiac function, vascular function, and cardio-respiratory responses to exercise are scarce. The purpose of the present study was to examine the acute effects of inhaling cannabis of various forms, and by different methods, on cardiovascular function and exercise physiology. Twenty-two young, ostensibly healthy, habitual cannabis users were recruited and enrolled in a randomized cross-over design study examining the effects of inhaling cannabis containing predominantly -9-tetrahydrocannabinol (THC) or cannabidiol (CBD) either via traditional smoking, or aerosol generated from a dry flower vaporizer. Prior to and following each condition, arterial stiffness, vascular endothelial function, cardiac function, exercise performance, and cardio-respiratory responses to exercise were assessed. Additionally, we examined the neuro-cardiovascular responses to inhaling these two forms of cannabis. Inhalation of cannabis containing THC increased resting heart rate and blood pressure regardless of inhalation method, whereas cannabis primarily containing CBD did not. All cannabis interventions resulted in an increase in arterial stiffness. In contrast, vascular endothelial function was not altered by cannabis inhalation. Cardiac function was altered by cannabis inhalation to a greater degree by cannabis with relatively higher levels of THC compared to CBD. Physiological responses to exercise and exercise performance were impaired by cannabis with THC, but not CBD containing cannabis. In contrast to previously held dogma, cannabis predominantly containing THC reduced sympathetic nervous system activity, whereas cannabis predominantly containing CBD had little effect on autonomic cardiovascular regulation. Our work highlights the robust effects of cannabis inhalation on hemodynamics, neuro-cardiovascular regulation, and exercise physiology. These effects appear to be influenced more by cannabinoid concentrations rather than inhalation method.

THE SAFETY AND COMPARATIVE EFFECTIVENESS OF NON-PSYCHOACTIVE CANNABINOID FORMULATIONS FOR THE IMPROVEMENT OF SLEEP: A DOUBLE-BLINDED, RANDOMIZED CONTROLLED TRIAL

Antonija Kolobaric, Corey Bryant, Christopher R. D'Adamo, Christopher S. Colwell, Derek Loewy, Jeff Chen, Emily K. Pauli

Clinical evidence on the use of Cannabidiol (CBD) for sleep remains limited. Even fewer studies have tested the comparative effectiveness of cannabinoid formulations found within CBD products used for sleep or how they compare to other complementary therapies such as melatonin. Participants (N=1,793 adults experiencing symptoms of sleep disturbance) were randomly assigned to receive a 4-week supply of 1 of 6 products (all capsules) containing either 15mg CBD or 5mg melatonin, alone or in combination with minor cannabinoids. Sleep disturbance was assessed over a period of 5 weeks (baseline week and 4 weeks of product use) using Patient-Reported Outcomes Measurement Information System (PROMIS™) Sleep Disturbance SF 8A, administered via weekly online surveys. A linear mixed-effects regression model was used to assess the differences in the change in sleep disturbance through time between each active product arm and CBD isolate. All formulations exhibited a favorable safety profile (12% of participants reported a side effect and none were severe) and led to significant improvements in sleep disturbance ($p<0.001$ in within-group comparisons). Most participants (56% to 75%) across all formulations experienced a clinically important improvement in their sleep quality. There were no significant differences in effect, however, between 15mg CBD isolate and formulations containing 15mg CBD and 15mg Cannabinol (CBN), alone or in combination with 5 mg Cannabichromene (CBC). There were also no significant differences in effect between 15mg CBD isolate and formulations containing 5 mg melatonin, alone or in combination with 15mg CBD and 15mg CBN. Our findings suggest that chronic use of a low dose of CBD is safe and could improve sleep quality, though these effects do not exceed that of 5 mg melatonin. Moreover, the addition of low doses of CBN and CBC may not improve the effect of formulations containing CBD or melatonin isolate.

THE TOLERABILITY OF SUPPLEMENTING CBD AT TWO DOSES FOR 9 MONTHS TO HEALTHY DOGS

Isabella Corsato Alvarenga, Hannah Hess, Kim Wilson, and Stephanie McGrath

Cannabidiol (CBD) has gained recognition for its therapeutic potential in companion animals. Dog owners have been using CBD mostly for neurological and inflammatory conditions, although long-term tolerability has not been established. Short-term studies have determined CBD is well tolerated with mild side-effects and an elevation in alkaline phosphatase. Hypothesis/Objectives: Determine the long-term tolerability of oral CBD administered to healthy dogs. Animals: Eighteen healthy adult research dogs were randomly assigned to 3 groups (n=6) that received either 0, 5 or 10 mg/kg/day CBD. After adapting for 3 weeks, dogs received 9 months oral treatment once daily postprandially. Adverse events were recorded daily. Monthly blood profiles, post-prandial bile acids, and plasma CBD at fasting state and 2h post-dosing were measured. Data were analyzed as repeated measures over time using a mixed model, with significance at $\alpha = 0.05$. Results: The 0 and 5mg/kg had similar fecal scores. Although 10mg/kg had greater incidence of soft-stools, no other significant AEs were noted. An elevation ($P < .0001$) in ALP occurred in groups that received CBD (61.4, 284.5 and 373.5 IU/L in 0, 5 and 10mg/kg, respectively). Remaining blood parameters were within reference range. Average plasma CBD at 5 and 10mg/kg were 97.3ng/mL and 236.8ng/mL pre-prandial, 340.8ng/mL and 1067.7ng/mL postprandial, respectively. A cumulative effect at fasting state over time occurred ($P = 0.0122$). Conclusions and clinical importance: Chronic administration of CBD at 5mg/kg was better tolerated than at 10mg/kg, and both doses caused elevated ALP.

THE USE OF CANNABIDIOL AS ADJUNCT THERAPY FOR REFRACTORY IDIOPATHIC EPILEPSY IN 51 DOGS: A DOUBLE-BLINDED CROSSOVER DESIGN

Breonna Kusick, Aaron Rozental, Brooke Gallagher, Isabella Corsato-Alvarenga, Daniel Gustafson, Sangeeta Rao, Lisa Bartner, Stephanie McGrath

Idiopathic epilepsy is the most common neurologic condition in dogs, affecting an estimated 0.5-5.7% of the canine population. Of dogs affected with idiopathic epilepsy, approximately 30% remain refractory to standard treatment. Recent studies have suggested that CBD may be an effective anticonvulsant in dogs with idiopathic epilepsy. This study includes 51 client-owned dogs with idiopathic epilepsy who were having at least two seizures per month while receiving at least one therapeutic antiepileptic drug (AED). This was a double blinded placebo-controlled crossover design. Dogs were randomly assigned to receive CBD in hemp seed oil or placebo hemp seed oil for three months followed by a one-month washout period prior to receiving the opposite oil for three months. Dogs were initially dosed at 5mg/kg/day, but the dose met futility requirements after 12 dogs and was increased to 9mg/kg/day for the remaining 39 dogs. Total seizures and seizure days were recorded, and bloodwork was performed monthly throughout the trial. There was no treatment effect on seizure frequency at the 5mg/kg/day dose. At the 9mg/kg/day dose, a decrease in total seizure frequency was statistically significant compared to placebo. There was a 24.1% reduction in seizure days for dogs receiving 9mg/kg/day of CBD and a 5.8% increase in dogs receiving placebo (p=0.0017). Bloodwork revealed an increase in alkaline phosphatase and alanine transaminase in both dosing groups and no statistically significant change in antiepileptic drug levels in either group. Results show that CBD oil may have a significant effect on reducing seizure frequency in dogs who have remained uncontrolled on routine antiepileptic drugs.

