ANNUAL REPORT

2024

Institute of Cannabis Research

COLORADO STATE UNIVERSITY PUEBLO

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LETTER FROM

The Chair of the Governing Board

In my inaugural year as the Institute of Cannabis Research (ICR) Governing Board chair, I'm very excited to share more about our amazing program, staff, and volunteers. Without our dedicated team, we simply would not exist, and the many tangible societal benefits would still only be wishful thinking. I also must take time to recognize the support for the Institute from the State of Colorado, who offers administrative and appropriated funding support through the Marijuana Cash Tax Fund. As a member of the Governing Board, we are charged with overseeing and guiding the role and mission of the institute, directing the expenditures of funds, and advising any Colorado institution of higher education that seeks to develop a cannabis-specific curriculum. I've served on the Board since 2020 and have witnessed amazing accomplishments. Currently, the ICR is managing cannabis research funding in the state of Colorado of $2.8 million, and, as some research projects come to a close this year, we aim to select new projects totaling about $800,000 in research to start next year. We are one of the largest funding organizations dedicated to solving some of the most crucial questions about cannabis. Newly awarded projects in 2024 explore the relationship of cannabis and Autism Spectrum Disorder, the microbiome, potential harmful effects of dabbing and vaping, co-use with alcohol, neuronal cell-types responsible for the rewarding and aversive properties of THC, and quantifying cannabis water use requirements in intensive horticulture production systems. We endeavor to support research for all Colorado research institutions and universities. New this year, we have initiated a unique program for primary undergraduate institutions to encourage broad-reaching impacts including underrepresented areas and help support the development of students and future scientists in the field.

While ICR functions primarily at the state level, we cannot ignore national issues. Many proposed regulatory changes are actively being evaluated to expand opportunities for cannabis research. Extending our reach across the state lines, we have ongoing partnerships with other cannabis centers including Washington, Oregon, and Nevada.

It's important to also continue efforts to reach our audience. We serve many interests including state and federal regulatory agencies, universities and Institutes, health agencies, diagnostic centers researchers, administrators, those involved in agriculture and commercialization, and, most importantly, YOU! We sponsor monthly educational webinars that cover many new discoveries. We've worked hard to enhance our website (**instituteofcannabisresearchcolorado.org**) Please take a few moments to explore and provide feedback. The premier event of the year is our annual Cannabis Research Conference, which will be hosted at Colorado State University, Ft. Collins, CO from August 7-9. I hope to see you there!

Warmly,

Dr. Jon Reuter

Dr. Malik Hasan, Dr. Melissa Reynolds, Dr. Cinnamon Bidwell, Dr. John Harloe, Ms. Elyse Contreras, President Armando Valdez, Mr. Sherard Rogers, Mr. Scott McWhorter, Dr. Joanna Zeiger and Dr. Jon Reuter.

ABOUT THE
Governing Board

The ICR has a state appointed Governing Board that plays a critical role in the operation of the Institute. The Board is comprised of four ex officio members including Dr. Jon Reuter (representing the President of the University of Colorado System), Mr. Armando Valdez (representing the Chancellor of the Colorado State University System), Ms. Elyse Contreras (representing the Executive Director of the Colorado Department of Public Health and Environment), and Mr. Scott McWhorter (representing the Executive Director of the Colorado Department of Higher Education). The Board also has four members that represent cannabis-related industries in the state. The members representing cannabis-related industries includes Mr. Sherard Rogers, Dr. Malik Hasan, and Dr. John Harloe, JD, with one position currently vacant. There are three Board Members associated with cannabis-related research that includes Dr. L. Cinnamon Bidwell, Dr. Joanna Zeiger, and Dr. Melissa Reynolds. In addition to serving important roles supporting the operation of the ICR, the Board brings a wealth of diverse experience and knowledge that directly relates to cannabis research.

LETTER FROM THE DIRECTOR
Dr. Chad Kinney

It has been another productive year for the Institute of Cannabis Research (ICR) with a number of items to celebrate. I will highlight several of these in this letter and encourage readers to review the rest of this report to learn more about the ICR in greater detail.

The ICR welcomed two new Governing Board Members as well as welcomed back some Board Members for another term of service. The ICR is grateful for the continued interest from experts in various fields of cannabis science in serving on the ICR Governing Board. This fall saw a transition in Board leadership with Dr. L. Cinnamon Bidwell concluding her time as the Inaugural Chair of the Governing Board. Thankfully, the ICR continues to benefit from Dr. Bidwell's expertise and leadership as she continues on as a Board Member. Dr. Jon Reuter has graciously agreed to step into the leadership role of Governing Board Chair and is doing an outstanding job as Chair.

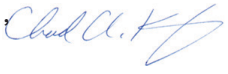
At the time of the drafting of this letter, the ICR is supporting 20 high impact research projects across the state of Colorado. Most of these are projects that have a duration of about 3-years. The first set of 3-year projects will be concluding spring of 2024. Details of the outcomes of many of these projects are included later in this report. As some of the projects that the ICR supports are coming to conclusion a new set of research projects are being selected through a rigorous review process and will be initiated in the summer of 2024. Colorado and the ICR is very fortunate to have such great cannabis researchers and research infrastructure in the state.

While I do not wish to diminish the very real impacts of a global pandemic, if you are anything like me, you are likely tired of hearing about the impacts of COVID-19 and excited to look forward. After several years of uncertainty around travel and gathering in large numbers, it was wonderful to have the Cannabis Research Conference (CRC) back in-person after operating virtually for 3 years. The CRC 2023 was held at the Auraria Campus in Denver in August 2023. It was wonderful to gather with colleagues, researchers and stakeholders to discuss the latest developments in cannabis science. The conference consisted of 341 attendees (318 domestic and 23 international) and 143 presentations. The next conference, CRC 2024, will be held August 7-9, 2024, at the Colorado State University Campus in Fort Collins. The planning committee is actively reviewing well over 100 abstracts for this conference, which promises to be a premiere event to share and learn about the latest advancements in cannabis research.

The ICR has sponsored the Journal of Cannabis Research (JCR) since its launch in 2018. Launching a journal is not for the faint of heart. Fortunately, the JCR has been under the unwavering leadership of Editor-in-Chief Dr. David Gorelick. Earlier in the fiscal year the JCR received its first Impact Factor, which is 3.7. While not everyone may be familiar with what an Impact Factor is or means, it is an important measure of journal success. In short, it is a measure of the importance/quality (impact) of a journal and is based on the number of citations of an article published in the journal by other authors and researchers. An initial impact factor of 3.7 is very good. Like the conference, the JCR is a tool by which the ICR is impacting cannabis research in Colorado, nationally, and globally. In its relatively short history there have been almost 600,000 downloads of JCR articles.

I wish that I had more space to brag about more of the good work and impact of the ICR. You will have to read the rest of this report to learn more. I will conclude with some notes of thanks. First, I wish to thank the ICR Staff that work tirelessly to support the multifaceted work of the ICR. Most of the time I am amazed at the diversity, quantity, and quality of work that the small but mighty Staff does every day for the citizens of Colorado. Second, I would like to thank the state appointed Governing Board that generously lends its expertise and commitment to advance cannabis research to the ICR and state. Next I would like to thank Colorado State University Pueblo, who has served as the host institution for the ICR since the inception. Without the infrastructure and assistance of a host institution it would be impossible for the ICR to do what it is called on to accomplish each year. Finally, thank you to the state of Colorado for entrusting the ICR, its Staff, and Governing Board with the responsibility of conducting important cannabis research on behalf of the citizens of Colorado.

With Gratitude



Chad A. Kinney, Ph.D.
Director

MEET THE ICR STAFF

Dr. Chad Kinney

Director

Dr. Kinney joined Colorado State University Pueblo in 2007 as a member of the Chemistry Department. In addition to serving as the Director of the ICR, Dr. Kinney has also served as the Chair of the Chemistry Department and served a year as interim Provost for the campus. Dr. Kinney's research interests include environmental chemistry related to pharmaceuticals and personal care products as environmental contaminants as well as cannabinoid chemistry and analytical techniques associated with cannabinoids. As Director of the ICR, Dr. Kinney works with a talented staff, a dedicated Governing Board, and researchers from around Colorado to ensure that the Institute meets the role and mission that the state has charged the ICR with.

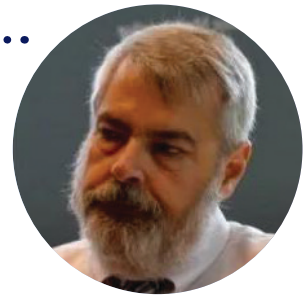
Dr. Jeff Smith

Strategic Partnership and Outreach Specialist

Professor Smith is an accomplished neuroscientist with research expertise focused on learning and memory and neurodegenerative diseases. This includes multiple publications in cannabis-related research. Dr. Smith's connection to the ICR is not new. He was part of the team that created the vision which led to the establishment of the ICR in 2016, as well as helped provide early leadership of the ICR as a member of the Institute's Steering Committee and served as the Interim Director of the institute for fiscal year 2022/2023. Further, Professor Smith is an experienced leader on the CSU Pueblo campus as a former Director of the graduate program in the Biology Department and former Chair of the Biology Department.

Dr. John Williamson

Associate Director of ICR Research Development



Dr. Williamson joined CSU Pueblo as the Senior Director of Research in 2019. He serves as the ICR's strategic development advisor in pursuing research partnerships, collaborations, and external funding opportunities. Dr. Williamson received his Ph.D. in medicinal chemistry and natural products chemistry from the University of Iowa. He served as a tenured professor of medicinal chemistry at the University of Mississippi for 25 years overseeing the drug discovery and development research program in infectious diseases. Dr. Williamson was also a branch chief of basic and mechanistic research at the National Institutes of Health in Bethesda, MD, and has served as a research consultant for a variety of governmental agencies, private industry, the media, and many universities across the country.

Dr. Sanghyuck Park

Associate Director of Research

Dr. Sanghyuck Park is a plant molecular biologist with extensive expertise in cannabis physiology and genetics, focusing on the interactions of cannabis with the environment and its genetic responses to biotic and abiotic stresses. Since his affiliation with the ICR in 2017, he has authored 23 research articles and presented at over 30 conferences. Dr. Park is also committed to education, actively teaching and mentoring CSUP students on various cannabis-related projects. Additionally, he chairs the ICR Cannabis Plant Science and Cultivation webinar series and collaborates extensively with both domestic and international partners on cannabis research.

Mr. DuShunte Carmon

Grants Manager and Program Officer

DuShunte D. Carmon received BA's in both Sociology and Behavioral Science from San Jose State University in 1999, a MS Degree in Sociology/Criminal Justice from Clark Atlanta University in 2002, and a Paralegal Certification from Emory University in 2010. Mr. Carmon has taught courses at Morehouse College, Clark Atlanta University, University of Memphis, and Voorhees College. Mr. Carmon was a Field Researcher and Data Analyst for Morehouse College in collaboration with the Department of Highway Safety, Seat Belt Study in 2001, as well as being a Research Associate for Morehouse College. Mr. Carmon has recently worked on projects involving virtual reality learning and has done philanthropic work.

