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TRAINEE SYMPOSIUM IN DEVELOPMENT OF BIOTIC PRODUCTS

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Welcome to the 1st Trainee Symposium in Development of Biotic Products

This academic event aims to strengthen the students' communication skills and promote scientific dissemination. It is also intended that the academic community and the attendants appreciate the relevance of the PhD students' ongoing research.

Presentation

Greetings and welcome to the 1st Trainee Symposium on the Development of Biotic Products. This program is sponsored by the Centro de Desarrollo de Productos Bióticos del Instituto Poltécnico, México (National Center for the Development of Biotic Products (CEPROBI) of the National Polytechnic Institute of Mexico)

CEPROBI´s vision is to enhance the value of Mexico's biota and derived products through research in plant biotechnology, medicinal plants, and functional and nutraceutical foods. Our research focuses on fundamental studies at the frontier of scientific knowledge and technological innovation aimed to develop products from agricultural raw materials, underutilized byproducts, and other resources. Our intention is to support local farmers and small producers across Mexico.

At CEPROBI, we are committed to training young Mexican scientists, emphasizing sustainability and efficient handling of biotic products. This symposium gives doctoral students the opportunity to showcase their research, exchange ideas, and engage in discussions with researchers and other graduate, and undergraduate students.

On behalf of CEPROBI, we would like to thank the academic community for its interest and participation. We hope this trainee program provides you with both inspiration and enjoyment.

Dr. Luis Arturo Bello Pérez
Coordinator of the Doctorate in Science in Development of Biotic Products

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Abstracts Index

DAY 1

DAY 2

DAY 1

Lentil flour feeding reduces body weight and intestinal inflammation in rats fed with high-fat and high-sucrose diet

Vareska L. Zárate-Córdova, Mónica Sánchez-Tapia, Nimbe Torres, Perla Osorio-Díaz

Flour is the main ingredient in foods that constitute the diet of a large part of the communities in the world. The most traditional flours are those made from wheat, corn, and rice. However, there is a growing interest in using alternative sources due to the pursuit of nutritionally relevant attributes that promote health. In that regard, lentils are a rich source of protein, carbohydrates and bioactive substances, such as flavonoids and phenolic acids, which can reduce the metabolic consequences of a Western diet, typically characterized by high fat and sucrose content. Several studies have indicated that high-fat consumption causes systemic inflammation which induces the overproduction of tumor necrosis factor alpha (TNF-α) and toll-like receptor 4 (TLR4) which are considered as biomarkers of inflammation. Also, systemic inflammation has been linked with some diseases development including obesity, diabetes, and cancer. Therefore, the aim of the present work was to evaluate the effect of lentil flour consumption on intestinal inflammation, adipose tissue, and serum biochemistry in rats fed a high fat diet with 10% sucrose in the drinking water (HFHS) for 8 weeks. Control group (C) was fed an American Institute of Nutrition 93 for maintenance (AIN-93M) diet. The experiment consisted of 4 treatments: C (rats fed with AIN-93M), HFHS (rats fed with high fat and high sucrose), C + lentil flour and HFHS + lentil flour. Biochemical parameters including serum glucose, cholesterol, and triglycerides, were assessed using test strips and a portable glucometer. TLR4 and TNF-α protein expression in the proximal gut was analyzed by Western blot before 8 weeks of experiment. Adipose tissue was examined histologically using hematoxylin-eosin staining. The results revealed that HFHS + lentil flour group significantly reduced body weight and counteracted HFHS-induced adiposity in comparation with HFHS group. Furthermore, results suggest that HFHS + lentil flour group reduced intestinal inflammation biomarker TLR4 expression in contrast with HFHS group. In conclusion, this study provides evidence of benefic change in the gut and metabolism by the effects of lentil flour consumption on a normal diet and high-fat and high-sucrose diet.

Triacontanol and energetic cellular regulations in squalene production on *Botryococcus braunii* microalgae.

Tomás Ernesto Juárez Yáñez, Edmundo Lozoya Gloria, Alma Leticia Martínez Ayala.

Triacontanol (TRIA) has many positive effects in plants and algae, including, increase in growth and development, it improves storage of nutrients like carbohydrates and lipids, increases the photosynthesis process, and provides tolerance of various stress types, but its mechanism of action is not well undestood. TRIA triggers a second messenger, AMP, which is a scaffold of ATP and other energetic molecules. Moreover, in the metabolism of plant and algae, SnRK1 protein kinase is a key molecule in the balance of AMP: ATP, it moderates the use and storage of carbohydrates and lipids and has similar activity to TRIA. SnRK1 is also an antagonist of the TOR protein complex that regulates organism development, among other physiological processes. Squalene, obtained from shark liver oil, is a triterpenoid unsaturated hydrocarbon (C30) of great interest in medical and cosmetic industry, however it is necessary to search for sustainable alternatives for its production and supply for a crescent demand that does not affect sharks' population. A promising alternative is the photosynthetic algae *Botryococcus braunii*, which has big potential for industrial scale due to its high production of squalene s. Research has not been performed to investigate the metabolic connection between TRIA and SnRK1 and TRIA has not been tested as an elicitor of metabolites production. The objective of this research is to evaluate the activity of SnRK1 proteins and gene expression elicited by TRIA in *B. braunni* to increase squalene production and the knowledge of TRIA mechanism of action, and determine if it has potential as an industrial elicitor of squalene.To achieve these purposes, it was set up the culture system to find the conditions to grow *B. braunii* in homemade bioreactors. It is proposed a simple experimental design with different amounts of TRIA in the culture medium to measure squalene production by chromatography techniques, then use molecular techniques to identify gene expression in the squalene pathway elicited by TRIA, and finally employ bioinformatics software in molecular dynamic research for data analysis and try to predict the action mechanism of triacontanol in *B. braunii* metabolism.

Synthesis and characterization of polylactic acid nanoparticles incorporating *Citrus limon* oil for minimally processed horticultural products