USING TECHNOLOGY TO ADVANCE CANNABIS RESEARCH AND MAXIMIZE BENEFITS TO MEDICAL CANNABIS PATIENTS: A PANEL DISCUSSION

Cheryl Fitzer-Attas, Joanna Zeiger

Cannabis is a complex plant that has been used for medicinal, recreational, and industrial purposes for thousands of years. Interest in the therapeutic potential of cannabis has led to increased research in this field. Advanced technologies have the potential to positively impact cannabis research, allowing for a more comprehensive understanding of the plant's chemical composition and the accuracy in which patients can be monitored for health and wellness. This PANEL DISCUSSION examines the use of advanced technologies in medical cannabis research and brings together Matthias Sommer, Executive Director, Product at Purpl Scientific, a company that produces a hand-held device that combines MEMS production techniques, near-infrared spectroscopy and machine learning to turn a phone into a lab-accurate tester for cannabis potency in flower and extracts; Otha Smith III, CEO & Founder at Tetragram a cannabis tracking SaaS platform and App leveraging consumer outcome data; and Prof. Bradley Conner whose lab in the Department of Psychology, Colorado State University has active projects researching how the potency of cannabis products predicts health outcomes. Using technologies in cannabis research allows researchers to collect more data than ever before, enabling a better understanding of the effects of cannabis on the body and mind. Additionally, technology can help researchers develop new cultivars with desired traits or improve existing cultivars. This can lead to more effective medical treatments. However, there are challenges associated with using technology in cannabis research, including legal barriers to research in many countries and regulatory approval status of technologies in different countries. Also, there are concerns about data objectivity, data privacy and the potential misuse of user data collected through mobile apps. Despite these challenges, using technology in cannabis research will continue to drive advances in the field.

AN EXAMINATION OF THE EXTENT OF ILLICIT USE OF CANNABIS IN BOTSWANA

Gabaikanngwe Ethel Mambo

Cannabis in botswana is categorized as one of the controlled drugs as its effects are detrimental to human health in case of being abused. The drugs and related substances act of 1992 for botswana is responsible for the registration, manufacture, importation and exportation, and distribution of drugs in the country. The act outlines under section 16 that cannabis as a habit forming drug. The study used secondary information from the relevant stakeholders such as botswana police service and statistics botswana. According to section 16 (2) of the drugs and related substances act of 1992, a person unlawfully found in possession of cannabis shall receive a minimum sentence of 5 years imprisonment to a maximum term of 10 years imprisonment or a minimum fine of 7,000 pula. In the years 2020, controlled drugs offences ranged from importation to the manufacture of drugs (importation of drugs, cultivation or manufacture of drugs), possession of drugs (possession of drugs for sale or supply, possession of drugs for personal use), other drug offences (failure to produce order, possessing or using a habit forming drug, failure to comply with conditions of drug permit or license, dealing in habit forming drugs, obstruction under the drugs act, cause death through intoxicating drugs). The range of age for males charged with the possession of controlled drugs ranged from the age of 15 to 64 years. Most offences relating to controlled drugs were committed by males aged between 25 years to 49 years. On the other hand, female offender's age ranged from the age of 20 years to 64 years. The majority of the offenders according to study were males. The study further revealed that there were 324 cases relating to the use of controlled drugs in botswana in the year 2020 to 2022. The study further revealed that 59 cases were acquitted whereas only 59 were found guilty and convicted for various offences relating to habit forming drugs. The study recommended a review of the drugs and related substances act of 1992 to strengthen the prevention and penalties for people found in possession of habit forming drugs.

CANNABIS – THE LATEST CONTRABAND FEDERALISM DISPUTE

James Thorburn

Cannabis has been unlawful on the federal level since the 1930's. It began with the Marihuana Tax Act of 1937, Pub.L. 75–238, 50 Stat. 551, enacted August 2, 1937 ("MTA"). The MTA was found unconstitutional by the Supreme Court in Leary v. United States, 395 U.S. 6 (1969). In response, in 1970, Congress created the Controlled Substances Act, 21 U.S.C. §801, et seq. ("CSA") "Marijuana" is listed as a Schedule I drug, the use, possession, or sale of which is unlawful. In November, 1996, California and Arizona became the first states to legalize cannabis, both of which were done by initiative. A coalition of federal agencies were convened to create a "federal response" to the legalization. On December 20, 1996, General McCaffrey submitted a strategy memo drafted by now Supreme Court Justice Elena Kagan setting forth the federal "response" to the state-legalization. President Clinton approved the memo. These actions opened the cannabis federalism dispute. One of the main provisions of the federal response was the IRS being instructed to apply the Tax Code against state legal cannabis in an attempt to destroy the legalization. To this end, the IRS has sued 26 USC Sec. 280 against sellers of state legal cannabis to create an "income" tax which is tax well in excess of 100% of any income derived from the sale. As a result, tax cases have become the most common place to find the constitutional litigation of the federalism dispute. See, e.g., Alpenglow Botanicals, LLC v. United States, 894 F.3d 1187 (10th Cir. 2018)(Sixteenth Amendment): Standing Akimbo, 955 F.3d 1146 (10th Cir. 2020), cert. denied, 141 S. Ct. 2236 (2021) (Opinion by Thomas, J.); High Desert Relief, Inc. v.United States, 917 F.3d 1170 (10th Cir. 2019). Thirty-nine states and the District of Columbia have legalized cannabis to some degree. The latest statement on the federalism dispute is from Justice Clarence Thomas in Standing Akimbo v. United States. Justice Thomas stated that even Congress has the power to regulate cannabis over the states, Congress' exercise of their power violates the Necessary and Proper Clause of the U.S. Constitution.

CANNABIS IN INTERSTATE COMMERCE
David Bush

As regulatory restraints on both the marijuana and hemp Cannabis industries continue to evolve and prohibitions on production and trade in Cannabis products are removed, questions arise concerning the safe, rational and orderly development of interstate markets. Among the challenges that have been the subject of intense debate and protracted litigation are residency requirements for licensing; transborder shipments of seed; regulation of products containing tetrahydrocannabinols; product testing and safety standards, social equity, taxation and classification of products as marijuana versus hemp. This presentation will address some of the conflicts that have arisen in emerging interstate Cannabis markets and transportation of raw, semi-processed and processed Cannabis products. Protectionist residency requirements for marijuana licensing have been the subject of lawsuits in California, Maine, Michigan, Missouri and Washington, challenging those requirements for unlawfully burdening interstate commerce. Confusion over the characterization of Cannabis products of marijuana or hemp have led to seizures of interstate shipments in several states. State regulatory regimes face mounting legal challenges on constitutional and other grounds. Proposed legislative and regulatory solutions are reviewed, and the potential use of interstate compacts to harmonize disparate state regulations are explored. Recommendations are made for additional changes in law and policy.

CANNABIS: SAFE AND EFFECTIVE
Michael Steward, Leonard Wisneski

Humans co-evolved with cannabis and our endocannabinoid systems (ECS) regulate homeostasis. An impaired ECS contributes to disease and can be modulated by the approximately 400 molecules found in Cannabis. These components work synergistically in what is known as the Entourage Effect and their natural complex mixtures far outperform any individual component. Medicinal safety has been established, in 2020 drug overdose deaths in the US increased nearly 30%; cannabis overdose deaths remained at zero. There has never been a confirmed fatality caused by any naturally derived active ingredient from cannabis. Synthesized cannabinoids however do have maximum doses and side effects typical of a toxin and their safety cannot be assumed. Side effects of cannabis include confusion, thirstiness, dry mouth, concentration problems, slower reaction, dry eyes, fatigue, headaches, dizziness, tachycardia, anxiety, and other mood changes. Rarely, hallucinations, paranoia, nausea, or vomiting have occurred. New research of hemp-derived formulations specifically taken sublingually do not report significant adverse effects. Acute cannabis intoxication is rare. Severe reported pediatric symptoms include depressed respiration rates, hyperkinesis, or coma. Adults and adolescents may experience increased blood pressure and respiratory rates, red eyes, dry mouth, increased appetite, or slurred speech. Management is supportive for all cases. Cannabis Use Disorders have been reported. The CBD to THC ratio is most predictive of the habit-forming nature of a chemovar, with higher ratios being less concerning. As of 2020, there were no reports of Cannabis Use Disorder in any medicinal cannabis patient. Mental health issues associated with cannabis include anxiety, depression, schizophrenia, and psychoses, although tracking the latter two with cannabis use does not support a causal relationship. Additionally, cannabis is used in the treatment of the above disorders. Cannabis is safe and effective.. Prohibition was not due to safety or lack of efficacy and cannabis, relative to other medications, should be regarded as safe.