Ms. Wendy Fairchild

Project Assistant

Ms. Fairchild creates, publishes, and distributes all in-house ICR outreach materials including the bi-monthly e-newsletter, annual reports, webinar ads, email blasts, news items, and manages the ICR's social media content. Ms. Fairchild has worked for the ICR as the Office Manager for six years and was recently promoted to the Project Assistant for the department. Ms. Fairchild works with many offices on campus and oversees administrative needs of the staff and governing board and assists with organizing the annual cannabis conference and with maintaining the ICR webpage. Though she has lived in the Denver area for 12 years, she lives and works in her hometown of Pueblo and is an alumna of CSU Pueblo.

Ms. Ingrid Carolina Corredor Perilla

Visiting Research Scholar, Ph.D Candidate

Carolina Corredor is an Agricultural Microbiologist, with a master's degree in Biological Sciences. She is also a Ph.D. candidate in Agroecology from the National University of Colombia. She has over 6 years' experience teaching fungal biology, introductory biology, general microbiology, agricultural microbiology, and microbes in cannabis production at Los Andes University, Agrarian Foundation of Colombia, and the National University of Colombia. Ms. Corredor is a Visiting Scientist with the ICR where she has presented at the CRC conference, served as the laboratory instructor for the CBC program at CSU Pueblo and published her manuscript in Rhizosphere. She will defend her doctoral dissertation in June.

Dr. Eun-Soo Kim

Visiting Research Scholar

Dr. Kim joined the ICR as a visiting scholar in 2019 conducting a glandular trichome project. His background is in plant morphology and development. Dr. Kim previously served as a professor of plant biology at the Konkuk University in South Korea for 26 years studying economic crops such as Cannabis, hops, and Ginseng. Dr. Kim published over 50 peer-reviewed publications with 870 citations in total. Dr. Kim founded the Korea Hemp Institute in 2007 and served for 7 years as a Director. Dr. Kim published three manuscripts on behalf of the ICR to the journals AoB Plants and Journal of Natural Fibers. The fourth manuscript to *Scientific Reports* has now passed through the review stage and is ready for revision.

Mr. Byeong-Ryeol Ryu

Visiting Research Scholar, Ph.D Candidate

Byeong-Ryeol Ryu, a Ph.D. candidate from Kangwon National University in South Korea, joined the Institute of Cannabis Research (ICR) as a visiting scholar in February 2024. Mr. Ryu has been actively involved in cannabis research at his home institution. His master's research focused on breeding new cannabis varieties for enhanced cannabinoid production, which successfully led to the development of a novel strain. His doctoral work delves deeper into the genomics and genetics of this newly developed variety to better understand its improved cannabinoid production. Additionally, he has utilized sequencing data to develop molecular markers for early sex determination, strain identification, and the selection of disease-resistant varieties. During his one-year tenure at the ICR, Mr. Ryu will conduct biochemical and molecular research on the stress responses of cannabis plants and explo mitigate these stresses.

NEW PROJECTS STARTING FALL 2024 (2024-2027)

1 Edible Roulette or a Sure Bet? Evaluating Testing Standards and Consistency in Colorado's Edible Products

PI: L. Cinnamon Bidwell, PhD
University of Colorado Boulder

PI: Duncan Mackie, PhD
Director of Pharmacology & Experimental Therapeutics

2 Defining offspring cardiovascular consequences of cannabidiol (CBD) consumption during pregnancy

PI: Emily Bates, Ph.D
University of Colorado Anschutz Medical Campus

3 Examining the effects of pesticide treatments on pest populations, cannabinoid concentrations and pesticide residues in Cannabis sativa

PI: Punya Nachappa, PhD
Colorado State University

Co PI: Nirit Bernstein
Professor, Agricultural Research Institute - Volcani Center, Israel

4 Cannabis Use and Neuropsychological Functioning among Emerging and Older Adults

PI: Rachel Thayer, Ph.D
University of Colorado Colorado Springs

5 Cannabinoids as a Treatment for Irritable Bowel Syndrome Symptoms

PI: Melissa Reynolds, Ph.D
Colorado State University

ACTIVE RESEARCH PROJECTS
2023-2026

1 Endocannabinoids in Children with Autism Spectrum Disorder and Changes with Cannabidiol (CBD) treatment (2023)

PI: Nicole Tartaglia MD
Professor Pediatrics
Developmental Pediatrics
University of Colorado
Anschutz Medical Campus

2 Examination of the bi-directional interactions between phytocannabinoids and a human-associated gut microbiota

PI: Jessica Prenni Ph.D
Associate Professor, Department of Horticulture and Landscape Architecture (JP)

Co PI: Tiffany Weir Ph.D
Professor, Food Science and Human Nutrition (TW), Colorado State University

3 Investigation of polycyclic aromatic hydrocarbons resulting from vaped or dabbed cannabis/cannabis-derived products with known adverse health effects

PI: Alison Bauer Ph.D
Associate Professor
Department of Environmental amp Occupational Health
University of Colorado
Anschutz Medical Campus

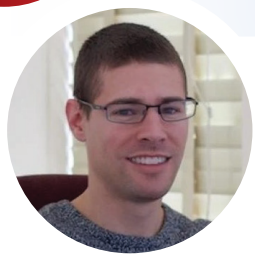
4 Developing predictive models to distinguish alcohol use, cannabis use and co-use: an exploration of electroenceph-alography (EEG) metrics and traditional intoxication measures

PI: Hollis Karoly Ph.D and Co PI: Patti Davies Ph.D (not pictured)
Assistant Professor Department of Psychology HK and Professor Department of Occupational Therapy PD Colorado State University

5 Increasing the Analytical Testing Capability of Cannabinoids and Concomitant Phytomolecules in Cannabis-derived Plant Matrices

PI: William Baurerle Ph.D
Professor Department of Horticulture and Landscape Architecture Colorado State University

6 Identifying the neuronal cell-types responsible for the rewarding and aversive properties of THC



PI: David Root Ph.D
Assistant Professor
Department of Psychology and Neuroscience University of Colorado Boulder

ACTIVE RESEARCH PROJECTS
2022-2025

1 Cannabinoids and Traumatic Brain Injury: A Randomized, Placebo Controlled Trial

PI: Kent Hutchison PhD
Institute of Cognitive Science Affiliated Faculty and Professor University of Colorado Boulder

2 Potential Health Effects of Heavy Metals in Cannabis Flower, Concentrates, Vape Devices, and Vape Emissions

PI: Mike Van Dyke PhD
Associate Professor Center for Health Work and Environment Colorado School of Public Health University of Colorado Anschutz Medical Campus

3 Examining the adaptive roles of plant defensive chemistry on pest resistance in Cannabis sativa

PI: Punya Nachappa PhD
Associate Professor Entomology Department of Agricultural Biology Colorado State University

4 Isolation and Pharmacological Evaluation of Phytocannabinoids for Alzheimer's Disease

PI: Duncan Mackie, PhD
Director of Pharmacology amp Experimental Therapeutics MedPharm Holdings

Co PI: L. Cinnamon Bidwell, PhD
Institute of Cognitive Science Faculty, Assistant Professor, University of Colorado Boulder

5 Preventative and treatment effects of broad-spectrum cannabidiol (CBD) in a rat model of comorbid autism and epilepsy: A mechanistic study

PI: Christopher Lowry PhD
Associate Professor Integrative Physiology University of Colorado BoulderAnschutz Medical Campus

RESEARCH PROJECTS Concluded in 2024

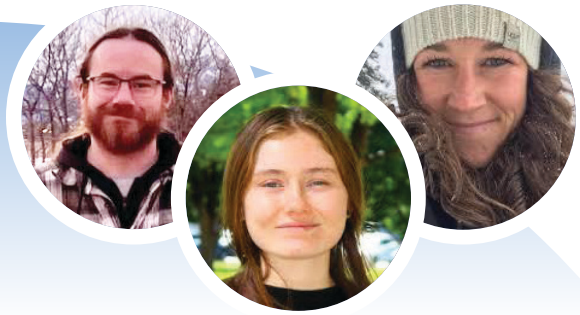
Isolation and Pharmacological Evaluation of Phytocannabinoids Microbiome-mediated effects of Cannabis, tetrahydrocannabinol (THC) and cannabidiol (CBD) on neurotransmitter-related molecular networks and anxiety

PI: Nichole Reisdorph, PhD
Professor Mass Spectrometry Facility Director Department of Pharmaceutical Sciences University of Colorado Anschutz Medical Campus

Individuals report a variety of effects when orally consuming Cannabis, ranging from anxiety to sleepiness. However, not many studies focus on consumption of Cannabis edibles. Our goal is to determine how regular use of Cannabis edibles effects anxiety and other health conditions that impact our fellow Coloradoans. We are also looking at how the make-up of a person's gut microbiome may explain the wide range of effects when using edibles. We are accomplishing this by feeding mice a Cannabis "treat" for two weeks and then measuring their behavior and levels of neurotransmitters such dopamine and serotonin. We also measure endocannabinoids which are endogenous cannabinoids; in other words, they are made by our own bodies. In contrast, THC and CBD are phytocannabinoids, made by plants. Our results show that ingesting Cannabis for 2 weeks can lower dopamine and several endocannabinoids in these mice. We've also shown that Cannabis significantly changes the make-up of the gut microbiome, which in turn may affect production of neurotransmitters and behavior. Our data suggests that an individual's body may adjust to consuming edibles regularly. One important finding was that female mice have a stronger behavioral reaction to Cannabis, becoming more anxious, compared to male mice or mice not receiving Cannabis. Finally, a small, separate study suggested that the make-up of a mouse's microbiome can affect their behavior; some mice had increased activity after consuming Cannabis while others have dramatically reduced activity (i.e. they mostly sleep). Because mice and humans have the same neurotransmitters and endocannabinoids, we are learning valuable information that can be used to design future human studies. Understanding how a person might personally respond to Cannabis can help Coloradoans make informed decisions about using Cannabis to treat their symptoms of anxiety, PTSD, and other health issues.

Key Outcomes

- Mice who eat Cannabis for 2 weeks have significantly different levels of certain neurotransmitters, including dopamine.
- Female mice who eat small amounts of Cannabis for 2 weeks appear to have increased anxiety compared to female mice who do not eat Cannabis. Male mice do not appear to have changes in anxiety after eating small amounts of Cannabis for 2 weeks.
- Eating small amounts of Cannabis for 2 weeks significantly changes the gut microbiome of both female and male mice, with larger changes to the microbiomes of female mice.
- A pilot study appears to show that the makeup of the gut microbiome affects how mice respond to a single oral feeding of Cannabis extract.



This work has been conducted with the help of three trainees (pictured left to right): Mr. Nathan Anderson, a PhD student in the Department of Integrative Physiology at CU Boulder, Ms. Ginger White, a student in the Cannabis Science and Medicine program at CU-AMC, and Dr. Winona Booher, a post-doctoral student in Pharmaceutical Sciences at CU-AMC.