Andrea Mendoza-Juárez, Zormy Nacary Correa-Pacheco, Silvia Bautista-Baños

To date, consumer preferences for easy-to-prepare healthy foods have recently increased. The horticultural industry's response to consumer demands includes a wide range of cut, refrigerated, and ready-to-eat agricultural products with a longer shelf life. These horticultural products are named ‘minimally processed horticultural products’. To preserve their quality, the use of modified atmosphere packaging is essential; however, the single-use plastics for this type of packaging significantly contributes to the pollution of many ecosystems. For this reason, the use of biopolymers, such as polylactic acid (PLA) is being promoted to replace conventional materials. The films made from biopolymers create a polymeric matrix to which bioactive substances, such as essential oils (EO) can be incorporated. The lime essential oil (LEO) exhibits notable antimicrobial activity due to its content of terpenoids. These compounds are highly volatile, it is necessary to encapsulate them to avoid this problem. In this context, the use of nanotechnology for encapsulation may contribute to extend the LEO antimicrobial activity. Among the encapsulation methods, nanoprecipitation, a biphasic dispersed system, has been widely employed. The objectives of this study were to synthesize and characterize PLA nanoparticles loaded with LEO using the nanoprecipitation technique. For this, to stabilize the system, surfactants such as polyvinyl alcohol (PVA) were used. For that, a 1% w/v PLA solution in acetone was prepared, with and without LEO (1% v/v) and a 3% w/v PVA solution in distilled water heated at 50°C. The PVA solution was added to the PLA and PLA-LEO solutions in a 1:1 ratio. Then, the emulsions were subjected to sonication for 10 min. After 24 h at room temperature, allowing complete evaporation of the acetone, PLA nanoparticles were collected by centrifugation. The characterization of the nanoparticles was carried out using transmission electron microscopy (TEM) and dynamic light scattering (DLS) analysis. From TEM, spherical nanoparticles were observed. DLS results revealed an average size of 181 ± 20.7 nm for the PLA nanoparticles (NP-PLA) and 233 ± 30.5 nm for the PLA nanoparticles with LEO (NP-PLA-LEO). The size difference was attributed to the incorporation of LEO, although both sizes fall within the range previously reported in the literature. Additionally, the polydispersity index (PDI), an indicator of nanoparticle homogeneity and colloidal stability, was 0.1 for NP-PLA and 0.2 for NP-PLA-LEO as indicative of a monodisperse sample. The nanoparticles were synthesized using biodegradable materials and LEO with the nanoprecipitation methodology.

Effect of the flour components on the starch gelatinization through extrusion

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Extrusion is a process used to disorganize the starch and change its functionality; it involves short residence time, low moisture and temperatures, pressure, and shear force. The cereals and pseudocereals are sources rich in starch (S), which are processed to obtain flours. To extend their uses; they are subjected to an extrusion process through different conditions that generate changes in the organization of the starch (gelatinization). The degree of gelatinization (DG) of the starch will depend on the quantity and type of the components in the flour (Proteins: P, lipids: L, and fiber F). The objective of the work was to analyze the effect of the extrusion temperature on the DG and structural changes of the starch in the flour. Amaranth flour (P: 15. F: 7.7, L: 6.4 and S: 57 %) and brown rice (P: 9. F: 3.9, L: 2.8 and S: 76 %) were moisturized at 30% and processed in an extruder with a speed of 250 rpm, through eight temperature zones, beginning at 40 °C until obtaining 70 °C, 110 °C and 160 °C on the 7th zone (which were the evaluated temperatures: TEx). The starches obtained a similar DG at TEx of 70 °C and 110 °C, suggesting that the lower extrusion temperature generates similar disorganization between starches partially gelatinized. The starch from the brown rice flour presented the highest DG at 160 °C compared to the amaranth flour, the lower presence of the flour components and the higher starch content exposed the carbohydrate to a higher disorganization, evidenced by the decrease in its crystallinity. The crystalline structure is disrupted due to the breaking of inter and intra-molecular hydrogen bonds, exposing them to form bonds with water and increasing the water absorption index (WAI) and water solubility index (WSI). Brown rice presented the highest WAI (4.2 – 5.0 g/g) compared to amaranth (2.7 – 3.0 g/g), whereas amaranth showed a higher WSI (0.077-0.083 g/g) than brown rice (0.039 – 0.049 g/g), the WSI behavior of the amaranth flour could be related to an interaction between protein-starch or protein-starch-lipid. The extrusion process caused the partial gelatinization of starch in the flour, the type of flour had only an effect on the DG at the highest temperature and on WAI and WSI properties.

Morphological variability of *Pouteria campechiana* related to endogenous phytohormone content and the environmental conditions

Karen Maybel Granados Vega, Silvia Evangelista Lozano

Phytohormones are natural products that regulate several functions within plants, including the activation and regulation of cell division, growth, and differentiation, as well as dormancy and germination. *Pouteria campechiana,* commonly known as the yellow sapote or canistel, is a fruit belonging to the Sapotaceae family. It is native to southeastern Mexico and has been known since pre-Columbian times. Currently, it is considered an underutilized species, displaying notable morphological variability. Furthermore, early seed germination (viviparity) is likely influenced by climatic factors that activate or inhibit phytohormones. This highlights the importance of understanding phytohormone dynamics about environmental factors, which is crucial for distinguishing varieties. This study aimed to examine the morphological variability of *P. campechiana* and its correlation with the phytohormone content influenced by environmental factors. Three accessions were sampled in Morelos (1Y, 2J, and 3C). Mature leaves (50) and semi-mature fruits (100) were sampled for characterization, analysis of morphological variability (morphometry, image analysis), and monitoring of climatic conditions from each accession. The seeds obtained from the fruits were classified according to their viviparous or non-viviparous status and were manually scarified. The non-viviparous seeds were sown in pots containing an inert substrate and monitored for three months. These seeds were sampled at five developmental stages: dormant, with a 5 cm radicle, with a 5 cm plumule, with true leaves, and at the 20 cm seedling stage. The samples were subjected to methanolic extraction following freeze-drying. The separation and purification of the extracts will be conducted in a solid phase. The phytohormones (abscisic acid, zeatin, t-zeatin, gibberellic acid, indoleacetic acid, jasmonic acid, and salicylic acid) will be identified using thin-layer chromatography and MS/MS mass spectrometry. An analysis of variance (ANOVA) and a principal component analysis were conducted. The fruits of accession 2J showed a larger size, a greater amount of pulp, a greater number of seeds and a higher percentage of Brix degrees (°Bx) than accessions 1Y and 3C, which makes this accession more attractive for fresh consumption. Also the leaves of this accession were solid, narrow, and long, thus displaying stylized and consistent (leaf blade less irregular). The most discriminant variables in the leaves were area, minor diameter, and circularity index. These variables are the most effective in explaining the leaf variability of *P. campechiana* and distinguishing between accessions. They may also serve as potential descriptors for varieties. The identification and quantification of phytohormones is in course.