CANNABIS RESEARCH AT THE NATIONAL INSTITUTE ON DRUG ABUSE

HEATHER KIMMEL, NATIONAL INSTITUTE ON DRUG ABUSE

While cannabis is illegal under federal law, an increasing number of states in the United States have moved to decriminalize or legalize it in some form. Public opinion about cannabis use has become more permissive, while proliferating cannabis dispensaries for medical or recreational use are providing novel methods and formulations for consuming cannabis. For the past few years, we have been learning about both the short-term and long-term public health effects of these policy changes as well as their social and economic effects. These questions are the focus of intense public and scientific debate as state citizens consider and vote on medical and recreational cannabis laws and as clinicians and policy makers seek treatment and legislative guidance from scientific research findings. One of the research priorities of National Institute on Drug Abuse (NIDA) is to support the science addressing public health challenges like those posed by changes in state and local cannabis laws. NIDA-supported research aims to help inform decision-making related to these policies, both in reducing the burden of drug related negative outcomes and in continuing to explore the therapeutic potential of cannabis-derived compounds for pain and addiction. This presentation will provide an update on the findings from cannabis policy research currently underway at NIDA described at previous ICR meetings, as well as information on available cannabis research opportunities in the context of overall NIDA priorities. We will also discuss NIDA's participation in trans-NIH and interagency activities.

DRIVING PERFORMANCE AND OTHER MEASURES OF IMPAIRMENT AMONG PARTICIPANTS USING COMMERCIALLY AVAILABLE CANNABIS

Ashley Brooks-Russell

Acute cannabis use is associated with increased risk of motor vehicle injury and fatal crashes, and the prevalence of driving after using cannabis is increasing in the United States. There is growing evidence that people who use cannabis frequently, such as daily and multiple times a day, may develop tolerance to impairing effects of THC, presenting practical and policy challenges to identifying impairment due to recent cannabis use. Specifically, there is an absence of reliable measures of recent cannabis use or impairment related to cannabis use. In a series of studies, we use an observational approach (within-subjects design) to examine driving performance and other measures of impairment related to acute cannabis use. Across these studies, participants smoked or vaped self-supplied cannabis product from commercially available sources, including flower and concentrate products. The participants had a range of cannabis use ranging from once a month to several times a day. Our studies have included biomarkers, such as blood and oral fluid, and emerging technologies, such as psychomotor and ocular assessments, that have potential for identifying either acute use and/or impairment related to cannabis. These measures are benchmarked to driving performance in car-based driving simulator (MiniSim™, National Advanced Driving Simulator) with a focus on changes to speed and lane position from before to after smoking cannabis. We will present findings from these studies (n=85; n=20; and n=30) and emerging work from a study of n=120 participants to present themes in the challenges and potential solutions to identifying recent use and/or impairment associated with cannabis. The results will focus on the contrast between drivers who use cannabis daily vs. those who use cannabis occasionally, and we will describe the evidence for tolerance among drivers who use cannabis daily. We will also present the relationship between psychomotor measures, such as reaction time, and simulated driving outcomes, and how product of use (flower or concentrate) is associated with differences in biomarkers and measures of impairment. These findings reinforce the importance of measuring impair

EMERGING TECHNOLOGIES IN WORKPLACE IMPAIRMENT TESTING

Mary Jo Mcguire

As employers struggle to comply with changing state laws while balancing their safety programs, many are looking for the cannabis impairment test that would be the equivalent to a simple breath alcohol test. Rumors have been circulating for nearly 10 years that the newly invented "marijuana breath test" is imminent. But is this accurate? This report will detail progress, insight into solutions and barriers to success of the cannabis impairment test and how employers should approach their policies and practices. This research was conducted via personal interviews with experts in the field of drug and alcohol testing, device manufacturing, drug recognition trainers, and legal consultants who serve the workplace. Data was requested from the device manufacturers to demonstrate efficacy as well as historical court decisions that have created a body of knowledge for what is and is not permissible for the workplace impairment testing environment. During the course of the interviews and research on emerging technologies, there is found to be a divide between criminal law and civil law pertaining to what methods employers can utilize to determine impairment that is legally applicable, compliant and fair. What is clear and what the drug testing industry uniformly agrees on: urine testing is not a solution, oral fluid testing likely has a key role to play in the future and will be the foundation of a "breath" test, however the non-traditional solution will fall somewhere between a new technology that is not based on human bodily fluids and a heavy reliance on physical manifestations that an employee is operating under-the-influence, which requires a well-trained observer. The result of this research project is an educational guide for employers on how to improve workplace policies with effective use of current methodologies, an understanding of ineffective policies, and an eye toward what may be on the horizon for creative solutions to the question of impairment, while maintaining compliance with adult use marijuana.

FOSTERING INTERACTIONS BETWEEN POLICY MAKERS, REGULATORS AND RESEARCHERS

David Gang, Katherine Hoffman, Trecia Ehrlich, Gillian Schauer, Steven Crowley

The goal of the panel will be to stimulate a lively discussion that will 1) identify barriers that inhibit interaction between the three groups, 2) identify areas where interaction can lead to significant advances in all concerned areas and 3) discover ways to stimulate those interactions so that cannabis/hemp industry development can be better supported by all three groups and broader society.

HEAVY METALS AND COLORADO CANNABIS: ANALYSIS OF 21 HEAVY METALS OF CONCERN IN COLORADO-MARKET CANNABIS FLOWER AND VAPE OIL

Mike Van Dyke, Stephen Goldman, Francesca Macaluso, Katherine A. James

Exposure to toxic metal or metalloid elements (otherwise known as "heavy metals") can lead to a myriad of adverse health effects even when inhaled or ingested at low-moderate levels. Cannabis plants and flowers are known hyper-accumulators and may absorb heavy metals from soil, irrigation water, or agrochemicals, presenting a potential risk of inhalation exposure from smoking or vaping cannabis products. In most states with a legal cannabis market, there are testing and contamination limits for only the "big four" heavy metals (lead, cadmium, arsenic, and mercury) although New York requires more. Many heavy metals beyond the "big four" are ubiquitous in Colorado soils and groundwater, especially near former mining or industrial contamination sites. The goal of this study is to characterize the heavy metal content of Colorado-market cannabis to better estimate inhalation and consumption-related health risks. We will assess average concentrations of heavy metals in Colorado legal market cannabis, flower (n=40, 20 each from indoor and outdoor growers) and cannabis vape oil (n=20) randomly selected from anonymized samples originating from 430 licensed Colorado cannabis producers and product manufacturers. The sample pool will be enriched by cannabis flower (n=20) and cannabis vape oil samples (n=20) randomly selected from anonymized samples failing initial heavy metal tests for lead, cadmium, arsenic, or mercury. We will use analysis of variance (ANOVA) to evaluate variations in heavy metal concentrations among the samples accounting for within-sample type variability. The expected outputs for this analysis will be estimates of the average, 95th percentile, and maximum concentrations of 21 heavy metals in a representative sample of Colorado legal market cannabis. We will present results for Colorado relative to other U.S. states to evaluate how profiles may differ based on the geography present at the cultivation site to the extent possible. These study findings will be critical for informing both policy makers and cannabis industry personnel as to the best practices for cannabis cultivation and regulation.