RESEARCH PROJECTS
Concluded in 2024
Continued

Is What You See What You Get? A Systematic, Public Health-driven Analysis of Cannabis Product Label Claims VS. Actual Cannabinoid Content

PI: Dr. Cinnamon Bidwell, PhD
Institute of Cognitive Science
Faculty Assistant Professor
University of Colorado Boulder

Co PI: Dr. Duncan Mackie, PhD
Director of Pharmacology & Experimental Therapeutics, MedPharm Holdings

High THC cannabis products are becoming popular in the US, but it's unclear if labels accurately show how strong they are. Past studies in this area were small and didn't cover all types of cannabis products, like high potency concentrates. This study wanted to see if there were differences between what was on the label and what was actually in the products, and if this varied between types of products. We checked 277 products from different dispensaries across Colorado, including 178 flowers and 99 concentrates.

Key Outcomes

- Concentrates were more likely to have the right amount of THC according to the label (96% accurate), compared to flower (56.7% accurate).
- When there were differences, the THC content was usually lower than what the label said.
- The minor cannabinoids CBG and CBGA were more abundant than CBD in both flower and concentrates.
- This shows that labeling rules in Colorado likely work well for strong concentrates but might not work as well for other types of cannabis products.

Exploring Intoxication During Acute Alcohol and Cannabis Co-Administration: A Focus on Cannabinoid Content and Order Effects

PI: Hollis Karoly, PhD
Assistant Professor
Department of Psychology
Colorado State University

Alcohol and cannabis co-use is increasingly common in the United States, and legal cannabis markets have made new formulations of highly potent cannabis concentrate products more available to consumers than ever. However, we currently lack research on the effects of combining high-potency cannabis (such as concentrate products) with alcohol. Our ICR-funded study, Exploring Intoxication During Acute Alcohol and Cannabis Co-Administration: A Focus on Cannabinoid Content and Order Effects, utilized a mobile lab design (compliant with federal cannabis research regulations) to explore the immediate effects of cannabis concentrates and a standard dose of alcohol. Following alcohol and cannabis use, participants completed a breathalyzer and several measures of alcohol and cannabis intoxication every 30 minutes for the duration of the session. Additionally, a "mini-pilot study" was conducted on a subset of these participants. This subset of individuals participated in an optional portion of the session to measure their brain activity using electroencephalography (EEG) before, 1 hour after, and 4 hours after consuming alcohol and cannabis. Participants included in the "mini-pilot" completed behavioral tasks on the computer while brain activity was recorded.

Key Outcomes

- On average, participants who used alcohol before cannabis showed a higher peak heart rate compared to those who used cannabis before alcohol.
- On average, those who used the alcohol before cannabis exceeded 100bpm (a commonly accepted cutoff for tachycardia) during the study session, while on average, the mean heart rate for those who used cannabis before alcohol did not exceed this cutoff.
- This could offer a practical and straightforward harm reduction option for individuals who co-use alcohol and cannabis (i.e., avoid using alcohol before cannabis during co-use sessions to reduce the impact of co-use on heart rate elevations).
- EEG measures showed that alcohol and cannabis co-use negatively impacts cognitive performance and suppresses brain activity in the hour after use, but that these measures return to close to pre-intoxication levels within 4 hours.

Concluded in 2024

Continued

Defining the Effects of CBD Consumption During Pregnancy on Fetal Neurodevelopment and Postnatal Anxiety

PI: Emily Bates, PhD
Associate Professor Pediatrics
Developmental Biology
University of Colorado
Anschutz Medical Campus

Cannabidiol (CBD) is a component of cannabis that does not make people high and is federally legal. People take CBD to help with sleep, pain, anxiety, and nausea which are common symptoms of pregnancy. But CBD crosses the placenta and reaches a developing baby in the womb. CBD acts on parts of the brain and organs to alter their development and the way that they work long-term. We found that taking CBD during pregnancy hurts brain development in the offspring so that is more difficult to solve problems. Male mice that were exposed to CBD during development were more sensitive to pain. We also found that mice exposed to CBD during development were predisposed to glucose intolerance and insulin resistance, the hallmarks of diabetes.

Key Outcomes

- Consumption of CBD during pregnancy increases pain sensitivity in male offspring.
- Consumption of CBD during pregnancy hurts brain development and problem-solving ability in female offspring.
- Consumption of CBD during pregnancy predisposes offspring to the signs of diabetes.

CBD is an alluring treatment for pregnancy symptoms, but our work shows that it poses a risk to the developing baby. Clinicians and pregnant patients need to know what is safe and not safe for consumption during pregnancy.

Investigating the Effect of Cannabidiol and Cannabidiol-trazodone Combination Treatment on Naturally Occurring Canine Cognitive Dysfunction Syndrome as a Surrogate for Alzheimer's Disease

PI: Stephanie McGrath, PhD
Associate Professor
Neurology Colorado State University

This research is innovative and critical because, to date, there are no therapeutic interventions that are broadly effective in treating Alzheimer's disease (AD) and canine cognitive dysfunction (CCD). Additionally, most, if not all, therapies that are successful in rodent models fail or demonstrate greatly reduced efficacy when they enter human clinical trials, highlighting the importance of a more translatable animal model. The dog model, given CCD's remarkable similarities, neuropathologically and behaviorally, to human AD, serves as an ideal surrogate in the clinical trial pipeline. The dog model will allow targeted and preventive therapy trials and, ultimately, will conserve resources and hasten discovery.

Our *hypothesis* for this study was that therapeutic intervention with cannabidiol (CBD) will delay or reverse the clinical signs and molecular biomarkers of CCD. To address this hypothesis, we enrolled senior companion dogs with clinical signs of CCD at the Veterinary Teaching Hospital at Colorado State University and administered CBD orally for 2 years or until death. We assessed cognitive changes, biomarkers, and tolerability of the drug, as well as neuropathological changes after death (postmortem).

Given the unique features of AD-like disease occurrence in the companion dog, we strongly believe that the dog serves as a powerful model in the AD interventional therapeutic clinical trial pipeline. Given the underwhelming benefits of the current therapeutic options for AD, the continued search for pharmacologic agents, such as CBD, is essential. With CCD serving as an exceptional large animal disease model for AD in humans, the translational power of this study will serve to substantially advance human medicine, as well as showcase the dog as a model for future interventional trials.

Key Outcomes

- Adverse events associated with CBD were assessed and determined to be non-existent to mild in all dogs. Therefore, it was determined that CBD was well tolerated in aged dogs with dementia.
- Neuropathological evaluation and full autopsy of the single deceased dog that received CBD did not reveal any abnormalities secondary to CBD administration nor evidence of toxicity.
- We proved that we were able to successfully enroll geriatric client-owned dogs with dementia in the first-ever longitudinal study, which included bi-annual spinal fluid collection and yearly MR imaging (under general anesthesia).

Concluded in 2024

Continued

Quantification of Endo- and Phytocannabinoids with Comparison to Pain Medication: Requirements and Surgical Outcomes for Patients Undergoing Abdominal Surgery for Cancer.

PI: Camille Stewart, MD
Assistant Professor of Surgery
Division of Surgical Oncology
University of Colorado
Anschutz Medical Campus

Co PI: Ana Gleisner, MD
Associate Professor of Surgery Division of Surgical Oncology University of Colorado Anschutz Medical Campus

Patients with cancer have a particular interest in the potential therapeutic effects of cannabis. The effect of cannabis on outcomes after surgery, such as complications and pain control, is poorly understood. We hypothesized that frequent cannabis users undergoing abdominal surgery for the treatment of cancer would have increased post-operative pain, but similar rates of complications compared to non-cannabis users.

We conducted a prospective clinical study of adult patients undergoing an abdominal cancer operation comparing non-users (no cannabis use in the last year) or frequent cannabis users (≥1x/week for the last 3 months) from 9/2021-3/2023. Blood cannabis metabolites were measured pre-operatively. Pain scores, pain medication requirements, and surgical complications were assessed.

Conclusions

Most, but not all, frequent cannabis users had detectable cannabinoid metabolites, and most, but not all, non-users did not have cannabinoid metabolites in their blood. This may be due to poor labeling of cannabis products or poor patient understanding of what products contain cannabis.

Frequent cannabis use significantly increases pain medication use and pain perception after abdominal surgery for the treatment of cancer but does not increase rates of complications. This information may impact decision making for patients who are considering frequent cannabis use prior to surgery.

Key Outcomes

- There were 220 patients screened, and 58 patients enrolled during the study period (19 (33%) frequent users, 39 (66%) non-users).
- In frequent users, positive THC and CBD metabolites were present preoperatively in 18/19 (95%) and 3/19 (16%) patients, respectively. There were 3/39 (8%) non-users positive for cannabis metabolites.
- Frequent cannabis users had higher pain scores at discharge compared to non-users.
- Frequent cannabis users had significantly more pain medication prescribed and taken after discharge compared to non-users.
- Frequent cannabis users had similar complication rates after abdominal surgery for the treatment of cancer compared to non-users.

ADDITIONAL RESEARCH PROJECTS
Concluding in 2024

Cannabinoid Conversion to CBN During Hemp Extraction and Post-Extraction Fluorination of CBD and CBN for Increased Bioavailability

PI: Ken Olejar Ph.D
Colorado State University Pueblo

Key Outcomes

- Synthesis of six novel CBN fluorinated derivatives.
- Developed new method for the conversion of CBD to CBN, which should save producers time and money.
- Four of the synthesized compounds are currently undergoing testing for biological activity in cell lines.
- Able to train post-doctoral researcher to begin becoming a future academic specializing in cannabis research.

Short-term Effects of Cannabis use and Cannabinoids in Youth: A Sibling-Comparison Study

PI: Jarrod Ellingson Ph.D
Assistant Professor Psychiatry
Substance Dependence
University of Colorado
School of Medicine

Key Outcomes

- Cannabis use is not associated with worse cognitive functioning among a sample that uses infrequently (1-2 days per month).
- When examining this same question in a sample that used cannabis more frequently (7-9 days per month), some aspects of memory are worse.
- We have found that twins living in states with legalized cannabis use cannabis more frequently than their co-twins in non-legal states, but they had few other observable consequences through the first five years of legalization.
- Some evidence suggests that cannabis use is most likely to lead to adverse consequences when it is frequent and persistent.

Observational Study of the Effects of Acute Cannabis Use on Ocular Activity Relevant to Driving

PI: Ashley Brooks Russell, Ph.D MPH

Associate Professor Director
IVPC Colorado School of Public Health University of Colorado
Anschutz Medical Campus

Key Outcomes

- Our research project is studying “driving monitoring systems” which are passive systems in cars to monitor drivers to detect risky driving, such as from drowsy or distracted driving, and drug or alcohol impaired driving. These systems can help prevent crashes but alerting the driver (or a fleet monitor) to dangerous driving before a crash occurs.
- We are finding evidence of “tunnel-vision” where the driver’s field of vision narrows after they use cannabis, which can be detecting with in-vehicle eye tracking technology.
- We are finding that there are changes to the eyes associated with recent cannabis use, particularly changes to how the pupil constrict and dilate in response to light.