Standardization of fractions of *Oenothera rosea* L'Hér. ex Aiton

Marcos Córdova de la Cruz, Rosa Mariana Montiel Ruiz, Gabriela Trejo Tapia

The WHO reports that 80% of people in developing countries use traditional medicine to prevent and treat diseases. Studies show that herbal medicine is more accessible, effective, and has fewer side effects than modern options. An example is *Oenothera rosea*, commonly known as “couch grass”. In traditional medicine, it is used in infusions or poultices to treat various conditions, such as bruises, inflammation, diarrhea, and headache. Recent research on the ethyl acetate fraction, derived from a hydroalcoholic extract of the aerial parts of *O. rosea*, has shown anti-inflammatory and antihyperalgesic properties. These effects relate to inhibiting pro-inflammatory cytokines such as IL-1β, IL-6, and TNF-α, as well as to its antinociceptive action, which manifests through the activation of pain pathways, including the NO-cGMP-potassium channel system and the GABAergic system. A recent study also reported that this plant exhibits wound-healing activity in an *in vitro* model. *O. rosea* contains alkaloids, tannins, saponins, and phenols. Among these, the ethyl acetate extract contains compounds such as quercetin, quercetin glycoside, myricetin, and gallic acid. This work aimed to standardize a fraction of the ethyl acetate extract of *O. rosea* using chromatographic and spectroscopic techniques. The standardization of the fractions guarantees the quality, efficacy, safety and reproducibility of the wound healing treatment. The plant material was grown under greenhouse conditions. A total of 362 g of the aerial parts of the plant were collected, dried, and crushed in an electric grinder to obtain particles of approximately 1 mm. Then, maceration was performed for 48 hours with a 70:30 water-ethanol mixture. Subsequently, a liquid-liquid partition was conducted with a 1:1 water-ethyl acetate mixture to obtain the ethyl acetate extract (23.74 g) with a yield of 6.55%. It was fractionated by normal phase column chromatography. The column elution was performed by gravity and according to the polarity of the compounds, using solvents from lower to higher polarity. Once separated, the fractions were subjected to High-Performance Liquid Chromatography (HPLC) analysis to characterize their composition. HPLC analysis is being conducted, and so far, it indicates that the fractions are constituted mainly by flavonoids. It should be noted that it is important to know the chemical composition of the fractions in order to establish the concentrations to evaluate the healing activity. In conclusion, the fractions of *O. rosea* analyzed so far mostly contain flavonoids.

Encapsulation of *Hibiscus sabdariffa* L. decoction residues in starchy matrices to enhance bioaccessibility and stability of the polyphenols

Monserrat Hernández Bautista, Luis Arturo Bello Pérez

In recent years, an increase in the prevalence of chronic diseases such as obesity, diabetes, and hypertension has been observed, thus there is interest in developing functional ingredients that offer health benefits after consumption. The compounds with antioxidant capacity, such as polyphenols, have stood out for their ability to neutralize free radicals and reduce oxidative stress in the body that is associated with diverse cancer types. The decoction residues (DR) of *Hibiscus sabdariffa* L. (jamaica) constitute a by-product rich in polyphenols, known for their antioxidant activity. Those residues are often discarded without commercial use despite their high functional value. Using by-products opens an opportunity to reduce pollution problems and improve the economy of the farmers with the concept of circular economy. The polyphenols are highly sensitive to environmental and physiological factors, reducing their stability during processing and after consumption, issues that are important in their bioaccessibility and bioavailability. Given their potential as functional ingredients, this study aimed to explore the utilization of DR by encapsulating them in starchy matrices through an extrusion process, to improve the stability and bioaccessibility of their polyphenols. Three commercial starchy materials (Capsul, N-Lok, and Globe) were used in combination with DR, and the morphological characteristics, antioxidant capacity, and bioaccessibility of the polyphenols were *in vitro* evaluated. The electron microscopy and the confocal laser microscopy revealed a collapsed structure in the extrudates and the presence of fiber, which can be related to the presence of polyphenols. Although extrusion reduced the total polyphenol content, a high antioxidant capacity was maintained in the extrudates. Capsul and Globe demonstrated better protection and gradual release of polyphenols during intestinal digestion, increasing their bioaccessibility. This work highlights the potential of jamaica DR as a functional ingredient in foods, using starchy materials as an effective strategy to improve their bioaccessibility in the digestive tract.

Homogenized nopal cactus mucilage and its coagulating/flocculating effectiveness for heavy metal removal in a barren solution

Allison Vianey Valle-Bravo, Javier Solorza-Feria, José Luis-Rivera

The mining industry, critical to Mexico's economy, generates significant environmental challenges, particularly concerning wastewater contaminated with heavy metals. Traditional treatments, while effective, often produce hazardous by-products, underscoring the need for sustainable alternatives. Nopal cactus mucilage has emerged as a promising bio-flocculant owing to its unique chemical and rheological properties. However, limited studies have explored the impact of process variables, such as mechanical homogenization time, on its effectiveness in heavy metal removal, which is the focus of this research. The objective of this research was then to determine the effect of mechanical homogenization on nopal cactus mucilage and evaluate its potential as a coagulant/flocculant for heavy metal removal in barren mining solutions. For this, nopal cactus mucilage samples from 15-day-old plants harvested from the same field were subjected to various homogenization times (30s, 60s) and analyzed to assess their structural and functional properties. Rheological behavior was examined using a rheometer, and infrared (IR) spectroscopy was applied to detect functional groups in mucilages, flocs, and barren solutions. Results indicated that structurally, a reorganization of mucilage chains was observed at 30 seconds of homogenization, suggesting an initial structural alignment. However, with longer homogenization times, improvements in water quality parameters were noted, such as a 64.27% reduction in turbidity in the barren solution using 800 mg/L of mucilage homogenized for 60 seconds. In comparison, the same concentration of a chemical control ($FeCl_3$) reduced turbidity by 85.13%. Additionally, chemical oxygen demand (COD) increased from 391.93 mg/L in the initial barren solution to 1000 mg/L after treatment, consistent with the addition of organic matter to the water. Particle size analysis showed that the non-homogenized mucilage had an average size of 2390 nm, the 30-second homogenized sample was 1849 nm, and the 60-second sample was 1458 nm, indicating polymer chain degradation with prolonged homogenization times. The findings suggest that controlled homogenization of nopal mucilage can improve its functionality as a bio-flocculant, offering a sustainable and effective solution for the treatment of mining wastewater. Future studies will focus on optimizing these conditions to maximize industrial applications.

Kingidiol mediates oxidative stress in the endoplasmic reticulum during acute kidney injury induced by $HgCl_2$