MEDICINAL CANNABIS AND DRIVING

Thomas Marcotte

Despite the growing literature on the driving impacts of cannabis use in healthy adults, there is limited information regarding the effects that cannabis used to address medical and/or psychiatric symptoms has on driving performance. Such studies are of interest since in addition to impairing effects, cannabis may improve functioning in domains that benefit driving abilities in these individuals. We report here on three cannabis trials for medical conditions and for which driving performance was a secondary outcome: short-term studies (days) of smoked THC for 1) spasticity associated with multiple sclerosis and 2) HIV-associated neuropathy, and 3) a 2-month treatment using vaporized 3.7% THC/5.6% CBD or oral dronabinol for chronic low back pain. All studies found significant symptom improvement. Driving performance was assessed using either a desktop simulator (studies 1 and 2) or console system (study 3). Primary outcomes of interest were standard deviation of lateral position (SDLP), or "swerving", during a divided attention driving task, and coherence (the ability to match a lead car's speed during a car following task). Acute use was associated with increased SDLP in studies 1 and 2. However, on the car following task (requiring controlled foot movements), the delay time in responding to lead car changes was least in those who demonstrated the greatest reduction in spasticity (Study 1) and neuropathic pain (Study 2). In study 3, which included repeated simulations over the course of a treatment day, including a second dosing, the THC/CBD vaporization and dronabinol groups demonstrated different patterns of performance on SDLP. When using cannabis to address medical conditions, drivers demonstrate declines similar to those seen in healthy adults. However, they may also experience symptom improvement, which has the potential to benefit driving ability. The degree of driving decline was not dissimilar to that seen with prescription medications, such as with anxiolytics, hypnotics and antidepressant initiation. It will be important to identify dosing approaches that maximize symptom relief but minimize the negative cognitive effects on safe driving.

NAVIGATING THE SHIFTING REGULATORY ECOSYSTEM OF CANNABIS AND HEMP RESEARCH AT AN R1 LARGE UNIVERSITY

Thomas Heddleston

Despite the growing literature on the driving impacts of cannabis use in healthy adults, there is limited information regarding the effects that cannabis used to address medical and/or psychiatric symptoms has on driving performance. Such studies are of interest since in addition to impairing effects, cannabis may improve functioning in domains that benefit driving abilities in these individuals. We report here on three cannabis trials for medical conditions and for which driving performance was a secondary outcome: short-term studies (days) of smoked THC for 1) spasticity associated with multiple sclerosis and 2) HIV-associated neuropathy, and 3) a 2-month treatment using vaporized 3.7% THC/5.6% CBD or oral dronabinol for chronic low back pain. All studies found significant symptom improvement. Driving performance was assessed using either a desktop simulator (studies 1 and 2) or console system (study 3). Primary outcomes of interest were standard deviation of lateral position (SDLP), or "swerving", during a divided attention driving task, and coherence (the ability to match a lead car's speed during a car following task). Acute use was associated with increased SDLP in studies 1 and 2. However, on the car following task (requiring controlled foot movements), the delay time in responding to lead car changes was least in those who demonstrated the greatest reduction in spasticity (Study 1) and neuropathic pain (Study 2). In study 3, which included repeated simulations over the course of a treatment day, including a second dosing, the THC/CBD vaporization and dronabinol groups demonstrated different patterns of performance on SDLP. When using cannabis to address medical conditions, drivers demonstrate declines similar to those seen in healthy adults. However, they may also experience symptom improvement, which has the potential to benefit driving ability. The degree of driving decline was not dissimilar to that seen with prescription medications, such as with anxiolytics, hypnotics and antidepressant initiation. It will be important to identify dosing approaches that maximize symptom relief but minimize the negative cognitive effects on safe driving.

PHYSICAL AND MENTAL HEALTH EFFECTS OF HIGH-POTENCY THC MARIJUANA AND CONCENTRATES, RESULTS FROM A STATE FUNDED SCOPING REVIEW

Gregory Kinney, Jon Samet, Gregory Tung, Lisa Bero, Sheana Bull, Rosa Lawrence

Under Colorado house bill 21-1317 (hb 1317) (concerning the regulation of marijuana for safe consumption, and, in connection therewith, making an appropriation) the colorado school of public health (coloradosph) was mandated to carry out a systematic review "…related to the physical and mental health effects of high-potency thc marijuana and concentrates." The mandated review was implemented in the fall of 2021 in the form of a scoping review, which includes findings of 40 articles selected from the total of 290 articles screened. The scoping review findings are summarized in the form of an evidence map, which facilitates screening by study characteristics including the thc exposures considered and the outcome domains addressed. The review team has used the evidence map to address four key pre-specified questions germane to the charge from the colorado general assembly and also to explore the studies to identify clusters sufficiently homogeneous to warrant full systematic review. Throughout the review process, the review team has received input from the scientific review council mandated by house bill 21-137. Under the bill, the colorado school of public health will also design and implement an educational campaign, based on the finding of the review. This presentation will provide an introduction to the scoping review and evidence map, and also review the utilization of the evidence map to address the pre-specified policy questions. It will also address next steps with regard to full systematic reviews. The session will review the overall findings and recommendations from the colorado school of public health, along with the input and comments from the scientific review council. The status of the educational campaign will be covered as well.

POLICY DEFINITIONS BACKED BY SCIENCE: ALTERNATIVES TO IMPAIRING, INTOXICATING, PSYCHOTROPIC

David Gang, Amber Wise, Brad Douglas, Jessica Tonani

Washington State (and other states) has faced significant challenges in recent years related to regulation of new/novel compounds derived from Cannabis sativa, especially but not only delta-8-THC from hemp produced CBD. Regulators face challenges in regulating such compounds when the current legal system in the state was established long before such compounds were even contemplated as hitting the market, and thus the compounds are not specifically included within the legal framework. Agencies tasked with regulation of C. sativa and derived compounds have turned to nebulous terms ("impairment", "intoxication", "psychotropic", etc., none of which really fit the effects of cannabis-derived compounds on the human body/mind) in an attempt to regulate such compounds, but such an approach has many problems, not the least of which is lack of clear definition of the terms used as the foundation for regulatory efforts. An alternative approach using a list system has been developed as a result of extensive discussions between regulators and scientists within WA State. This issue and the new system to address it will be presented and discussed by the panel, with the goal of generating significant community engagement in the process through the Q&A session.

REGULATORY CHALLENGES IN THE CANNABIS INDUSTRY: THE RISE OF INTOXICATING PRODUCTS, SYNTHETIC CANNABINOIDS, AND STATE RESPONSES. A PANEL DISCUSSION.

John Harloe, Dominique Mendiola, Susan Hays, Bonny Jo Peterson, Sunny Summers, Katherine Hoffman

Since the passage of the Farm Bill in 2018, the cannabis industry has seen extraordinarily rapid change leading to a multitude of new challenges for both industry and their regulators. For example, due to the ambiguity of the Farm Bill, the past two years have additionally seen a dramatic rise in intoxicating hemp-based products, such as Delta-8-THC, resulting in the appearance of de facto nationwide legalization of recreational THC. This PANEL DISCUSSION will focus on the rapidly changing environments of marijuana and hemp, and how various states are responding to these new challenges. Comprised of advocates, academics, and regulators; the panel brings together experts central to these discussions from Colorado, Washington, Oregon, and Texas. Drawing from their experiences, the panel will address a variety of topics affecting the cannabis industry such as: current regulation and enforcement, the rise of synthetic cannabinoids and non-phytocannabinoids, public health concerns, state advisory committees and their challenges, legislative updates, coordination amongst state regulators, commercial trends, and changes to product testing requirements. The panel will additionally reserve time for questions and answers from those in attendance.

THE CONUNDRUM OF FEDERAL CANNABIS REGULATION

Garrett Graff

Presently, while cultivating hemp is federally lawful and hemp-derived cannabinoids are not controlled substances, in the eyes of the FDA, hemp-derived products remain "adulterated." Moreover, marijuana remains entirely federally unlawful. FDA's stance applies not only to conventional naturally occurring CBD products, but also to novel and synthesized (and potentially intoxicating) cannabinoids such as CBN, delta-8 THC and more, which are typically accessed via synthesis. Most recently, FDA opined it did not believe existing regulatory frameworks were appropriate to regulate cannabis, suggesting that FDA and Congress must collaborate to create an entirely new regulatory scheme – a re-invention of the wheel. Resultantly, FDA's inaction has thrust the industry into uncertainty and left state and local regulators to their own devices (and resources, or lack thereof) to develop appropriate regulations, which vary widely and dramatically across jurisdictional boundaries. There remain a number of factors which continue to impact and impede regulation of hemp-derived products and, more broadly, cannabis holistically. This session will explore several of these factors, which include: 1. Synthesis: FDA already permits synthesis of certain food additives such as vitamin C, so synthesis alone cannot be condemned; however, application of synthesis to cannabis does complicate the issue of product safety, as many cannabinoids are only viably accessed via synthesis – such as CBN. How can existing regulations concerning synthesis be adapted and applied to the manufacturing of synthesized cannabinoids? 2. Drawing the line: Where is most appropriate to "draw the line" as to cannabinoids permitted for manufacturing and those which are prohibited? Ranging from naturally occurring and extracted cannabinoids (CBD) to naturally occurring but synthesized cannabinoids (CBN or delta-8 THC) to non-naturally-occurring and synthesized cannabinoids (THC-O). 3. Universal Regulation: For years, the "Source Rule" – determined by whether a product originated from marijuana or hemp – dictated the legality of a product and rules of engagement. However, as the distinctions between marijuana-derived products and hemp-derived products becomes ever less clear – with low potency marijuana products and potentially intoxicating hemp products – coupled with inconsistent regulations across federal, state and local jurisdictions, is holistic federal cannabis regulation (of both marijuana and hemp) the solution?