Continued from previous page

Dissecting the Genetic Basis of Sex and Dioecy in Cannabis Sativa

PI: Nolan Kane Ph.D
Associate Professor Ecology and Evolutionary Biology University of Colorado Boulder

Key Outcomes

- Generate full, chromosome scale assemblies including X and Y chromosomes, with genes identified, for males, females, and monoecious varieties grown in Colorado.
- Generate genetic mapping populations of hemp and grow them out in agricultural field conditions to quantify the genetic segregation patterns to identify the genetic and environmental determinants of male and female floral production.

RESEARCH AT THE Institute of Cannabis Research

ICR Internal Research Overview

ICR is actively involved in a broad range of cannabis research projects. Our efforts encompass the study of cannabis physiology and the genetic mechanisms responsible for cannabinoid production, as well as investigating the potential therapeutic applications of phytocannabinoids in treating various human diseases and syndromes. The ICR research team is led by Dr. Sanghyuck Park, Associate Director of Research at ICR, and includes three visiting scholars: Dr. EunSoo Kim, Ms. Ingrid Carolina Corredor-Perilla, and Mr. Byeong Ryeol Ryu.

ICR offers a wide range of research opportunities and actively collaborates with the Mentoring Access & Platforms in STEM (MAPS) and the Cannabis Biology and Chemistry Degree programs. Our team at the CSU Pueblo campus also comprises four dedicated undergraduate students: Mr. Chaylen Richards, Jalen Gordon, Brandon Blanchard, and Luis Vargas. The research at ICR is organized into several focused categories:

1. **Photostability of CBD-Infused Products**
2. **Microbial Effects on Cannabis Growth**
4. **Fungal Treatment Effects on drought-stressed Cannabis**
4. **Pre-clinical testing of phytocannabinoids in Novel Invertebrate Models**

ICR Student Research Team, left to right: Dr. Sanghyuck Park, Chaylen Richards, Abigail Blanchard, Ingrid Carolina Corredor-Perilla, Laura Livelli, Jarod Lueker, and Brandon Blanchard.

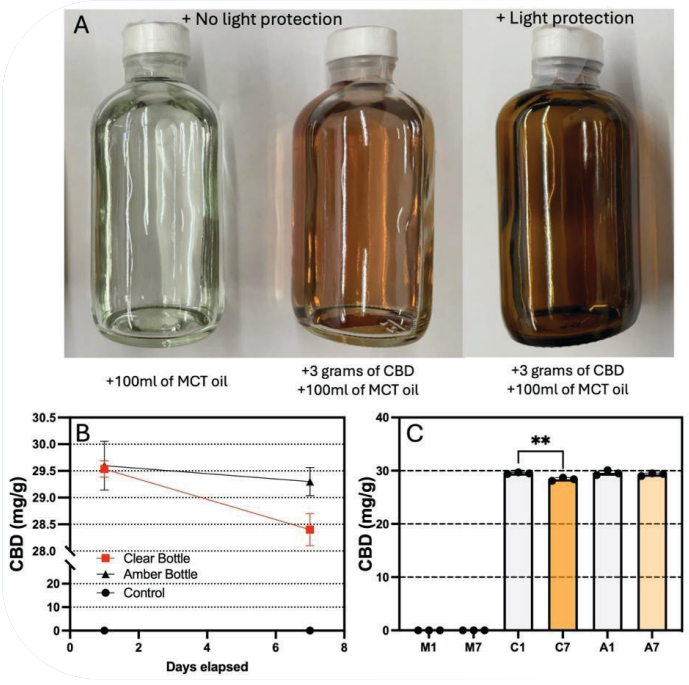
ICR Research Team members, left to right: Jalen Gordon, Brandon Blanchard, Dr. Eunsoo Kim, Chaylen Richards and Visiting Scholar Ms. Ingrid Carolina Corredor-Perilla.

Cannabis Biology & Chemistry (CBC) Student Researchers, from left to right: Daniel Rogers, Noah Reid, Chris Moody, Chico Ryder, with Instructor Ms. Ingrid Carolina Corredor-Perilla.

ICR Director Dr. Chad Kinney with CBC students, listed from left to right: Daniel Rogers, Chris Moody, Jalen Gordon, and Noah Reid, at the NOCO Hemp Expo, April 11-13, 2024, in Estes Park, Colorado.

Photostability of CBD-Infused Products

ICR has identified that CBD-infused products exhibit significant photosensitivity, leading to rapid oxidation when exposed to environmental conditions. Initial pilot studies conducted by our institute have demonstrated that CBD can undergo oxidation within just a few hours, with noticeable color transitions from yellow to purple and eventually to brown within a span of three weeks. Our ongoing research efforts are directed towards identifying the specific degraded (oxidized) forms of CBD and evaluating their efficacy and potential side effects. Furthermore, this research aims to establish a correlation between the observable color changes and the quality of commercial CBD oils, with the goal of improving public health safeguards by providing more reliable and safer CBD products.



Photosensitivity of commercial CBD oil under constant light exposure and oxidation. The CBD infused in medium-chain triglyceride (MCT) extracted from coconut oil initially exhibits a clear, water-like color. However, it undergoes discoloration when exposed to light and air, turning yellowish within a couple of hours and progressing to purple or brown within a couple of weeks.

INTERNAL Research *Continued*

Microbial Effects on Cannabis Growth

Soil microbes are crucial in cannabis cultivation, enhancing nutrient uptake, improving soil structure, and protecting plants from pathogens. The ICR team is particularly interested in the unique rhizomicrobial communities present in cannabis soil and their interactions with the plant. To examine the variations in these microbial communities during different growth phases, such as the vegetative and flowering stages, two CBD hemp varieties were selected: 'Cherry Wine' (CW; CBD 15-20%, THC 0.25%) and 'La Crema' (LC; CBD 0.18-0.38%, THC 0.2%). The study utilized two DNA markers—the 16S ribosomal RNA region V3-V4 for bacteria and the internal transcribed spacer 1 (ITS1) for fungi—to monitor microbial changes. Genomic DNA extracted from the cannabis soil was analyzed using Illumina MiSeq 2x300 bp paired end reads. Led by Ms. Ingrid Carolina Corredor-Perilla, a visiting scholar from Colombia, the research revealed significant variations in the cannabis rhizobiome across different cultivation phases, influencing plant growth, development, and cannabinoid production. These findings suggest the potential industrial application of beneficial microbes as biostimulants.

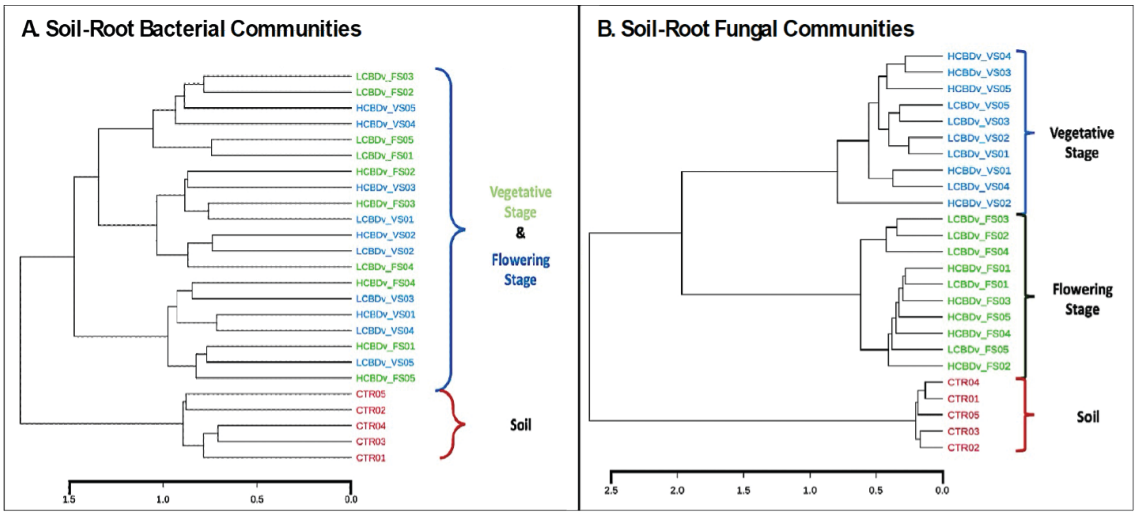


Figure 1. Impact of root exudates (chemicals expelled) from Cherry Wine and La Crema hemp varieties on soil-root-attached microbial communities during different growth stages.

A. Depicts the variation in bacterial communities, comparing unplanted soils with the vegetative and flowering stages.

B. Focuses on fungal communities, highlighting differences across these stages. The findings underscore significant shifts in microbial community composition, influenced by the developmental stage of hemp plants.

A controlled environment is employed for cannabis cultivation within ICR research. The hemp strain "Cherry Wine" is cultivated under two distinct environmental conditions to study the environmental impacts on its growth and cannabinoid production.

Visiting scholar, Ms. Ingrid Carolina Corredor-Perilla, a Ph.D. candidate from the National University of Colombia, conducts microbial assays on soil from cannabis plants.

Fungal Treatment Effects on drought-stressed Cannabis

In a collaborative effort with Kangwon National University, South Korea, our research team is investigating the potential benefits of soilborne-fungus Trichoderma hamatum. on drought-stressed hemp cultivars. Trichoderma, a genus of fungi known for its role in biocontrol and plant growth enhancement, is being studied for its ability to alleviate drought stress in plants. By employing RNA-Seq analysis, the study has scrutinized over 35,000 genes, uncovering substantial modifications in genes associated with photomorphogenesis and the production of stress-response metabolites. These findings suggest that Trichoderma spp. may significantly mitigate drought effects through molecular interactions. The research, spearheaded by Mr. Byeong-Ryeol Ryu, a visiting scholar at the ICR, has yielded promising results that are on the verge of being submitted to a prestigious journal specializing in plant physiology. This study not only enhances our understanding of fungal-plant interactions but also opens up new avenues for improving crop resilience to environmental stresses.