Caroleé Chuzeville-Munguía, Edgar Cano-Europa, Gabriela Trejo-Tapia

Acute kidney injury (AKI) is defined as an abrupt decrease in renal function, associated with high mortality and morbidity, with an increasing prevalence. Therefore, research on effective treatments is of great importance. AKI has a complex pathophysiology in which endoplasmic reticulum (ER) homeostasis plays an important role. When disrupted, for example, by the accumulation of reactive oxygen species (ROS) leading to oxidative stress, the unfolded protein response (UPR) activates three ER-resident membrane proteins that monitor protein quality: inositol-requiring enzyme 1 (IRE1), transmembrane transcription factor 6 (ATF6), and protein kinase R-like ER kinase (PERK). There is evidence that UPR signaling may be related to internal activation mechanisms derived from natural compounds. Kingidiol (Kn) is a diterpene found in the medicinal plant *Baccharis conferta* Kunth. This molecule has a relevant anti-inflammatory effect, with very few studies on its applications and so far, its beneficial effect on AKI has not been evaluated. The present work aimed to evaluate the effect of Kn on markers of oxidative stress, including ROS, lipid peroxidation and molecules involved in ER stress, in a mouse model of AKI induced by $HgCl_2$. Kn was isolated from aerial parts of *B. conferta*. Male NIH Swiss mice were used, and AKI was induced by administering a single dose of 5 mg $HgCl_2$/kg. Five groups (n=3) were tested: (1) vehicle with 0.1% Tween administered by oral gavage (og), (2) $HgCl_2$ (ip) + vehicle (og), (3) 10 mg Kn/kg (og) + vehicle (og), (4) $HgCl_2$ (ip) + 2.5 mg Kn/g (og), and (5) $HgCl_2$ (ip) + 10 mg Kn/kg (og). Animals were sacrificed after 48 h. Biochemical assays allowed the evaluation of oxidative stress and ER markers, while signaling in response to stress was performed by Western blot assays. Kn administration at 2.5 and 10 mg/kg restored the levels of ROS and maintained the levels of lipid peroxidation, compared to the damage group and reduced the overexpression of PERK and ATF6, the activation of the IRE1 pathway, and the overexpression of caspase 12 and Bax, which are associated with cellular damage. In conclusion, Kn reduces the level of oxidative stress markers and help maintain homeostasis. Thus, it is associated with the prevention of oxidative and ER stress, and it modulates signaling pathways involved in glomerular and tubular cell damage.

Gamma-oryzanol nanoencapsulates development through spray-drying and freeze-drying of nanoemulsions obtained by ultrasonication and high-pressure homogenization

Jaime-Báez Rodrigo, González-Soto América Rosalia, Saldo, Jordi

Gamma-oryzanol (GO) is a bioactive compound with functional characteristics such as hypocholesterolemic effect, glucose metabolism regulation, and high antioxidant capacity. This makes it a good candidate to be incorporated into high-consumption food matrices to improve their nutritional characteristics. However, in the literature, it is referred to as a compound of difficult incorporation due to its low solubility and stability. Nanoencapsulation is a technology whose objective is the packaging of a compound of interest in a nanometric range to improve its bioavailability. The objective of the work was to develop and physicochemically characterize GO nano encapsulates fabricated through freeze and spray drying of GO nanoemulsions obtained by ultrasonication and high-pressure homogenization. The methodological process consisted of freeze and spray drying two nanoemulsions obtained by ultrasonication (90% amplitude, for 3 minutes) and high-pressure homogenization (100 MPa for two cycles), containing 87% water, 0.2% GO diluted in 6.1% rice bran oil, 6.1% sodium caseinate and 0.6% citrus pectin that acted as emulsifiers in the nanoemulsion and the wall material in the drying processes. The nanoparticles obtained by the drying techniques were physicochemically characterized by determining the particle size and distribution (PDI), image analysis by scanning electron microscopy (ESEM), encapsulation efficiency (EE), antioxidant capacity, and chemical functional groups analysis by Fourier transform infrared spectroscopy (FTIR). The powders obtained a size <250 nm with a monodisperse distribution (PDI <0.4). Image analysis showed the appearance of spheres with a smooth morphology and some of these with wrinkles and dents in the nanoparticles obtained by spray drying. For the freeze drying, the nanoparticles showed the formation of pores in a film-like matrix material. The EE showed a value higher than 83%, for the two drying methods. The antioxidant capacity showed differences, where the freeze-dried nanoparticles reached an antioxidant capacity higher than 80%, in contrast to the spray-dried nanoparticles with an antioxidant capacity of 45%. FTIR analysis showed an association with the wall material, oil, and GO, probably for the high energy and drying techiques used that modify the chemical compound structures. The Ultrasonication and high-pressure homogenization techniques improved the EE of GO in the nanoencapsulates, and the antioxidant capacity was negatively affected by spray drying. FTIR analysis confirmed the encapsulation of GO in the nanoparticles complex. The freeze-drying technique in GO nanoemulsions allowed obtaining nanocapsules with a particle size at nanometric scales (<150 nm) and manteind the GO high antioxidant capacity.

Compounds from leaves of *Tilia americana* var. mexicana and their *in silico* affinity to monoamino oxidases

Maribel Osorio-García , Antonio Ruperto Jiménez-Aparicio, Maribel Herrera-Ruiz, Alejandro Zamilpa-Alvárez, Manasés González-Cortazar

This study describes the chemical compounds isolated and characterized from the methanolic extract of the leaves of *Tilia americana* var. mexicana and their *in silico* affinity to monoamino oxidases, which constitutes a target of interest due to its fundamental role as a therapeutic agent, since the use that monoamine oxidase inhibitors have in the treatment of neurodegenerative diseases such as Parkinson's. The genus *Tilia* has been used as a tranquilizer, anticonvulsant and analgesic. Its infusions are widely used in traditional medicine in Europe and Latin America for the treatment of enterocolitis, gastroenteritis, liver and kidney colic, but mainly as a tranquilizer. Regarding the chemical content of *Tilia Americana*, the presence of sugars such as fucogalactoxyloglucan, L-fucose, D-galactose, D-xylose and D-glucose has been reported. Terpenes such as β-sitosterol have been found as well as the presence of flavones, flavonols and their glycosides such as quercetin O-glucoside, quercetin 1,3-O-diglucoside, tiliroside, rutin, quercitrin, kaempferol and quercetin. The methanolic extract (Ta-ExMeOH) obtained was subjected to fractionation using an open column, obtaining 11 groups (R1-R11) according to their similarity in thin plate chromatography and after different purification processes, it was possible to obtain the following compounds: saccharose I, β-sitosterol glucoside II, 3-O-β-D-(6”-E-p-coumaroyl)glucopyranoside, kaempferol (tiliroside III) and a novel compound: (4ε)-α-terpineol 8-O-[β-D-xylopyranosyl-(1→6)-β-D-glucopyranoside IV. This confirms the presence of different types of secondary metabolites in this plant of the genus *Tilia*, which includes sugars, terpenes and flavonoids, which may be related to the different biological activities attributed to this species. Molecular docking was carried out on the isolated compounds I, II, III and IV in order to determine their binding affinity against the monoamine oxidases obtained from the PDB (Protein Data Bank) MAO-A: 2z5x cocrystallized harmineMAO-B: 2v5z cocrystallized safinamide in the MOE program (Molecular Operating Environment).The binding affinities were obtained for II, III and IV as: -10.8733 Kcal/mol, -11.1866 Kcal/mol and -11.1434 Kcal/mol toward MAO-B compared to -7.2729 Kcal/mol of the safinamide that was used. For reference, showing that Tiliroside III was the best target according to the best binding affinities. As a conclusion in the methanolic extract of *Tilia Americana var*. Mexicana, compounds such as terpenes, flavonoids and sugars could be identified and four compounds were obtained. According to docking molecular results, tiliroside III is seen as a promising compound to have activity both *in vitro* and *in vivo.*