THE ROLE OF INDIVIDUAL DIFFERENCES IN MODELING CANNABIS DRIVING IMPAIRMENT

Thomas Burt, Tim L. Brown, Gary Milavetz, Amir Meghdadi, Gary Gaffney, Rose Schmitt, Chris Berka, Daniel McGehee

Driving during acute cannabis intoxication impairs psychomotor function, critical driving-related skills, and has been associated with increased risk of motor vehicle injury. Unlike some other intoxicating agents, there is currently no widely accepted impairment standard for cannabis-impaired drivers. Modeling cannabis-induced driving impairment, and predicting driver performance, is complicated by individual variances in response to the drug. These individual differences are attributed to biological and genetic differences, as well as psychological vulnerabilities. Accurately modeling these individual differences across all cannabis users remains a challenge, necessitating further examination. Prior research has shown that a driver's perceived state of acute cannabis impairment may hold value in predicting psychomotor performance while operating a motor vehicle. To better explain this variability, examination of the impact on brain function may help to differentiate why some users perceive the effect differently and how that might relate to changes in performance. Data were collected in a within-subjects study (n=52) examining the effects of cannabis on driving performance and brain activity. Driving performance data were collected in a car-based driving simulator (MiniSim™, National Advanced Driving Simulator). Performance measures included both continuous (e.g., SDLP) and discrete indices of driving errors (e.g., lane departures). EEG data and subjective self-assessments were collected for both placebo and active cannabis dosing conditions. Analysis will center around the effect sizes these predictors have on safety outcomes, as measured by simulated driving performance. Further results will show where, and to what extent, brain activity is correlated with subjective perceptions of state. Overall, these findings present potential biomarkers of cannabis impairment., and aim to address the challenges faced in developing a standard for cannabis-impaired driving performance.

VAPING, CANNABIS, AND TOBACCO USE: PATTERNS AND POPULATIONS OF CONCERN IN COLORADO ADULTS (2015-2022)

Francesca Macaluso, Mike Van Dyke, Katherine A. James

Electronic cigarettes and vaping devices have proliferated in U.S. markets in recent years despite a lack of longitudinal data on their safety and human health effects. While these devices were initially purported as an alternative nicotine delivery system to traditional cigarettes, in U.S. states where cannabis is legal for recreational and medicinal use (like Colorado) vaping has also become a means for cannabis consumption. Understanding patterns of use of these devices is critical to estimating the potential health risks posed by vaping in the adult population. The Attitudes and Behaviors Survey (TABS) on Health is a population-based survey of Colorado adults developed and implemented in partnership between the University of Colorado's Community Epidemiology Program and Evaluation Group (CEPEG) and the Colorado Department of Public Health and Environment (CDPHE). Using TABS survey data from 2015, 2018, and 2022, we will assess longitudinal trends in vaping of both nicotine and cannabis among Colorado adults and identify groups where use of these devices is trending higher over time. All estimates will be weighted to represent the Colorado population at the time of each survey wave administration. We will present overall trends in vaping of both nicotine and cannabis over the study period (2015-2022), as well as breakdowns for key sociodemographic groups, occupational groups, and other priority populations in chronic disease prevention, as designated by CDPHE and CEPEG. Our results and discussion will provide needed context for vaping and tobacco use prevention efforts by highlighting rates of vaping for dual users (cigarette smokers who also consume nicotine through vapes), co-users (individuals who are vaping with both tobacco and cannabis products), and as a smoking cessation tool. Electronic cigarettes and vaping devices may impact human health in a myriad of ways. Findings from this study will help to assess which groups within the Colorado adult population are most at risk of vaping-related health effects, especially among cannabis users, and inform prevention efforts within the state.

WHAT'S NOT ON THE LABEL? DETERMINING THE CONCENTRATION OF 10 MAJOR AND MINOR CANNABINOIDS IN REPRESENTATIVE SAMPLES OF THE COLORADO RECREATIONAL CANNABIS MARKET

Colin Brook, Ashley Master, Greg Giordano, Ortiz Torres, Camden McFarland, Cinnamon Bidwell, Duncan Mackie

When Colorado legalized adult-use recreational cannabis in 2012, an argument in favor of legalization was improved safety and transparency in the cannabis market. However, to our knowledge, there has never been a state-wide assessment of the accuracy of the cannabinoid potency claims on product labels. This study is the first of its kind independent and double-blinded evaluation of the cannabinoid potency label claims in the Colorado recreational cannabis market. The goal of this study is to test a representative sample of the current recreational cannabis market in Colorado. Currently, the recreational market consists predominantly of four categories: flower/pre-rolls (50.7% of total sales), vape pens (19.0%), edibles and beverages (14.7%), and concentrates (12.6%); the remaining 3.0% consists of tinctures, topicals, and capsules. The Colorado Marijuana Enforcement Division requires testing for five cannabinoids by state-certified labs: d-9 tetrahydrocannabinol, tetrahydrocannabinolic acid, cannabidiol, cannabidiolic acid, and cannabinol. Measured potencies must be within ± 15% of the packaging label. In addition to the five required cannabinoids, this study will also quantify minor cannabinoids cannabigerol, cannabigerolic acid, cannabichromene, tetrahydrocannabivarin, and d-8 tetrahydrocannabinol. In all, 10 cannabinoids are being measured. This study is currently 20% complete, with a total of 101 out of 500 samples purchased and analyzed; of the samples analyzed, 46 were flower/pre-rolls (45.5%), 14 were concentrates (13.9%), 27 vape pens (26.7%), 2 edibles (1.98%), 8 beverages (7.92%), 2 tinctures (1.98%), and 2 topicals (1.98%). In most samples analyzed, one or more of the five non-required minor cannabinoids were identified, some making up more than 1.0% by mass of the product. Indeed, CBG was quantifiable in 93/101 samples (24/101 ≥1.0% CBG), CBGA 67/101 (21/101), CBC 48/101 (9/101), THCv 40/101 (0/101), and d-8 THC in 25/101 (0/101). While this study is still early on, the regular presence of minor cannabinoids in the recreational market suggests monitoring them could be of interest to the cannabis consumer.

AFLATOXIN AND OCHRATOXIN PREVALENCE IN HYDROCARBON EXTRACTS OF MICROBIAL CONTAMINATED MARIJUANA
Stephen Cobb

Beginning September 15th, 2019, all marijuana concentrates in Colorado made from regulated marijuana that failed microbial testing became subject to mandatory mycotoxin testing that assessed the presence of Aflatoxins (B1, B2, G1, and G2) and Ochratoxin A. While hydrocarbon extraction is an effective method of remediating microbial contaminations in marijuana, the new testing requirements sought to address the potential risk of residual mycotoxins concentrating in the final extract. We sought to assess the prevalence of Aflatoxin and Ochratoxin in concentrates produced by hydrocarbon extraction of marijuana that had failed microbial testing by collaborating with multiple licensees in both Colorado and in Oklahoma to pull their METRC data on mycotoxin testing performed on batches flagged for microbial remediation. While batches included in the assessment were all extracted utilizing hydrocarbon solvents, multiple product consistencies and marijuana input types were included. Specifically, input types included trim, whole plant, and fresh frozen flowers, and product consistencies included shatter, wax, live resin, bulk oil, and distillate. 698 batches were included in the data set. Results showed that all 698 concentrate batches passed mycotoxin testing with results indicating either 'none detected' or 'less than limit of quantification' (set at 1 ppb) for both Aflatoxins (B1, B2, G1, and G2) and Ochratoxin A. This preliminary assessment provides evidence supporting that Aflatoxins and Ochratoxin are not prevalent in concentrates made from microbial contaminated marijuana via hydrocarbon extraction. Follow up studies should assess whether this result is due to a lack of presence of Aflatoxins and Ochratoxin in microbial contaminated cannabis or due to these mycotoxins not co-extracting with cannabis oil during the hydrocarbon extraction process. Microbial contamination of marijuana poses a critical and commonly occuring public health risk. As additional methods of microbial remediation and decontamination are employed, properly assessing the potential risk posed by residual mycotoxins in these products will be equally as critical to protecting public health.