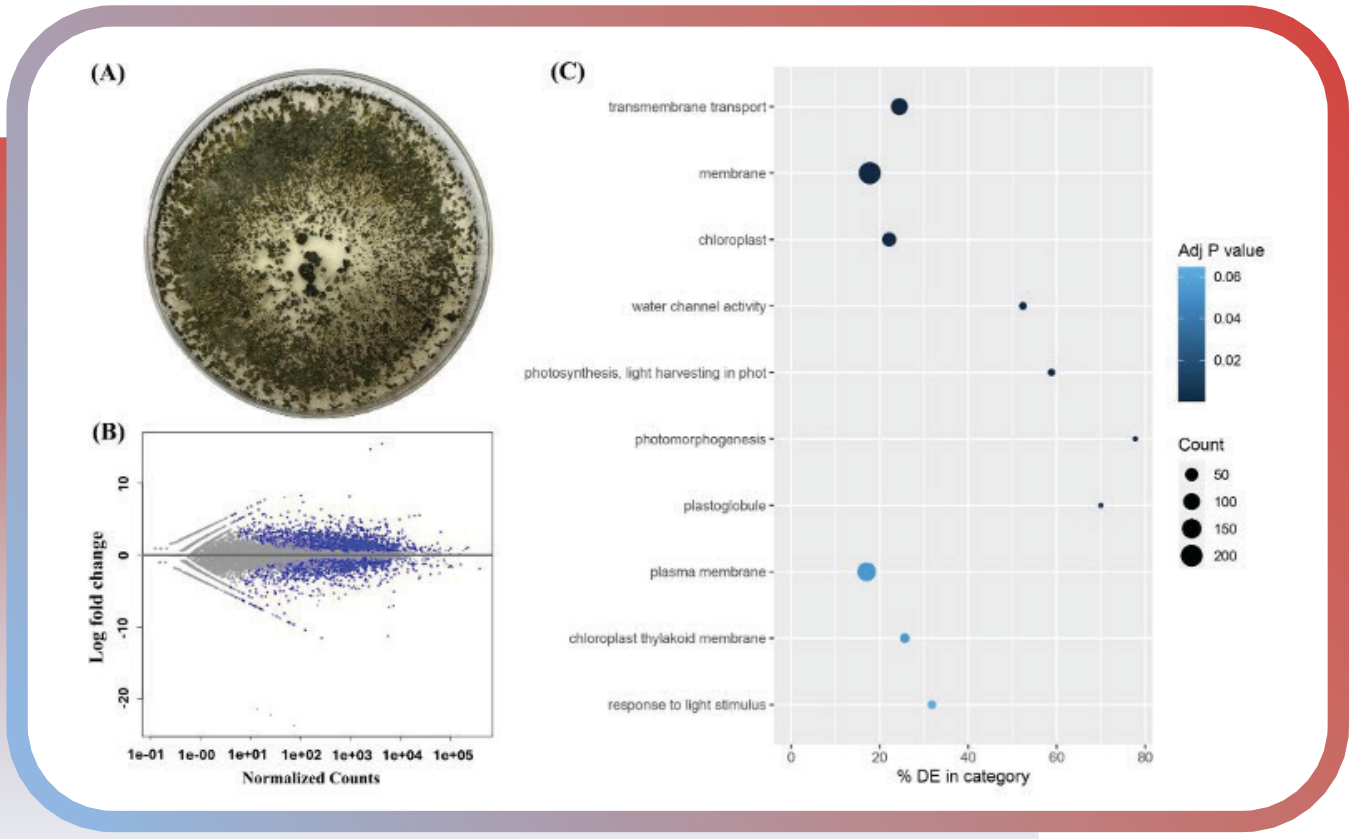


Figure 1. (A) A photograph of Trichoderma hamatum, a beneficial fungus isolated from soil in a cannabis cultivation site. (B) As a result of treating cannabis with Trichoderma hamatum, 1,271 genes out of a total of 34,253 genes were significantly upregulated, and 840 genes were significantly downregulated. (C) Functional analysis (GO analysis) of the significantly expressed genes revealed that they regulate genes belonging to groups such as cell membrane, photosynthesis, and water channel.

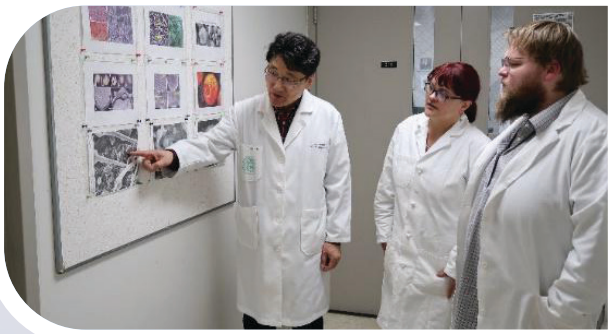
INTERNAL Research *Continued*

Pre-clinical testing of phytocannabinoids in Novel Invertebrate Models

In collaboration with the Chuncheon Bioindustry Foundation (CBF) in South Korea, this segment of our research is dedicated to examining the defensive and potential therapeutic properties of cannabinoids using invertebrate models. Dr. Eunsoo Kim, a visiting scholar at the Institute of Cannabis Research (ICR), spearheads this pioneering study on the impact of minor cannabinoids on tobacco hornworms, Manduca sexta. The research meticulously documents physiological and behavioral transformations throughout the lifecycle of the hornworms, with a focus on the influence of phytocannabinoids on growth and cuticle development. This involves examining the interactions with the Manduca sexta ecdysis-triggering hormone (Mas-ETH) and epitracheal glands. Advanced scanning electron microscopy (SEM) technology is employed to provide intricate details of cellular interactions.

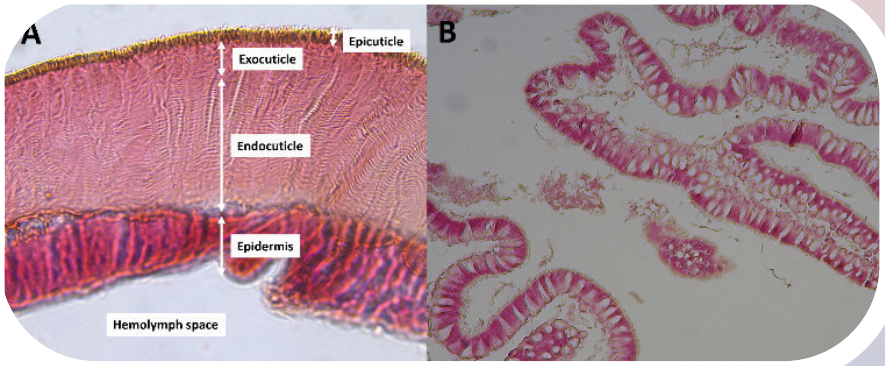
Additionally, a team of ICR student researchers, including Mr. Luis Vargas, is expanding this investigation to other invertebrate species, such as lady beetles. The goal is to broaden our understanding of the biological roles and mechanisms of phytocannabinoids across various invertebrate systems. This research not only enhances our knowledge of cannabinoid biology but also potentially lays the groundwork for new bio-based therapeutic applications.

Mr. Luis Vargas' Lady Beetle study.



Dr. Eunsoo Kim, visiting scholar, working with students, Institute of Cannabis Research (ICR)

Student Luis Vargas and Dr. Eunsoo Kim, Institute of Cannabis Research (ICR).



A. A light microscopy (LM) image of a tobacco hornworm larva, stained with hematoxylin-eosin to highlight the cuticle structure.

B. An LM image displaying the epitracheal glands in a tobacco hornworm larva, known to secrete Manduca sexta ecdysis-triggering hormone during metamorphosis.

ICR Visiting Researcher

Byeong-Ryeol Ryu

Hello, my name is Byeong-Ryeol Ryu and I came to the Institute of Cannabis Research (ICR) as an exchange researcher from Kangwon National University in South Korea.

Medical cannabis research has been actively pursued in South Korea for several years due to increasing interest in its medical benefits. However, despite the traditional use of hemp for fiber purposes, research in the area of medicinal cannabis remains insufficiently established. It is with this understanding that I have chosen to join the ICR (Institute of Cannabis Research), driven by my aspiration to attain comprehensive education and specialized knowledge in the field of medicinal cannabis.

In Korea, I have been actively involved in various research areas related to cannabis, including the rapid quantification method development for the main cannabinoids of cannabis, development of molecular markers for early sex determination of cannabis, comparison of the efficiency of decarboxylation between natural and extract states of cannabis, development of Korean cannabis variety, and the genome project of developed cannabis strains.

These research outcomes could not have been achieved without the ongoing collaboration between Korea and the ICR over the past several years.

During my time at the ICR, I am conducting biochemical and molecular research on the stress response of cannabis growth, as well as investigating methods to reduce stress. Additionally, I am also conducting research related to the preservation of commercially used cannabis extracts.

I consider it a great honor to have the opportunity to contribute to the advancement of both Korea and the ICR through diligent and systematic research during my stay. I am deeply grateful to everyone who has provided me with the opportunity to conduct research at the ICR.

ICR

Student Researchers

Student Award at the CSU Demo Day

Chris Moody from the Cannabis Biology and Chemistry program at CSU Pueblo has won the Creative Innovation Award at the CSU Demo Day for the second year in a row. His award-winning project explores the use of cannabinoids in sports drinks and supplements. Expressing his appreciation, he said,

"I wanted to thank you and the ICR for all the guidance, encouragement, and opportunities you have provided me. I would not be where I am today without your support and the help of the ICR."

Chris Moody, a CBC student and ICR student researcher, won the Creative Innovation Award at the 2024 CSU Demo Day for the second consecutive year.

Participants in the CSU Demo Day, listed from left to right: Chico Ryder, Noah Reid, Dr. Fnu Urvashi (postdoctoral research associate), Chris Moody, and Brandon Blanchard, showcasing their Cannabis project.

Hear From Students

Nathan Anderson

"My opportunity to collaborate with Dr. Reisdorph has been foundational in my development and career trajectory. Specifically, my award from the Institute of Cannabis Research enabled me to take essential time to focus on both my research and my training. There is burgeoning evidence that inflammatory and immune dysregulation and alterations in the microbiome both play significant roles in trauma- and stressor-related and anxiety disorders. In a landscape with far greater access to and use of Cannabis "edibles", understanding the relationship to anxiety-like behaviors as well as the underlying mechanisms as assessed with multi-omics approaches is of immediate and significant import. This award and collaboration continue to shape my career with a forthcoming clinical study I am playing a lead role in now well in the works, building on the collaboration between Dr. Reisdorph and Dr. Lowry, my PI. I continue to be humbled by and benefit greatly from the opportunity my award afforded me with our collaboration, not least of which has been truly outstanding mentorship."

Luis Vargas

"The Institute of Cannabis Research at Colorado State University-Pueblo ignited my passion for refining my research skills and developing into a more effective researcher. The ICR and my research team have pushed me beyond my comfort zones, significantly enhancing my growth and development."

Winona Catherine Booher

"As a postdoctoral fellow, my collaboration with Dr. Reisdorph has been one of the most beneficial developments in my professional career. It has been an honor to combine my expertise in animal behavior with Dr. Reisdorph's expertise in Cannabis and the microbiome. The importance of a healthy microbiome has been well established, but with the recent surge of oral Cannabis consumption, it is imperative we understand the relationship between the two. The collaboration and mentorship I have received while working on this project has been the impetus for my decision to accept a research associate position, where I will continue to pursue this line of research."