Identification of microplastics in nixtamalised foods

Israel Mejia Vigueras; Martha Lucía Arenas Ocampo; Francisco Rodríguez González

Microplastics (MPs) are plastic particles of between 1-5000 μm that have recently been identified in all ecosystems of the planet. Their presence in food has also been demonstrated. Several studies have verified the presence of PMs in foods such as poultry, seafood, salt, sugar, honey, carbonated beverages, and alcoholic beverages. The main PMs identified in the above mentioned food were polyethylene (PE), polyethylene terephthalate (PET) and polypropylene (PP). It has also been shown that the PMs can affect the bone, intestinal, and immune systems, as well as the lungs and liver, among others. It is therefore important to identify and evaluate the presence of these contaminants in foods of high consumption, such as nixtamalised foods. The objective of this research is to identify and quantify the presence of PMs in tortillas, as well as to evaluate the effect that human digestion exerts on them and the cytotoxic and inflammatory effect in an in vitro intestinal line. For this, tests were carried out for the chemical digestion of 5 g of sample (tortilla+MPs: PE, PET, and PS from 37 to 450 mm) using: KOH, H2O2, NaOH, and NaClO, at concentrations of 0.025, 0.05, 0.075, and 0.1 (grams of sample/ mL of reagent) at 60 ºC for 4 days. They will be identified and quantified by optical microscopy and Fourier transform infrared spectroscopy and environmental scanning electron microscopy. Additionally, to observe the physical and chemical changes that human digestion can cause to the MPs, an in vitro digestibility protocol will be applied. Finally, on a mouse fibroblast line (3T3-L1), the cytotoxic effect will be evaluated through MTT test kits and the oxidative stress test measured through super oxide dismutase (ROS), as well as the evaluation of its inflammatory effect through an ELISA test for interleukins 6, 8, and TNF-a. The best conditions for the extraction of MPs from the MP-added tortillas was using H2O2 at concentration of 0.05 g/mL at 60ºC for 4 days with a recovery efficiency of 96.2%. Therefore, a methodology was obtained, which allowed the extraction of MPs added to the tortillas made in the laboratory.

DAY 2

Analysis of bioadhesive properties of insect and plant biomaterial for development a novel tissue glue

Camacho-Rodriguez Y.E., Jiménez-Aparicio A.R., Palacios I.M., Stollewerk A.

Within the field of medicine and dentistry, there is high demand for adhesives, either as tissue glues or minimally invasive methods that cannot be combined with traditional surgical techniques. A promising branch of research has diverged into the field of naturally occurring bioadhesion in nature. In this PhD project, It will be taken a comparative approach investigating the adhesive properties of biomaterial produced by the plant *Agave angustifolia* and the insect *Drosophila melanogaster*. This last one, uses glue to adhere to the surface before developing a pupal case. The glue can stick to hydrophobic and hydrophilic surfaces with an adhesion strength of 137-244 kPa. The glue genes are well known; however, their role in glue production, adhesion, and hardening is not known. *Agave angustifolia* which is used in Mexican folk medicine produces, among others, metabolites that are a complex mixture of carbohydrates called agavins which have been used in gel formulations due to their properties. The aim of the project is to analyse the adhesive properties of the plant and insect material and to develop a novel, non-toxic, biodegradable tissue glue for surgical treatment. Physicochemical and morphological properties of the biomaterials will be characterized by Fourier-Transform Infra-Red-Spectroscopy, NMR, ESEM, fluid transport tests, HPLC, and rheology. Cytotoxicity of the biomaterials will be assessed by *in vitro* cell culture experiments and its ability to support cell attachment and proliferation via direct incubation of the whole biomaterial with human cell lines. Preliminary results showed the same characteristic spectrum at 900-1200 cm^{-1} reported as the fingerprint range, main characteristic of agavins. The absence of peaks at 1550, 1250, and 2030 cm^{-1} indicated purity of the sample. The IR spectrum from fly biomaterial showed absorption bands at 600-1200 cm^{-1} corresponding to C-N groups and a peak between 1400-1550 cm^{-1} belonging to amide groups. These results were correlated with Confocal Scanning micrographs where the images indicated mainly the presence of proteins. In conclusion, FTIR spectrum of agavins confirms a purified product. Confocal micrographs and FTIR spectrum of the fly glue confirm not only the presence of proteins as the main component, but also carbohydrates and lipids.

Extraction of phytosterols from *Agave angustifolia* Haw. using Natural Deep Eutectic Solvents

Edna, García-Avila, Brenda, Camacho-Díaz, Martha, Arenas-Ocampo

The mezcal production chain, along with other products such as sweeteners and fructans derived from Agave, generates 25,000 tonnes of bagasse annually, which damages the environment in the regions where the plant is cultivated and exploited. This waste is a significant source of lignin, cellulose, sugars, and other bioactive compounds, such as phenols and phytosterols, which can be used in pharmaceutical or food products. The extraction solvent plays a crucial role for the yield and the quality in obtaining these compounds. Biocompatible solvents with high solvating power, like Natural Deep Eutectic Solvents (NADES), can replace traditional organic solvents, making the process more environmentally friendly. This study aimed to obtain phytosterols from the bagasse derived from the *Agave angustifolia* Haw. fructans extraction process developed in the Technology Development Department of the Centre for the Development of Biotic Products (CeProBi-IPN) using Natural Deep Eutectic Solvents (NADES) with different ultrasonic-assisted extraction times. NADES were formulated in a 1:2 molar ratio with L-proline (PROL) as hydrogen bond acceptor (HBA) and Levulinic acid (ALEV) as hydrogen bond donor (HBD), incorporating varying percentages of water in their formulation like 5%, 10% and 15% (w/w). The formulated NADES were characterized for their polarity, pH, conductivity and by FTIR to evaluate whether they formed interactions between their individual components. To obtain extracts, ultrasonic-assisted extraction was applied for different times (40, 60 and 80 min) at a plant material/solvent ratio of 1:10. Phytosterols in the extracts were identified using thin layer chromatography (TLC), while total terpenes were quantified by UV spectrophotometry. From the characterization of the NADES, they showed hypsochromic behaviour (less polar) with lower percentage of water in their formulation and alkaline pH values with high conductivity as the percentage of water increased. During the identification of phytosterols, chromatography revealed distinctive violet bands at an RF of 0.7 to 0.8. In the quantification of total terpenes, a bathochromic behaviour was observed relative to the reference standard, which could be associated with another compound from the phytosterol group. An absorption peak maximum at 610 nm was detected in all formulations with higher amplitude using NADES with 10% water at an ultrasonic-assisted extraction time for 60 min. The results showed that the solvent NADES was suitable for extracting phytosterols from agave bagasse.