AUTOMATED PRESSURIZED LIQUID EXTRACTION (PLE) METHOD FOR NATIVE QUANTITIES OF COMMON CANNABINOIDS IN CANNABIS SATIVA L.
Chad Kinney, Monica V. Alonso

Extraction of cannabinoids from cannabis for quantitative analysis is important for regulatory and industry/economic applications. Most commonly, manual liquid extraction methods are used for this purpose. However, manual liquid extraction methods can be resource intensive and leave room for inconsistencies during the extraction process. An effective, automated extraction method can eliminate some human errors and potentially improve throughput. Here we share information about an automated pressurized liquid extraction (PLE) method for determining the native quantities of cannabinoids in cannabis sativa L. As part of the validation of this method, it was benchmarked against a published method from the United Nations of Drug and Crime (UNODC) and a method from US Department of agriculture (USDA) that is currently in review. The optimized PLE method used methanol as the solvent to extract cannabinoids from 0.5 g of biomass. The PLE was operated at 80 °C and 10,350 kPa for two static cycles of 3 minutes each. The quantity of six common cannabinoids (CBD, CBDA, CBG, CBGA, THC, THCA-A) was used for comparing these extractions methods using three cannabis chemotypes. The automated PLE method consistently yielded a greater sum of the six cannabinoids studied, which was statistically greater for two of the three chemotypes (two-way ANOVA), as well as yielded greater CBDtotal, CBGtotal, THCtotal. For example, the PLE method resulted in a greater sum of the six cannabinoids (67.4±3.5mg/g) when compared to the UNODC extraction method (54.4±3.6mg/g) and USDA method (60.2±2.7mg/g) in chemotype 1, a moderated CBDtotal cannabis, which demonstrates a greater extraction efficiency compared to the other extraction methods tested. In the same chemotype the CBDtotal, (54.6±2.9mg/g) using the PLE method is greater when compared to the UNODC extraction method (41.0±3.5mg/g) and USDA method (48.8±2.5mg/g). Similarly, CBGtotal, (2.60±0.31mg/g) using the PLE method is greater compared to the CBGtotal recovered using the UNODC extraction method (2.48±0.09mg/g) and USDA method (2.04±0.11mg/g) and THCtotal (2.46±0.38mg/g) using the PLE method is greater compared to the THCtotal recovered using the UNODC extraction method (1.93±0.13mg/g) and USDA method (2.22±0.20mg/g). Similar trends were observed for the other two chemotypes used during the method validation.

CHALLENGES OF ENSURING FITNESS FOR PURPOSE OF MICROBIOLOGY METHODS IN A CONTINUALLY EVOLVING CANNABIS MARKET

John Mills

As the cannabis market continues to mature, so do the challenges that face the industry. Cultivators have incorporated GMP processes and point of care tests into their grow facilities to optimize yield production and minimizing failing results. Expanded cultivation of cannabis flower has resulted in concentrate and edibles markets reaching all-time highs in revenue in 2021. These two categories have flourished with innovation leading to a diversity of products which highly benefits consumers, but poses additional safety risks. Onsite and third party laboratories need methods that are easy to use, robust and have the necessary validations to ensure they are fit for purpose for the evolving needs of the cannabis industry. Methods for pathogens (GENE-UP®) and quality indicators (TEMPO®) were evaluated on select matrices through the AOAC Research Institute's Performance Tested Methods program (testing included matrix studies, selectivity and specificity studies, and method robustness studies). Separate verification studies were conducted to meet the requirements in select states and point of analysis fitness for purpose. Data from the AOAC PTM validation studies was reviewed by three independent experts. Each study component met performance requirements and certification was granted. Verification studies to meet specific state needs were completed and methods were approved for use in those laboratories. The design and difficulty of conducting multiple studies, sometimes within the specific geographic location in a state, make it difficult for technology providers to validate their solutions for end users. Multiple studies, often at third party locations, are required to ensure state regulations are met and methods are fit for purpose.

ENHANCING YIELD RATES THROUGH POINT OF CARE TESTING IN CANNABIS PLANTS.

Eleanor Kuntz

The quickly expanding cannabis industry in the United States and globally presents unique challenges for production quality from both public health and agricultural standpoints. Accessible rapid diagnostic assays beyond detection of human pathogens to ensure efficient operations are becoming more critical in this growing market. To support these needs novel, in increased emphasis on point of care testing to identify hazards, such as Hop Latent Viroid, or gender identification to increase yield are vital to the sustainability of cultivation. To examine the performance of a cannabis and hemp sex DNA test and a test for plant pathogens (HLVd, Cannabis Cryptic Virus, Botrytis, Fusarium, etc.) for accuracy, specificity and sensitivity. Multiple leaf samples were sourced for sex determination based on phenotypic (visual) expression of gender and for suspected pathogen infection. Health plants (based on observed typical/atypical plant growth) were also included. Each sample tested for gender identification and plant pathogen matched expected results (observed female or male phenotype and suspected pathogen infection). Internal assay controls, monitoring for DNA extraction efficiency, polymerase and reverse transcriptase function, demonstrated successful assay performance in each sample. The data supports the accuracy of the method in rapid analysis of sex determination and detection of plant pathogens. To greatly improve yields and minimize the occurrence of failing results, cultivators should emphasize point of care testing at the earliest stage possible. Identifying female plants will allow for higher yields and identifying pathogens can reduce risk of contamination from sick plants to healthy plants.

INTEGRATING RISK MANAGEMENT STRATEGIES IN CULTIVATION TO REDUCE LEVELS OF MICROBIAL CONTAMINATION.
Tess Eidem

Despite the rigorous compliance testing of cannabis products, microbial contamination continues to be a major challenge for cannabis manufacturers, specifically in flower products. These herbal products often fail microbial tests due to heavy bioburdens of indicator microorganisms and/or detection of human pathogens. Cannabis plants and products can pick up molds or bacteria while growing (particularly if they are grown outdoors or in a non-sanitary indoor environment) or during subsequent handling and processing. Although microbes can pose a risk to plants, workers, and consumers, little is understood about them across the cultivation and post-harvest processes. To reduce failing results, cultivators need to incorporate a risk management strategy into their decisions. These strategies can help identify the hazards in the life cycle of cannabis production, allowing for the incorporation of interventions that will minimize the risks through data collection and analysis. Method: an overview of ways cultivators can manage microbial risks and practical guidelines on applying hazard analysis, good sanitation practices, and environmental monitoring to ensure product quality and consumer safety will be outlined. The impact of implementing risk mitigation strategies by cultivators will be discussed to identify the beneficial impacts on reducing microbial contamination. Conclusion: implementing risk management strategies through improved cultivation techniques, enhanced sanitation practices and strategic environmental monitoring practices can improve the overall quality of cannabis flower as it relates to microbial contamination.