INTERNATIONAL Partnerships

ICR-Chuncheon Bioindustry Foundation (CBF) international partnership

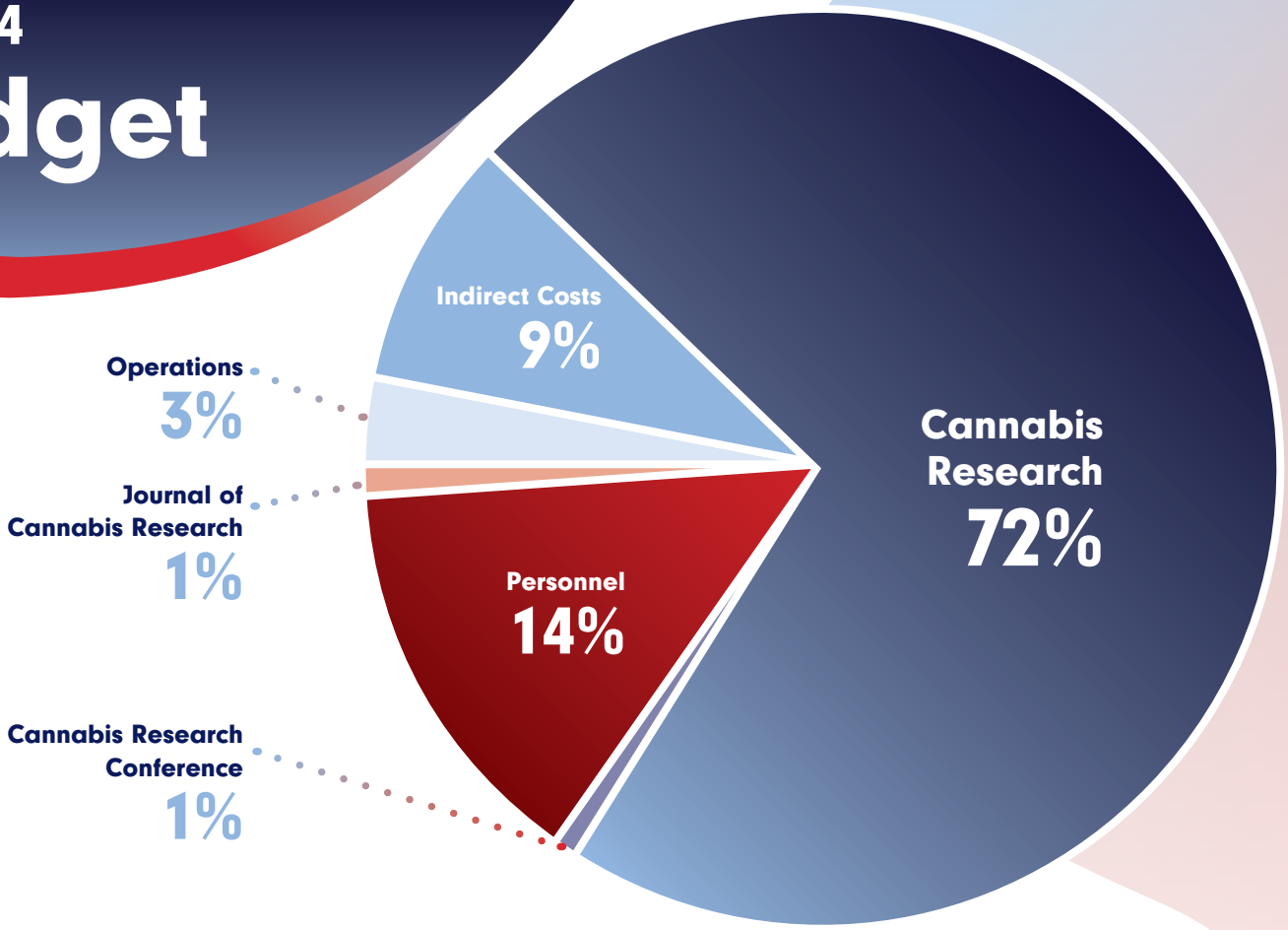
Entering its third year, the ICR project will receive $40,000 in support from the Chuncheon Bioindustry Foundation (CBF), South Korea for the preclinical testing of minor cannabinoids. This study utilizes invertebrate model systems to investigate the potential therapeutic functions of phytocannabinoids, with the aim of developing insights into their use as therapeutic agents for various diseases and human syndromes.

ICR-Korea Medical Cannabis Research Association (KMecaRA) International Partnership

The ICR Team (Dr. Jeff Smith, Mr. Dushunte Carmon, Dr. Eunsoo Kim, Dr. Sanyhyuck Park, and Dr. Chad Kinney) meeting with Dr. Hyun Joo Shim, Dr. HanJung Chae, and Jae Chul Jeong from the Korea Medical Cannabis Research Association.

Following the Memorandum of Understanding (MOU) signed in 2023, the ICR team has embarked on a joint initiative with KMecaRA and Jeonbuk Province to pursue the National Science Grant in Korea. This grant is dedicated to 'the medicinal utilization of cannabinoids and the establishment of related platforms.' The pre-proposal, put forward by KMecaRA and supported by JeonBuk National University and JeonBuk Province, has been successfully accepted. Looking ahead, ICR will continue its close collaboration with our Korean partners to develop and submit a comprehensive grant proposal, aiming to secure funding in the range of $50-100 million.

FY 2024 Budget



This year the Institute of Cannabis Research (ICR) expended just over $3.8M in financial resources in executing its mission and activities. This exceeds the appropriated funds for fiscal year 2024 as a result of the fact that some resources dedicated to research were rolled forward from FY23 to FY24, which is common for multi-year research projects. The annual expenditures largely reflect the key aspects of the mission of the Institute. The key activities of the ICR are to conduct cannabis research to support innovations in medical applications of cannabis and its constituents, protecting public health, economic development, and biotechnology, and to ensure that the results of cannabis research are publicly disseminated. In FY24 the ICR is supporting 20 multi-year research projects being conducted throughout the state of Colorado and are at various stages of progress with some of the projects wrapping up at the end of the fiscal year. The Institute of Cannabis Research encourages diversity in student participation in research and the development of future generations of researchers in the field of cannabis science and beyond.

The use of state appropriated resources by the ICR reflects the mission that the Institute is charged with executing. It should be no surprise that the most costly endeavor is the research itself, which accounts for 71% of expended of funds. This includes both internal ICR conducted research and external studies conducted by researchers throughout the state of Colorado. A total of 15% of the budget was dedicated to supporting the ICR Personnel that execute the various activities of the Institute. Although highly impactful, the key activities to support the dissemination of cannabis research results are relatively low costs. *The Journal of Cannabis Research* required less than 1% of the budget. The Journal of Cannabis Research is a resource for researchers to publish peer reviewed articles to share the results of their work with peers. The Journal impacts cannabis research on a global scale. The Cannabis Research Conference required only about 1% of the appropriated funds. And the two webinar series that are freely available to interested parties, makes up a small fraction of the operating expenses and less than 0.1% of the overall budget.

The budget for the Institute of Cannabis Research is expected be similar for Fiscal Year 2025. The Institute is committed to using the resources provided by Colorado to effectively and efficiently advance cannabis research to the benefit of its citizens.

2024 CANNABIS RESEARCH CONFERENCE
Keynote Speakers

Mechoulam Lecturer

Dr. Lumir Ondrej Hanus

Lumír Ondřej Hanuš (November 20, 1947) obtained his M.S. in analytical chemistry (1972), Ph.D. in analytical chemistry (1974) and associate professor in organic chemistry (1994) from Palacký University (Olomouc, Czech Republic) and his D.Sc. in pharmaceutical chemistry (1995) from Charles University (Prague, Czech Republic).*

Between the years 1971 and 1990, I did research on cannabis and taught hygiene at Medical Faculty, Palacký University (Olomouc), 1976-1978 Postgraduate studies of Modern instrumental chemistry (Jan Evangelista Purkyně University, Brno). Period 1978–1979 spent as a research associate at the School of Pharmacy, University of Mississippi, USA. From 1990 up to 2020 (as a researcher, professor chair, and research fellow) with the School of Pharmacy (Hebrew University, Jerusalem, Israel). Between years 1997 and 1998, I was a visiting associate (NIDDK, NIH, Bethesda, USA) and in 2001–2002 as a research fellow at NIAAA (NIH, Bethesda, USA). Steering Committee member (CMCER) and Senior Fellow in the Jefferson Institute of Emerging Health Professions, Thomas Jefferson University, Philadelphia, Pennsylvania (from 2017 to 2019). Visiting professor, Centro de Estudios Interdisciplinarios, Universidad Nacional de Rosario, Rosario, Argentina, 2021.

He was Chief Scientist at Lumir Lab (Asana Bio Group Ltd.) and retired Professor Chaver and Research Fellow of Hebrew University in Jerusalem. He was awarded with Honorary Doctorate degree - Chemiae Doctor honoris causa (2007) and Medicinae Doctor honoris causa (2011), Hanuš medal (2005), Memorial medal (2006), Outstanding Immigrant Scientist in Life Sciences and Medicine (2010), Addictology Award (2012), Recognition (Ljubljana 2014), Olomouc City Award (2013), Lifetime Award Winner (Washington D.C., 2016), Commemorative Medal of the Palacký University in Olomouc for extraordinary representation of Palacký University in the Czech Republic and abroad (2016) and Lifetime Achievement Award (Jamaica, 2018).

On March 24, 1992, he was the first person to isolate from the brain first endogenous ligand for cannabinoid receptor which was named anandamide. The discovery of this first endocannabinoid opened the world to medicinal use of cannabis.

8th Annual
CANNABIS RESEARCH CONFERENCE
AUGUST 7-9, 2024
FORT COLLINS, COLORADO
COLORADO STATE UNIVERSITY
HOSTED BY
Institute of Cannabis Research
COLORADO STATE UNIVERSITY PUEBLO
Oregon State University Global Hemp Innovation Center

Opening Plenary Speaker

Dr. Todd Michael

Todd loves sequencing and analyzing plant genomes. At the Salk his group is part of the Harnessing Plant Initiative (HPI) that aims to develop crop plants that sequester more carbon via extensive root systems containing recalcitrant carbon polymers to fight climate change. Before joining the Salk, Todd directed genome centers at Monsanto, Abbott Laboratories, Rutgers University and the J. Craig Venter Institute (JCVI), where his group sequenced thousands of plant, animal and microbial genomes. He received his PhD on the plant circadian clock from Dartmouth College in the lab of Rob McClung, BA from the University of Virginia where he worked in Michael Timko's lab, and conducted Postdoctoral research in the lab of Joanne Chory at The Salk Institute for Biological Studies. For more information, visit **https://michael.salk.edu/**.

Diversity in Cannabis Research Keynote Speaker

Dr. Nirit Bernstein

Dr. Nirit Bernstein is a senior research scientist at Volcani Center, Ministry of Agriculture, Israel. She is the first scientist in Israel to study whole plant cannabis and her research projects focus on development of cultivation techniques for Cannabis sativa, and cannabis physiology. Nirit has a PhD in Plant Physiology from the University of California, Davis USA, and a B.Sc. in Agricultural Sciences from the Hebrew University of Jerusalem, Israel.

Dr. Bernstein is an associate editor of the 'Journal of Cannabis research', she is a member of editorial boards of 7 international scientific journals, editor of special issues in scientific journals, and she published more than 100 peer reviewed academic publications, invited reviews and book chapters. Nirit is a lecturer of three graduate level courses at the Hebrew University, Israel, including a course on "Medical Cannabis".

Dr. Bernstein's specializes in regulation of plant derived pharmaceuticals in medicinal plants by manipulation of environmental and agronomic treatments; optimization of agrotechniques for environmentally stressed plants; mineral nutrition of plants, and plant stress physiology.