Evaluation of the antihyperalgesic and antiallodynic effect of the methanolic extract of *Rhus virens* Lindh. ex A. Gray in a model of neuropathic pain induced by paclitaxel in mice

Jaqueline Molina Cabrera, Rosa Mariana Montiel Ruiz, Antonio Ruperto Jiménez Aparicio

Chemotherapy-induced peripheral neuropathy (CIPN) is a common side effect caused by oncological treatment and have a prevalence from 40-85%. CIPN can occur acutely, during chemotherapy but in a few cases, it will persist, resulting in a chronic symptom after finishing chemotherapy. If severe, it can require a reduction in the dose, or even stopping prior to completing the planned course, however, this may have implications for efficacy of the oncological treatment and survival of patients. Patients with CIPN usually experience spontaneous burning, numbness, allodynia (a painful sensation caused by innocuous stimuli), and hyperalgesia (exaggerated responses to noxious stimuli). Currently, there is no effective pharmacological treatment to prevent or treat CIPN. Drugs used for its treatment are nonsteroidal anti-inflammatory drugs, opioids, and adjuvant drugs (antidepressants or anticonvulsants), they are used only to treat the painful symptoms. However, chronic use of these drugs can cause undesirable side effects, such as liver damage, gastrointestinal bleeding of irritation, sedation, addiction, and other symptoms. This makes it necessary to search for new pharmacological alternatives. Medicinal plants have been successfully used to treat several diseases. *Rhus virens* Lindh. ex A. Gray, is a shrub widely used empirically to treat various symptoms of many diseases, including pain. There´s only one evidence about the antinociceptive and anti-inflammatory effect of *R. virens*, so they suggest that *R. virens* is a good candidate for the treatment of acute pain, being considered for future studies on chronic pain. The aim of this investigation is to determine the antihyperalgesic and antiallodynic effect of the leaves of *R. virens* in a murine model of neuropathic pain induced by paclitaxel. The methanolic extract of *R. virens* leaves obtained in previous studies will be used to determine its activity on paclitaxel-induced peripheral neuropathy. For this purpose, mice (ICR strain) will be used with hyperalgesia and allodynia induced with paclitaxel which will be administered for three alternate days, subsequently the Von Frey filaments test will be carried out. The animals will be treated with the dose of 30 and 100 mg/kg of the extract, fractions, and active compounds from the first administration with paclitaxel. Subsequently, samples of the sciatic nerve and spinal cord will be extracted to quantify the concentration of proinflammatory cytokines (TNF-α, IL-1b and IL-6), in addition to determining their effect on substance P and the density of IENF.

Effect of a *Hibiscus sabdariffa* L. drink on hypertensive disorders associated with pregnancy

Victor Eduardo Alcantar Rodríguez, Perla Osorio Díaz, Jordi Saldo Periago

Hypertensive disorders of pregnancy are complications that affects 10% of worldwide pregnancies and are the main cause of maternal and fetal morbidity and mortality. There are four types of disorders: chronic hypertension, gestational hypertension, preeclampsia, and preeclampsia superimposed on chronic hypertension. The treatment begins with nutritional modifications and vitamin supplements, until pharmacological treatment in the case of severe hypertension (≥160/110 mmHg). However, drug treatment can have adverse effects on the woman and fetus. An alternative that prevents and control hypertensive disorders is the use of natural products since they have compounds that regulate blood pressure. Roselle (*Hibiscus sabdariffa* L.) is a perennial plant that has been traditionally used for therapeutic purposes for its antihyperlipidemic, anti-inflammatory, antimicrobial, anticarcinogenic, and antihypertensive effects. These effects are attributed to its bioactive compounds, mainly polyphenols (anthocyanins). This work aims to evaluate the effect of a drink with *Hibiscus sabdariffa* L. in the prevention of hypertensive disorders associated with pregnancy. The raw material was selected from crops in the Puebla and Morelos states. The calyces were dried by exposure to the sun and dried under dark conditions. The calyces were evaluated by proximal composition and anthocyanin content (differential pH method). The drink was developed, and the acceptability and tolerability were evaluated (sensory evaluation and presence of gastrointestinal symptoms) in women in the second trimester of pregnancy after consuming a daily dose of drink for four weeks. In addition, blood pressure values and biochemical indicators (glucose, cholesterol, creatinine and triglycerides) were measured before and at the end of the test. The calyces of *H. sabdariffa* that were dried in the dark had a higher anthocyanin content. There were significant differences in all the composition parameters of the calyces of cultivars from Puebla and Morelos, except in the dietary fiber content. The drink was developed using the calyces from Morelos because they had the highest anthocyanin content (1.68 mg cyanidin-3-glucoside equivalents/g). The drink was well accepted and showed tolerability, some gastrointestinal symptoms like constipation, diarrhea, flatulence and abdominal pain occurred, but they may be due to hormonal effects of pregnancy. Blood pressure and biochemical indicators were maintained because there were no significant changes after the test. The *H. sabdariffa* drink can be evaluated in longer-term clinical trials because it maintained blood pressure (<140/90 mmHg) and biochemical indicators at adequate values for pregnant women according to World Health Organization.

Kalanchoe daigremontiana root extracts: Cytotoxic evaluation on breast cancer cell lines

Casales-Tlatilpa, Yessica, Maycotte González Paola y Del Villar-Martínez Alma Angélica.

Breast cancer is a public health issue due to its high incidence and mortality rates. The heterogeneity and diversity in the clinical course of this disease hinder the effectiveness of treatments, prompting a search of plant-derived compounds with pharmacological potential. Among the plants used in traditional medicine are species from the *Kalanchoe* genus, which have previously been reported to have anticancer activity. *Kalanchoe daigremontiana,* commonly known as the "mother of thousands", is native to Madagascar and widely distributed. In traditional medicine, the leaves of *K. daigremontiana* are used as an alternative treatment for gastric ulcers, rheumatism, cough, and primarily against cancer. There are few reports on the biological activity and identification of bioactive substances present in *K. daigremontiana* root extracts. However, recent studies have demonstrated significant activity against tumor cell lines, attributed to two groups of chemical compounds: flavonoids and bufadienolides. This study aims to evaluate the cytotoxic activity of root extracts of *K. daigremontiana* (*Kd*Et, *Kd*Ac, and *Kd*Dc) on breast cancer cell lines, including non-cancerous (MCF10A) and cancerous (MCF7, MDA-MB-231) types. Roots of *K. daigremontiana* were extracted to obtain three fractions: ethanolic (*Kd*Et), aqueous (*Kd*Ac), and dichloromethanolic (*Kd*Dc). Cytotoxic activity was evaluated using the MTT cell viability assay across the different cell lines. The extracts of *K. daigremontiana* demonstrated significant cytotoxic effects on breast cancer cell lines. In the MTT assay, the extracts exhibited varying degrees of cytotoxicity. The *Kd*Et extract demonstrated the highest cytotoxic effect across all cell lines tested, including both non-cancerous and cancerous types, with IC_{50} values within a low micromolar range. The *Kd*Ac extract exhibited moderate cytotoxic activity, with IC_{50} varying across the cell lines: it was more potent in MCF7 and MDA-MB-231 cells, but less effective in MCF10A cells. Finally, the *Kd*Dc extract demonstrated a relatively consistent cytotoxic effect in both MCF7 and MDA-MB-231 cell lines, although its potency was reduced in MCF10A cells. These results suggest that the metabolites present in the evaluated extracts have significant cytotoxic efficacy, highlighting the role of both the solvent and the specific part of the plant used in extracting metabolites with higher cytotoxic potential.