IS WHAT YOU SEE WHAT YOU GET? EVALUATING THE ACCURACY OF CANNABIS PRODUCT LABELS
Ashley Master, Greg Giordano, Marco Ortiz Torres, Camden McFarland, Colin Brook, Duncan Mackie, Cinnamon Bidwell,

It is crucial for legal market cannabis products to report accurate cannabinoid potency information. However, previous independent testing of commercially available products indicates that this is not always the case. Our study aims to independently test a wide variety of Colorado cannabis products, and compare these potency results to those listed on the product labels. This study represents an Institute of Cannabis Research funded collaboration between MedPharm Holdings, a licensed cannabis testing facility with the capacity to purchase, handle, and test state market cannabis, and a research team at the University of Colorado Boulder who will maintain, manage, and blindly analyze the product data. Data collection proceeded as follows: 1) a designated researcher purchased each product, then recorded and uploaded information from the label, 2) products were homogenized and blindly analyzed for potency, and 3) potency results were compared to values on the product label using a chi-square test. Label vs. analyzed values were considered discrepant if the analyzed value was significantly over or under the label value, using a difference threshold of +/-15%.This study was recently launched, with current data on N = 58 cannabis products (N = 29 flower/joints, N = 29 concentrates) purchased from several Colorado cannabis dispensaries. Product labels for THC potency were 48.3% accurate for flower, and 100% accurate for concentrates. Flower and concentrate products showed similar absolute differences of M = 3.48 (3.9) for flower, and M = 3.09 (2.43) for concentrate. When converted to percentages, the label and analyzed differences were M = 15.2 (13.6) for flower, and M = 4.13 (3.25) for concentrates. We expected that flower potency claims would be less accurate than to concentrates; our results support this hypothesis. Our presentation will include data from additional samples that will be collected and analyzed in the next 3-4 months (currently targeting 60 additional flower and concentrate products), as well as preliminary results for CBD and other minor cannabinoids.

ISO 17025 LABORATORY ACCREDITATION - UNDERSTANDING THE BENEFITS AND LIMITATIONS

Seth Wong

ISO 17025 is the international standard used to accredit testing laboratories that established their competency in generating reliable results. Accreditation to this standard is recognized globally throughout many different industries, including the cannabis industry. As more states have legalized cannabis for adult-use (21) and medicinal (37) use, ensuring products that reach consumers are safe is paramount. Most state testing guidance references the requirements for laboratories to accredited to ISO 17025 to ensure quality of testing, but gaps exist in the application of this standard that can still result in unsafe or inaccurately labeled product reaching consumers. As the first ever ISO 17025 accredited cannabis laboratory, TEQ Analytical has first-hand experience at addressing the benefits and limitations of the accreditation requirement. Insight into where the gaps exist and how to overcome them will be shared. A review of ISO audit findings and public warnings by regulatory agencies identifying deficiencies in compliance testing at ISO 17025 accredited laboratories will be presented and discussed. Further, solutions to resolving the gaps in the standard will be presented. The final check in ensuring public safety in the cannabis industry is through accurate and reliable compliance testing. This is accomplished through third party testing at ISO 17025 accredited laboratories. The accreditation is a must to ensuring the quality of products, but additional steps should be implemented by regulatory authorities to ensure that the gaps in the standard are met.

PROFICIENCY TESTING CHALLENGES FOR CANNABIS AND CANNABIS PRODUCTS

Julia Bramante

State regulations explicitly require (or implicitly through laboratory accreditation regulations) that laboratories involved in compliance testing pass proficiency testing (PT) samples. PT samples are designed to provide verification that laboratory methods are fit for purpose as well as demonstrating training of personnel is sufficient. It has been observed over past PT events that PT analyses in cannabis and cannabis products present several challenges. Key contributing factors to these challenges are sample format, analyte concentration, and participant pools. Statistical regression analysis was performed on inter-laboratory data to explore the relationship between concentration mean and reproducibility variance. Intra-laboratory experiments were also conducted to study the analytical interference between closely-eluting cannabinoids. These analyses revealed a trend in which cannabinoids at a low concentration have a higher relative standard deviation when compared with high concentration cannabinoids. The variance is inflated even more for certain cannabinoids when their chromatographic peak overlaps with another cannabinoid. As emerging isomeric forms of THC are added into the list of tested analytes, higher technical challenges are introduced to resolve the ambiguity between closely-eluting, or co-eluting, compounds. PT samples are necessary requirement for laboratories to demonstrate their methods and technicians are competent to perform the compliance tests set forth in state regulations. With emerging forms of THC, and more diverse and complex matrices, PT samples must evolve to provide more accurate representations of products on the market.

RISK ASSESSMENT OF HEAVY METAL ACCUMULATION IN HEMP ON NON-CONTAMINATED AGRICULTURE SOIL

Josh Kraft

Hemp is a recently reintroduced farm commodity in the United States grown for fiber, seed, oil, and secondary metabolites. Many of the uses of hemp require topical application, oral ingestion, or close skin contact. Research suggests that hemp can accumulate heavy metals at high rates and that the contaminants are stored in all parts of the plant. This presents a danger to both growers and consumers, as elevated heavy metal levels may render the commercial parts of the plant unusable or be transferred to downstream products. This study aimed to assess the risk to both growers and consumers of heavy metal accumulation in hemp tissue when grown on agricultural soil with no history of heavy metal contamination. This was accomplished by comparing uptake of four heavy metals in hemp, corn, and soybean growing concurrently at 3 field sites. Plant samples were microwave digested and heavy metal content was determined using ICP-OES. We report that hemp accumulates significantly more lead and cadmium than either corn or soybean ($p < 0.05$) but differences in nickel and chromium accumulation were non-significant between all plants. Cadmium, chromium, and nickel accumulation levels were below those set by the OEKO-TEX threshold. Lead levels in above ground hemp tissue were higher than the OEKO-TEX threshold. Previous research looking at what organs Cannabis stores heavy metals in shows that hemp holds most heavy metals in their leaf tissue, meaning the fiber in this study likely falls below the OEKO threshold. This study is the first we are aware of to test the safety of field grown fiber hemp using soil not enriched with heavy metals.

THE SCIENCE BEHIND UTILIZING OZONE AS A KILL-STEP: DIVING DEEP INTO THE DATA

Carly Bader

Cannabis cultivators have tough decisions to make when it comes to selecting which of the various remediation options are the most beneficial to their processes. Considerations including safety and quality are imperative for businesses to address for them to thrive in a competitive market. Currently, ozone treatment as a kill-step decontamination method is novel to the industry as a viable choice with established efficacy. Cannabis cultivators have expressed their concern regarding terpene and cannabinoid potency loss, which affect both quality and their bottom line, as any potency degradation would be viewed as an opportunity cost. Data collected evaluating microbial bioburden, product terpene content, and cannabinoid potency, both pre- and post-treatment, at varying treatment exposure times was analyzed into a paired T-test statistical analysis to confirm that ozone is a viable method to both reduce contamination as a kill-step and remediate failed cannabis without compromising terpene and cannabinoid potency. Ozone treatment as low as one hour shows 66.7% kill, while an additional hour increases kill to 99.8%, which emphasizes the kill percent as a function of time. On average, a 2-hour run results in a 1.2-log reduction (approximately 92% kill), a 4-hour run results in just under 1.5-log reduction (approximately 94% kill) and a 6-hour run approaches a log reduction of almost 2 (approximately 98% kill).We averaged individual terpene data points (N=329 paired sets) and concluded that in the terpenoid data of untreated vs. treated, overall statistical results of the paired-t test indicated that there is a non-significant very small difference between Control (M = 0.1 ,SD = 0.3) and Treated (M = 0.1 ,SD = 0.3), t(329) = 0.07, p = .948. We averaged individual THC potency data points (N=63 paired sets) and concluded that in the cannabinoid data of untreated vs. treated, overall statistical results of the paired-t test indicated that there is a non-significant, very small difference between Control (M = 19.6 ,SD = 4.8) and Treated (M = 19.4 ,SD = 4.2), t(63) = 0.4, p = .665. Microbial, terpene, and cannabinoid data all suggest that ozone exposure treatment times, ranging from 2 to 24 hours do not result in significant potency change while effectively reducing microbial load over 99%. A slight positive change and increase in terpenoid and cannabinoid potency can be observed in longer ozone exposures, due to putative drying of the biomass, as ozone reacts with water to produce hydroxyl radicals, albeit still statistically insignificant. This study comprised of robust and well-sampled data sets from several cannabis cultivators should assure cultivators in choosing ozone remediation as a viable choice in reducing microbial loads and passing quality assurance regulations without sacrificing quality of their product.