OUTREACH AND IMPACTS of ICR

Cannabis Research Webinar Series:

The Institute of Cannabis Research has hosted the Cannabis Research Webinar series since October 2020. The series focuses on allowing expert speakers on various cannabis-related endeavors to present their research and information. Presenters for this webinar series speak on topics ranging from medical science and public health and policy, industrial perspectives to cannabis research funding opportunities. These webinars are cosponsored by the Institute of Cannabis Research at CSU Pueblo and the Lambert Center at Thomas Jefferson University. This webinar series regularly schedules a presentation on the second Thursday of each month. Recordings of the webinars are made available on our website shortly after the live presentation. Recent webinars have included Dr. Jane Metrik, speaking on 'Cannabis and Alcohol Co-Use and Comorbidity,' Dr. Emily Bates, providing an overview on whether "Is CBD Consumption During Pregnancy Safe? Postnatal Consequences of CBD Exposure During Gestation," Dr. Andrea Hohmann, speaking on "Preclinical Assessment of Cannabinoid-Based Medications for Treatment of Multidimensional Opioid Withdrawal," Dr. Cassie Moore, sharing her work on"Why We Need A More Medical Medical-Cannabis System," Dr. Jodi Gilman, providing an overview of the "Identification of THC Impairment Using Functional Brain Imaging," Dr. Allyn Howlett, sharing "How the CB1 cannabinoid receptor communicates within the cell via associated proteins," as a few examples.

The webinar is free and open to the public, and registration and past webinars are archived at **https://www.instituteofcannabisresearchcolorado.org/series/research/**

Cannabis Plant Science and Cultivation Series:

Since 2022, ICR has hosted a the Cannabis Plant Science and Cultivation monthly webinar series, drawing over 500 participants in 2023. These webinars feature distinguished research scientists from various fields of cannabis research, including cultivation, pest management, and phytocannabinoid biochemistry. This series provides in-depth insights into current research on hemp cultivation and risk management, highlighting its implications as a newly emerging crop in agribusiness. ICR aims to broaden the range of topics to encompass diverse aspects of cannabis plant science, thereby enriching the current knowledge base.

Newsletter:

The ICR e-newsletter is a bimonthly, digitally produced newsletter focusing on the work of the ICR with information about our twice monthly webinars, our annual conference, the Journal of Cannabis Research, and our partners, both domestic and international and is now distributed to over 9500 people. This number reflects a growth of over 100% since last year at this time. The ICR newsletter is one of our most successful outreach tools as it reaches a large audience and highlights many aspects of the work we conduct. The newsletter contains current links to webinars for easy registration, up-to-date information regarding our conference with quick access to registration for this event, and to recent and archived journal articles. We provide relevant and current information in each issue and stive to grow our distribution list to reach as many scientific researchers and industry leaders in the cannabis space as possible. Please feel welcome to view our e-newsletter here and find our archived issues on this same link. **https://www.instituteofcannabisresearchcolorado.org/communications/**

2023

Media Coverage

Public Relations efforts in 2023 generated awareness for the ICR locally, nationally and internationally. In total, there were 264 stories that reached more than 70,000,000 readers. The PR value of that coverage exceeded half-a-million dollars and was generated with a budget of around $10,000. The press releases that generated the coverage included information on the Cannabis Research Conference and Call for Abstracts, the Call for Applications for grants, and the announcement of the newest grant recipients.

264
Mentions

$595,598
Value

70,687,489
Audience

JOURNAL OF Cannabis Research

David A. Gorelick, MD, PhD, DLFAPA, FASAM
Editor-in-Chief

The Journal of Cannabis Research (JCR) began accepting manuscripts in September, 2018. This 6th year of publication continues the journal's solid growth and international scope. We accepted 40 manuscripts this year, for a cumulative total of 230 articles published to date (which have been cited almost 2000 times [1933]). These papers reflect the broad interdisciplinary scope of the journal, encompassing all aspects of preclinical and clinical cannabis, cannabinoid, and endocannabinoid science, as well as cannabis agriculture, economics, regulation, and history.

JCR is international in scope. Our distinguished editorial board of 44 cannabis experts hails from 9 countries on five continents. In FY 2023, a total of 117 manuscripts were submitted from 28 different countries (about half from the US and Canada) on 4 continents; the 40 accepted articles came from 13 countries on 5 continents.

JCR is the only international, multi-disciplinary, open-access journal in the cannabis field. Anyone in the world can find our articles on our web site or on PubMed and read them without paying a fee. This makes our articles readily accessible to those in low-income countries or without access to an academic library. In FY 2023, JCR articles (from any year) were viewed by 148,908 unique readers in 210 countries and territories, with an average of 1456 views per article.

Twenty-nine articles published in FY 2023 received news and social media attention, measured via Altmetric. These were mentioned 771 times (581 social media, 188 in news and 2 on YouTube), with an average of 26.6 mentions per article. The enhanced visibility and international reach of articles published in JCR is an advantage to authors when deciding on where to submit their manuscripts for publication.

JCR is included in 3 major online indexing services, PubMed, Web of Science, and Scopus, and had an impact factor of 3.7 in 2023 and a new impact factor of 4.1 in 2024 as calculated by Clarivate (the industry standard). JCR is a member of two respected international societies: Committee on Publication Ethics and International Society of Addiction Journal Editors. Our manuscript acceptance rate of 35% this year and 1933 article citations after almost 6 years of publication are similar or better than comparable, more established journals in our field.

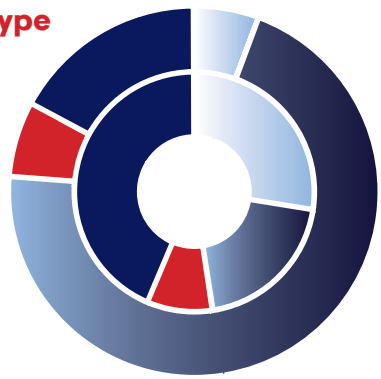
The outcome of final editorial review for manuscripts submitted in FY2023:

Submitted	Accepted	Rejected
114	17	32

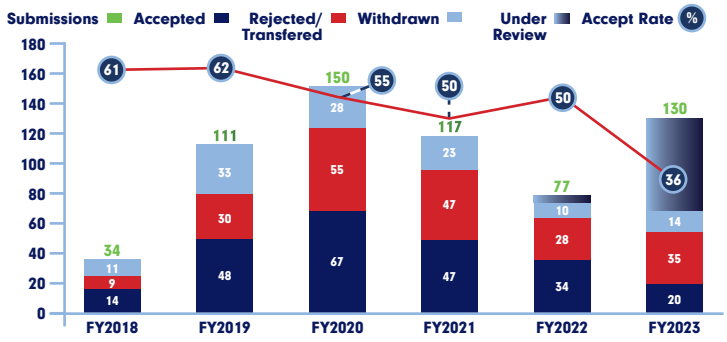
Withdrawn by author	Under editorial review
9	56

Reader Bias - Article Type

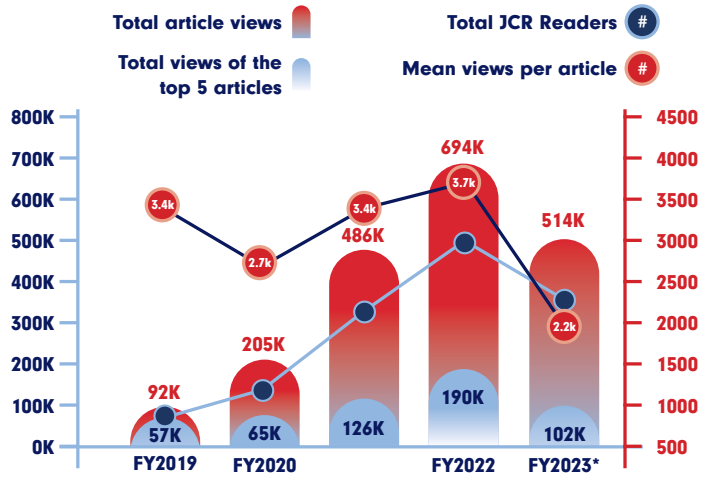
The outer edge shows the number of articles published between 2018–2023. The inner edge shows the mean number of views per article type.



Manuscript Submissions



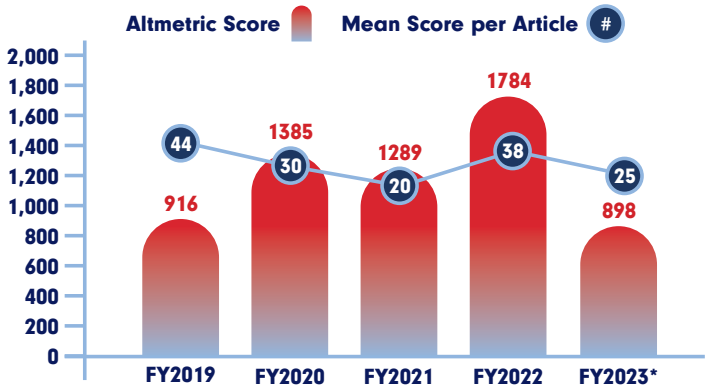
Readership



Published Articles by Colorado Authors

Authors' Institution	Articles	Citations
University of Northern Colorado, USA	1	58
Institute of Cannabis Research, Colorado State University-Pueblo, USA	1	29
Canna Research Group, USA	2	15
Colorado State University-Pueblo, USA	5	25
UCB 345, University of Colorado Boulder, USA	1	9
Colorado Mesa University, USA	2	4
University of Colorado School of Medicine, USA	1	3
University of Colorado Anschutz Medical Campus, USA	3	2
Colorado State University	1	1

Altmetric Scores



Altmetric tracks and analyzes online attention to published research to see where research is making a difference. Scores cover research cations, social media, policy documents, news articles, etc.

Readership of Articles by Colorado Authors

Organization	# of articles read	# of readers	# of times read
Colorado State University - Pueblo	55	177	238
Colorado State University	47	130	178
University of Colorado	75	151	177
University of Denver	19	26	34
University of Colorado Boulder	10	16	24
University of Northern Colorado	9	14	16
University of Colorado Denver	6	6	7
Colorado Mesa University	3	3	3
University of Colorado Hospital	2	2	3
Metropolitan State University of Denver	1	1	1
Children's Hospital Colorado	1	1	1
		527	682

Notable News Sources Citing

LabRoots: leading scientific social-networking website, offering both news and education
Forbes: business, investing, entrepreneurship and technology news
CNN News: leading US-focused news network
High Times: #1 magazine in US advocating for positive role of cannabis in society
Medscape: comprehensive one-stop resource for latest info relevant to clinical medicine
The New York Observer: US-focused commentary on culture, politics and society
Vice: Canadian-American youth-focused lifestyle, culture, and news/politics magazine
The Conservative: Australian-based, globally-focused publisher of research-based news and analysis
Finazen: Swiss hub of finance, stocks and trading information

5 Most Mentioned Published Articles

Title	Affiliations	Altmetric	News	X
Delta-8 THC: Delta-9 THC's nicer younger sibling?	University at Buffalo; University of Michigan-Ann Arbor	839	158	38
Reasons for cannabidiol use; a cross-sectional study of CBD users, focusing on self-perceived stress, anxiety, and sleep problems	NIHR; University College London	497	127	98
Communication between healthcare providers and medical cannabis patients regarding referral and medication substitution	University of Michigan-Ann Arbor	490	90	11
Cannabidiol use and effectiveness: real-world evidence from a Canadian medical cannabis clinic	Santé Cannabis	472	95	75
Cannabis consumption is associated with lower COVID-19 severity among hospitlized patients: a retrospective cohort analysis	UCLA; VA Greater LA Healthcare System	370	16	713

RESEARCH PUBLICATIONS AND PRESENTATIONS FROM ICR SUPPORTED PROJECTS

2023-2024

The cannabis research which the ICR administers, and conducts is published in leading peer-reviewed scientific journals and presented at scientific conferences. This new scientific knowledge is thereby made available to the greater scientific community on a local, national and international level and so is available to guide best practices in cannabis related decision-making processes based on solid science.