Microencapsulation of Starfruit (*Averrhoa carambola L.*) by spray drying: Partial characterization

Santana-Galeana, R.S.[1*], Bello-Pérez, L.A[1]

Star fruit (*Averrhoa carambola L.*) belongs to the Oxilidaceae family, whose application has been shown to have effects against diseases derived from oxidative stress, such as diabetes and hypercholesterolemia. Several investigations on this tropical fruit indicate that the polyphenolic compounds, flavonoids, proanthocyanins, and tannins could be the reason for those biological effects. These compounds are found in greater quantities in the pulp of the unripe fruits and progressively decrease as their degree of maturity increases. Microencapsulation by spray drying technology has been one of the most used alternatives to preserve compounds and control their release, increasing their bioaccessibility. Their low contact time with temperature causes less degradation of thermolabile compounds. This study aimed to microencapsulate the pulp of *Averrhoa carambola* pulp by spray-drying with different wall materials. The physicochemical characterization of the immature Star fruit juice was evaluated before the spray drying to know the chemical characteristics. The juice was microencapsulated with Maltodextrin 10, Maltodextrin 20, Capsul and N-lok obtained by Ingredion Inc.®, in 1:10, 1:10, 2:10, and 2:10 ratios, respectively. The morphology, particle size distribution, adsorption isotherms, total phenolic content, and antioxidant properties (DPPH, ABTS, and FRAP) were evaluated. The content of malic acid was 0.4 g/100 g juice and a pH of 2.9. The encapsulated with maltodextrin 10 and 20 showed a polyhedral morphology. Capsul and N-lok resulted in low capsule formation and possible partial leaching of the core material. Encapsulation with maltodextrin 10 resulted in high retention of phenolic content (18.57 mg GAE/g db) compared with the juice (56.26 mg GAE/g db) and the other wall materials (Maltodextrin 20: 16.68, Capsul: 6.98 and N-lok: 4.16 mg GAE/g db). A similar pattern was found with the antioxidant capacity front radical of DPPH, ABTS, and FRAP. The use of maltodextrin 10 as wall material provides greater retention and stability of the bioactive compounds from *Averrhoa carambola* fruit, as an alternative to avoid its degradation and obtain a higher bioaccessibility in the intestine. The encapsulating products of this fruit could be incorporated into different food matrices to take advantage of these compounds.

In vitro colonic fermentation of prebiotic fibers with fecal inoculum from sedentary vs. physically active people

Amalinali Portillo-Ayala, Perla Osorio-Díaz, Brenda Camacho-Díaz

The intestinal microbiota (eubiosis), mainly composed of bacteria, plays multiple roles at both the systemic and metabolic levels, modulating health. It can be influenced by factors such as diet, body weight, gastrointestinal health, and physical exercise. It is known that physically active people (PAP) have a higher abundance of beneficial bacteria compared to the sedentary people (SED). However, intense or poorly programmed exercise, as well as the use of ergogenic aids, can induce dysbiosis and negatively affect sports performance. Prebiotic fibers, such as banana flour and agavins, have been shown to benefit the intestinal microbiota, as they serve as the primary substrate for intestinal bacteria. However, there are not enough studies on their effect on the microbiota of physically active people. Therefore, the aim of this study was to compare the metabolic products of the microbiota of sedentary versus physically active population through *in vitro* colonic fermentation of two substrates. *In vitro* colonic fermentation was performed according to the procedure reported by Martín-Carrón and Goñi (1998). Short-chain fatty acids (SCFA), gas produced, pH and unfermented residue (UFR) were determined. The total SCFA production was greater in the FAP microbiota compared to the SED microbiota. The most predominant fatty acids, in both groups were acetic, propionic and butyric acids. No significant differences were found in the production of acetic acid (238±7.05 µmol/ml PFA and 226.70±7.38 µmol/ml in SED), or propionic acid (129.27±12.12 µmol/ml FAP and 106.37±5.52 µmol/ml in SED). However, butyric acid production was significantly higher in the SED microbiota (53.40±1.67 µmol/ml) that FAP (39.25±0.34 µmol/ml). On the other hand, the pH value resulting from the use of agavins as substrate was 6.54±0.04 in FAP, and 6.45±0.04 in SED. Gas production was higher in both populations, using agavins as substrate (14.31±1.54 ml/g in PFA and 15.16±1.67 ml/g in SED), compared to plantain flour (10.17±1.36 ml/g in PFA and 13.06±1.12 ml/g in SED). In agreement the UFR was higher using plantain flour (58.16±4.42 mg in PFA and 45.95±4.65 mg in SED) than agavins. The results show that only gas and UFR were different with both substrates. However, the FAP microbiota produced less butyric acid, probably due to the differences between the microbiota of each population.

Kefir grain biomass: physicochemical characterization of the powder and rheology of its filmogenic solutions

Moreno-Leon, G.R., Avila-Reyes, S. V., Solorza-Feria, J.

Kefir grains are a symbiotic association of several species of bacteria and yeasts, immobilized on a matrix of exopolysaccharides (EPS) called kefiran, which can become a sustainable and innovative source of biopolymeric materials such as carbohydrates and proteins. One of the main problems of kefir is the yield, which prevents its large-scale production and limits its applications, so the comprehensive use of biomass, as well as the addition of other carbon sources like agave fructans opens up the possibilities to improve the fermentation and yield of the biopolymer. This work aimed to evaluate the physicochemical properties of kefir biomass powder fermented with agave fructans and the rheological properties of the solutions. The type of substrate (Agave fructans, glucose, galactose) was evaluated as a carbon source in the initial inoculum. The optimal biomass production was determined through a response surface analysis (RSA). The morphology of the grains was determined by image digital analysis (IDA). A proximal analysis (moisture, carbohydrates, proteins and lipids) was performed on the powdered biomass, and its filmogenic solutions' rheological behavior was studied. The Ostwald-de Waale model was used to evaluate the rheological behavior of the filmogenic solutions, and the frequency and amplitude sweep coefficients were determined. The RSA showed that 2% inoculum and 27.5°C were the best fermentation parameters and 6% w/w of agave fructans in the culture favored biomass growth (75.94%) concerning the control. The IDA allowed the identification of morphological changes in the kefir grains through the modification of the microorganism profile due to the change of substrate. An increase in fat (3.76%), ash (5.57%), and protein (7.12%) content was observed. The filmogenic solutions showed values of $n<1$, with characteristics of pseudoplastic materials. The viscosity vs. shear rate values showed that the solutions exhibited non-Newtonian behavior in the biomass samples fermented with agave fructans. The storage (G') and loss (G'') moduli at low frequencies were G'<G'' and at high frequencies were G'>G''. The potential properties of kefir biomass powder can be improved and have applications as an innovative biopolymer by adding agave fructans as a carbon source.