VOLTAMMETRIC DETERMINATION OF Δ9-TETRAHYDROCANNABINOL AND CANNABIDIOL IN CANNABIS SAMPLES USING SCREEN-PRINTED ELECTRODES CHEMICALLY MODIFIED WITH REDUCED GRAPHENE OXIDE (RGO-SPE)
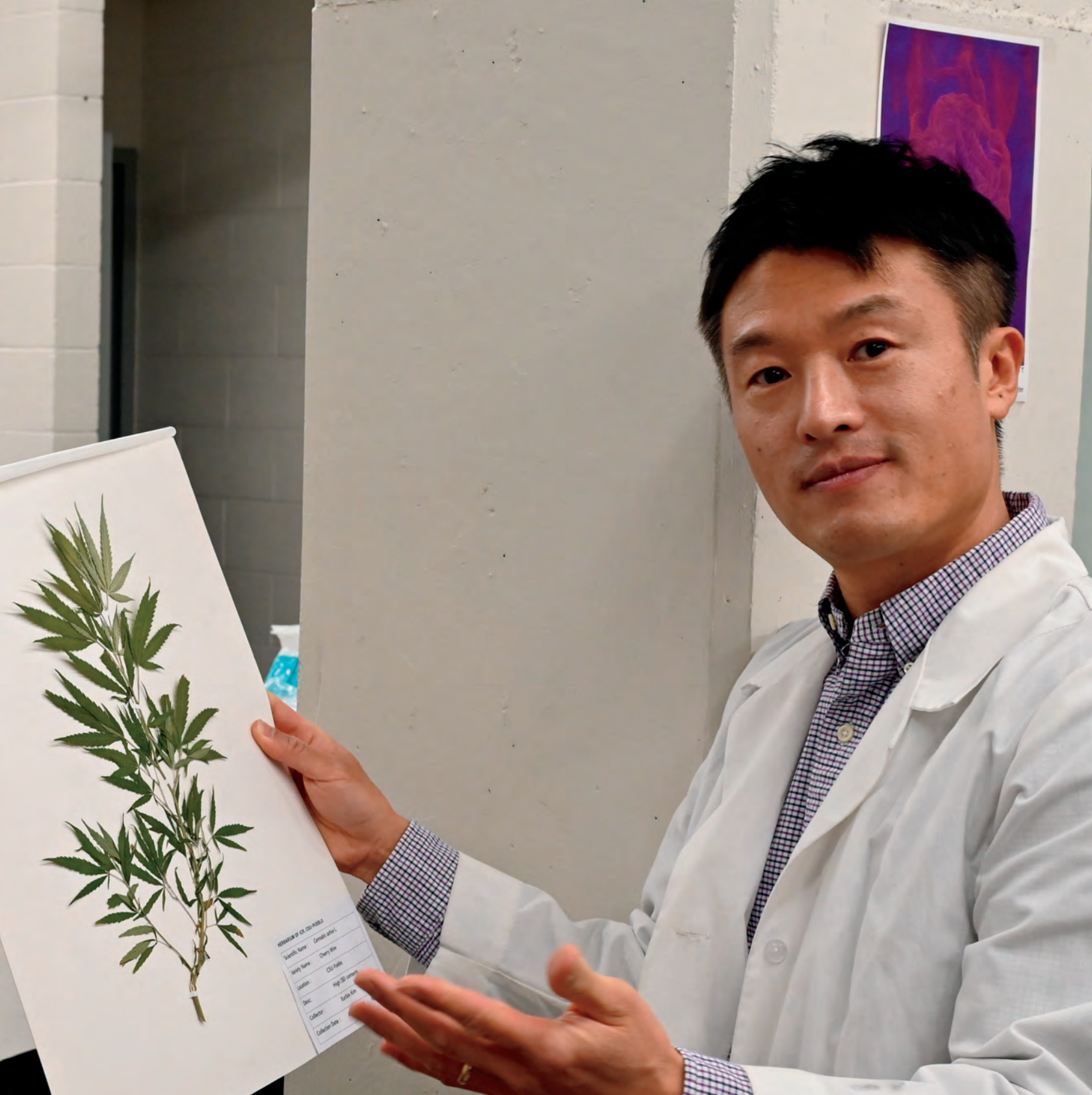
Marcelo De Oliveira, Juliene Morais de Faria, Jullia Nascimento Silva, Grace Kelli Pereira

Cannabis sativa L. is a plant derived from the genus Cannabis, widely used for its medicinal and psychotropic properties. Among the more than 400 chemical compounds present, Δ9-tetrahydrocannabinol (Δ9-THC) and Cannabidiol (CBD) deserve special attention. Both act on CB1 and CB2 receptors, directly influencing neurotransmitters, but while Δ9-THC acts as a psychoactive substance, CBD does not have these properties. It is possible to identify and differentiate these two compounds using thin layer chromatography. This work presents a faster, cheaper and more selective alternative method to identify and quantify Δ9-THC and CBD. Initial chemical profile of the extracts of the marijuana samples was provided using a GC-MS. Voltammetric analyzes were obtained using a potentiostat employing CV and LSV modalities. The chromatograms of the marijuana extracts presented different composition according to the type of solvent employed. Methanolic extracts presented mostly higher levels of Δ9-THC while ethanolic extracts presented a distribution among Δ9-THC, CBD, Δ9-THCV, CBL, CBG, and CBN. Both methanolic and ethanolic extracts were quantified by the voltammetric method in terms of Δ9-THC and CBD using commercial chemical standards diluted in a hydroalcoholic Britton–Robinson buffer 1 mol L-1, pH 7.0, containing 30% methanol. Voltammetric analysis were carried out using both conventional electrodes system (platinum disk as auxiliary, carbon paste as working electrode, and Ag/AgCl.KCl(sat) as reference) and disposable commercial SPEs of platinum and carbon chemically modified with reduced graphene oxide (RGO-SPE) prepared in this project. The results indicated that the RGO-SPE devices prepared in this project can be promptly used to quantify Δ9-THC and CBD in   mol L-1 levels, being possible to expand this chemical analysis to forensic, clinical and pharmaceutical samples.

WEED OUT THE MISINFORMATION: THE PROCESS OF VERIFYING CANNABIS PRODUCT LABELS

Camden Mcfarland, Greg Giordano, Marco Ortiz Torres, Ashley Master, Colin Brook, Duncan Mackie, Cinnamon Bidwell

Colorado legalized cannabis use in 2012, but standardization and regulation of cannabis production and distribution remain limited. The Leading Action for Better Labeling (LABeL) study aims to conduct the first independent verification of Colorado's labeling system by evaluating the accuracy of cannabis product labels across different product types (flower, edible, concentrate, and other) from dispensaries around the state. The LABeL study is a collaboration between MedPharm, a licensed cannabis testing facility, and a research team at the University of Colorado Boulder. Phase 1 of the project involved developing a standardized process to collect and maintain cannabis product label and cannabinoid analysis data in a blinded fashion. To ensure high-quality reproducible results, the research teams developed a rigorous standard operating workflow to address issues such as lack of standardization across product labels and maintain a blinded cannabinoid analysis process. The standard operating workflow consists of a series of verification steps and triplicate cannabinoid analysis for each cannabis product. First, a member of the MedPharm team buys a product, uploads photos of the product and enters data from its label into Qualtrics. These data are double-checked and uploaded into a custom web application developed by the CU Boulder team. After the product's cannabinoid analysis is complete, the data are uploaded to the web application. The individual conducting the cannabinoid analysis is blinded and refers to each product by a sample number. The verification team has access to all recorded information for each product via the web application for comparing label and analyzed values. If abnormal values (outside of expected range for product type) are found, the cannabinoid analysis is repeated. Data flow and management processes were carefully established to promote high-quality data and analysis, supporting strong public health conclusions across multiple product types. The data from this study will provide information about the accuracy of current cannabis product labels and help standardize labeling processes to promote clarity for cannabis users and researchers.