The ICR's research projects that were first funded in 2022 have matured to the point of producing high quality peer-reviewed research publications. The following were produced by ICR-funded researchers this fiscal cycle:

MGibson, LP, Giordano, GR, Bidwell, LC, Hutchison, KE, & Bryan, AD. (2023). Acute Effects of Ad Libitum Use of Commercially Available Cannabis Products on the Subjective Experience of Aerobic Exercise: A Crossover Study. Sports Medicine, 1-16. ***https://doi.org/10.1007/s40279-023-01980-4***.

Hinckley, JD, Mikulich-Gilbertson, SK, He, JP, Bhatia, D, Ellingson, JM, Nguyenkhoa Vu, B, Ries Merikangas, K, & Sakai, JT. (2023). Cannabis Use Is Associated with Depression Severity and Suicidality in the National Comorbidity Survey-Adolescent Supplement. JAACAP open, 1(1), 24–35. ***https://doi.org/10.1016/j.jaacop.2023.02.002***.

Innes, PA, & Vergara, D. (2023). Genomic description of critical cannabinoid biosynthesis genes. Botany, 101(7), 270-283. ***https://doi.org/10.1101/2022.12.15.520586***.

Kirsch M, Paglia H, Araujo T, Madsen H, Franco SR, Hamermesh M, Weiss R, Gleisner A, Schulick R, Del Chiaro M, Stewart C. (2023). Cannabis use and postoperative outcomes in patients undergoing hepatectomy. HPB, 25: S121-2. ***https://doi.org/10.1016/j.hpb.2023.05.232***.

Kulkarni, KR, Schafer, M, Berner, LA, Fiore, VG, Heflin, M, Hutchison, K, Calhoun, V, Filbey, F, Pandey, G, Schiller, D, Gu, X. (2023). An Interpretable and Predictive Connectivity-Based Neural Signature for Chronic Cannabis Use. Biol. Psychiatry Cogn. Neurosci. Neuroimaging. 2023 Mar;8(3):320-330. doi: 10.1016/j.bpsc.2022.04.009.

MacWilliams, J, Peirce, E, Pitt, WJ, Schreiner, M, Matthews, T, Yao, L, Broeckling, C, Nachappa, P. (2023). Assessing the adaptive role of cannabidiol (CBD) in Cannabis sativa defense against cannabis aphids. Frontiers in Plant Science, 14, 1223894. ***https://doi.org/ 10.3389/fpls.2023.1223894***.

Steinhart, B, Brooks-Russell, A, Kosnett, MJ, Subramanian, PS, & Wrobel, J. (2023). A Video Segmentation Pipeline for Assessing changes in Pupil Response to Light After Cannabis Consumption. bioRxiv : the preprint server for biology, 2023.03.17.533144. ***https://doi.org/10.1101/2023.03.17.533144***.

Swenson, K. (2023). Cannabis for morning sickness: areas for intervention to decrease cannabis consumption during pregnancy. J Cannabis Res 5, 22. ***https://doi.org/10.1186/s42238-023-00184-x***.

Swenson, KS, Gomez Wulschner, LE, Hoelscher, VM, Folts, L, Korth, KM, Oh, WC, Bates, EA. (2023). Fetal cannabidiol (CBD) exposure alters thermal pain sensitivity, problem-solving, and prefrontal cortex excitability. Molecular psychiatry, 28(8), 3397–3413. ***https://doi.org/10.1038/s41380-023-02130-y***.

Swenson K. (2023). Cannabis for morning sickness: areas for intervention to decrease cannabis consumption during pregnancy. Journal of cannabis research, 5(1), 22. ***https://doi.org/10.1186/ s42238-023-00184-x***.

In addition, the ICR conducts its own research at CSU Pueblo which was disseminated in the following publications:

Kim, ES, Park, SH, Kinney, CA, Olejar, KJ, Corredor-Perilla, IC. (2024). Comparison of decarboxylation rates of acidic cannabinoids between secretory cavity contents and air-dried inflorescence extracts in Cannabis sativa cv. 'Cherry Wine'. Sci Rep 14, 16411 (2024). ***https://doi.org/10.1038/s41598-024-66420-3***

Kim, ES, Han, JH, Olejar, K, Park SH. (2023). Degeneration of oil bodies by rough endoplasmic reticulum (rER)-associated protein during seed germination in Cannabis sativa L. AoBP 15(6):1-11. ***https://doi.org/10.1093/aobpla/plad082***

Kim, ES, Kwon, TH, Park SH. (2023). Structural characteristics of shells in a fibrous cultivar of Cannabis sativa L. J Natural Fibers 20(2): Article ID 2216951. ***https://doi.org/10.1080/ 15440478.2023.2216951***

ICR researchers also presented several abstracts at scientific conferences. Such presentations typically precede the production of peer-reviewed publications such as those presented above:

Brook C, Master A, Giordano G, Ortiz Torres M, McFarland C, Mackie D, Bidwell LC. (2023). What's not on the Label? Determining the Concentration of 10 Major and Minor Cannabinoids in Representative Samples of the Colorado Recreational Cannabis Market. Cannabis Research Conference. Denver, CO.

Ellingson, JM, Schafer, J, Stern, E, Corley, RP, Hinckley, JD, McGue, M, Vrieze, SI, Wilson, S, Rhee, SH, Hopfer, CJ. (2023). Cannabis Use and Suicidality: A Multi-site, Co-twin Control Study from Adolescence Through Middle Adulthood. Paper accepted for oral presentation at the 7th Annual Meeting of the Cannabis Research Conference, Denver, CO.

Kirsch M, Paglia H, Araujo TB, Madsen H, Rodriguez Franco S, Hammermesh M, Weiss R, Gleisner AL, Schulick RD, Del Chiaro M, Stewart CL (2023). Cannabis Use and Postoperative Outcomes in Patients Undergoing Hepatectomy. Americas Hepatopancreaticobiliary Association Annual Meeting, Miami, FL.

Kirsch M, Paglia H, Araujo TB, Madsen H, Rodriguez Franco S, Hammermesh M, Weiss R, Gleisner AL, Schulick RD, Del Chiaro M, Stewart CL. (2023). Cannabis Use and Postoperative Outcomes in Patients Undergoing Hepatectomy. Cannabis Research Conference. Denver, CO.

Master A, Giordano G, Ortiz Torres M, McFarland C, Brook C, Mackie D, Bidwell, LC. (2023). Is What You See What You Get? Evaluating the Accuracy of Cannabis Product Labels. Cannabis Research Conference. Denver, CO.

McFarland C, Giordano G, Ortiz Torres M, Master A, Brook C, Mackie D, Bidwell LC. (2023). Weed Out the Misinformation: The Process of Verifying Cannabis Product Labels. Cannabis Research Conference. Denver, CO.

Rodriguez Franco, S, Madsen, HJ, Furniss, A, Gleisner,AL, Del Chiaro, M, Schulick, RD, McCarter, MD, Stewart, CL (2023). Rates of Cannabis Use versus Other Illicit Substances in Surgical Oncology Patients. Cannabis Research Conference. Denver, CO.

Swenson, KS, Sarbaugh, D, Folts, L, Minne, C, Bates, EA. (2023). Fetal cannabidiol (CBD) exposure induces glucose intolerance and insulin resistance in a sex- and dose-dependent manner. Cannabis Research Conference, Denver, CO.

Swenson, KS. (2023). Marijuana for morning sickness: Marijuana consumption during pregnancy in Colorado. Colorado Capitol, Presentation to Legislators.

MacWilliams, J. (2023). Adaptive Role of Cannabinoids in Plant-Aphid Interactions. ESA Joint North Central & Southwestern Branch Meeting, Lincoln, NE.

MacWilliams, J. (2023). Assessing the Adaptive Role of Cannabinoids in Herbivore Defense in Hemp. Cannabis Research Conference, Denver, CO.

In addition, ICR researchers at CSU Pueblo also presented several abstracts at scientific conferences:

ECorredor-Perilla, IC. (2024). Changes in Diversity of the Rhizomicrobiome Through the Development of Cannabis Sativa L., in a Controlled Cultivation Environment, Cannabis Research Conference, CSU Fort Collins, Institute of Cannabis Research, Oregon State University, Global Hemp Innovation Center, Institute of Cannabis Research, CSU-Pueblo.

Corredor-Perilla, IC. (2023). Effects of relative humidity on the development and cannabinoid production of Cannabis sativa L., Cannabis Research Conference 2023, Institute of Cannabis Research, Oregon State University, Global Hemp Innovation Center, Institute of Cannabis Research, CSU-Pueblo.

Park, SH. (2024). Cannabis and Therapeutic Implications of Cannabinoids, School of Pharmacy, Korean Medical Cannabis Research Associate, South Korea.

Park, SH. (2024). Cannabis and Therapeutic Implications of Cannabinoids, JeonBuk State Institute, South Korea.

Park, SH. (2023). Cannabis: A Historical Perspective, Dispelling Misconceptions, and Exploring Medicinal Potential, Atomy Co. Ltd. – Pharmaceutical Company, Gongju, South Korea.

Park, SH. (2023). Cannabis and Therapeutic Implications of Cannabinoids, School of Pharmacy, JeonBuk National University, South Korea.

Park, SH. (2023). US Medical Cannabis Research and Current Regulatory Status, 2023 Symposium and Annual Meetings of the Korean Society of Medicinal Crop Sciences, Chuncheon, South Korea.

Park, SH. (2023). Current Regulatory Status and Advancements in Medicinal Cannabis Research in US, Founding Conference of Asia-Pacific Cannabis Research Association, Busan, South Korea.

Finally, CSU Pueblo researchers created two inventions:

Olejar, K, Hatfield, J. (2023). In-extraction conversion of CBD to delta 8-THC utilizing pressurized liquid extraction. The disclosure describes a method for conversion of CBD to delta 8-THC during the extraction process.

Olejar, K, Druelinger, M, Hatfield, J, Urvashi. (2023). Synthesis of fluorinated cannabinods. THe disclosure describes the process of synthesizing fluorinated CBN compounds with FTEDA. Four compounds are novel and two are compounds synthesized utilizing an alternative method.

COLORADO STATE UNIVERSITY PUEBLO
Institute of Cannabis Research
ADVANCING CANNABIS SCIENCE

csup_icr@CSUPueblo.edu
719.549.2294