Evaluation of the neuroprotective effect of *Opuntia matudae* Scheinvar fruits in a model of diabetic peripheral neuropathy.

Joanna Ramón Santos, Rosa Mariana Montiel Ruiz, Antonio Ruperto Jiménez Aparicio.

Diabetic peripheral neuropathy (DPN) is the damage caused to the nerves by diseases such as diabetes, which mainly affects the extremities and produces sensations such as electric shocks and stabbing. In Mexico, there are no statistics on DPN. Still, according to international statistics and studies in some states, it can be deduced that between 7% and 8% of the population suffers from this problem. DPN presents symptoms such as hyperalgesia and allodynia due to hyperglycemia, together with altered insulin signaling, leading to pathological alteration of different pathways in neurons. Approved drugs include pregabalin and duloxetine; however, only one in three patients have significant relief, they may have undesirable effects and are even contraindicated in some patients. Over the years, the importance of natural health products has increased. One example is *Opuntia matudae* Scheinvar, a plant species used in traditional Mexican medicine to treat different pathologies, including diabetes. In addition, due to the diversity of secondary metabolites it contains, it could help treat DPN. However, there has not been enough research to identify its biological properties. There is a great need to search for new pharmacological alternatives, this work aims to evaluate the neuroprotective effect of *Opuntia matudae* Scheinvar fruits in a rodent model of DPN and to characterize phytochemically the most active extract. *O. matudae* fruits will be harvested and methanolic and aqueous extracts will be obtained by continuous maceration. Mice weighing 25-30 g will then be induced with streptozotocin at a dose of 150 mg/kg, and as mentioned in the literature, hyperalgesia will develop in approximately 6 weeks. Subsequently, hyperalgesia and mechanical allodynia will be assessed using von Frey filaments with the up-down method. In addition, lipid peroxidation and protein carbonylation in the spinal cord and sciatic nerve will be quantified by carbonyl group reaction. Finally, molecular markers of nerve damage COX-2 and ATF3 will be determined by Bradford's method and electrophoresis. Methanolic and aqueous extracts of *O. matudae* fruits were obtained. In addition, the standardization of the diabetic peripheral neuropathy model in rodents was carried out, for which weight and glucose levels were controlled, and the development of DPN was monitored weekly. This work will allow us to know the neuroprotective effect of *O. matudae* extracts.

Whole corn tortilla can differ in glycemic response and fecal fermentation compared with traditional tortilla: partial characterization

Luis A. Bello-Perez

Tortilla is the main staple food of Mexican people living in the United States, and it is also an important food in some Central American countries. The health problems associated with the consumption of starchy foods promote the search for the production and consumption of foods with low glycemic impact. Ecological nixtamalization with calcium carbonate reduces the pollution problems associated with the wastewater of traditional nixtamalization with calcium hydroxide. Ecological nixtamalization maintains the pericarp of the maize grain, resulting in a higher dietary fiber content. The use of pigmented maize increases the functional effect of tortillas due to the presence of bioactive compounds (anthocyanins). The present study aims to evaluate the effects of the nixtamalization method and the maize variety on the *in vitro* glycemic response and colonic fermentation of tortillas. In this first stage of the study, the proximal composition, the dietary fiber content of tortillas “as eaten”, indigestible fraction, and *in vitro* starch hydrolysis rate are presented. White and blue maize were nixtamalized using traditional and ecological methods in CINVESTAV-Queretaro. The four nixtamalized flours and a commercial nixtamalized white maize flour were used to prepare tortillas. Tortillas were dried in a convection oven at 45-50 °C for 12 h, crushed with mortar and pestle, and sieved to a particle size of 40 μm for proximal analysis and indigestible fraction measurement and 2 mm for dietary fiber and starch hydrolysis rate assessment. The proximal composition (moisture, protein, lipid, ash, total starch, and total dietary fiber) was determined with AACCI-approved methods; total dietary fiber in products “as eaten” was determined with an enzymatic kit. The starch hydrolysis rate was assessed with a protocol simulating gastrointestinal digestion. The indigestible fraction was determined with an enzymatic procedure after gastrointestinal digestion. The blue maize flour showed higher protein content than white maize, and the nixtamalized blue maize presented lower ash content, differences that may be due to the agronomical variety. Total starch content was similar in both varieties, and the nixtamalized flour with calcium carbonate showed higher dietary fiber content than the calcium hydroxide-nixtamalized one. The soluble indigestible fraction was lower in the blue tortillas, and the insoluble fraction did not differ between varieties or with the nixtamalization processes. Tortillas of white and blue maize showed differences in the proximal composition characteristics, indigestible fraction content, and starch hydrolysis rate, which may result in differences in the colonic fermentation pattern of tortillas.

Evaluation of hydrocarbon and intracellular lipid extraction methods from *Botryococcus braunii*

Ana Guadalupe Fracchia-Durán, Alma Leticia Martínez-Ayala

Botryococcus braunii is a colonial microalga of interest and biotechnological potential due to its high content of liquid hydrocarbons compatible for use as biofuels, which are contained in an extracellular matrix, and can represent between 20-86% of its dry biomass, exceeding what has been reported for other microorganisms. However, *B. braunii* also has hydrocarbons, lipids and other intracellular metabolites of great potential, for example, race B of this species has been identified as the one with the highest squalene content among microalgae. There are few studies focused on the extraction of intracellular hydrocarbons and lipids, and therefore, not many methodologies applied for this purpose. The extraction of these compounds requires several treatments due to the protection offered by the extracellular matrix and fibrillar sheath produced by the colonies of this species. Therefore, in the present work, several methods reported by authors were evaluated, including biomass separation by centrifugation and filtration, as well as by decantation and pipetting; drying by lyophilization or in an oven, cell lysis by sonication, homogenization with mortar and pestle, and saponification; as well as new proposals such as saponification under concentrations of 5, 10, 15 and 20% KOH with 50% methanol using fresh samples obtained directly from the culture medium, without applying separation and drying processes of the microalgae. All this followed by the subsequent extraction of intracellular lipid fraction using hexane. With the results obtained from preliminary tests, eight methodologies for the extraction of the lipid fraction of *Botryococcus braunii* Showa (race B) were evaluated, with the objective of identifying an efficient and practical methodology to apply, also considering the time required for its implementation. The highest lipid fraction content obtained was 37.91 ± 5.74 % under stress-free growing conditions, by applying a 30-minute sonication treatment with 15% KOH in fresh samples, which did not present significant differences with other six evaluated methodologies. Therefore, the application of this methodology, that does not require initial biomass separation and drying processes, offers an efficient, practical and fast alternative for the extraction of the intracellular lipid fraction of *Botryococcus braunii,* compared to other alternative methodologies where time-consuming drying of the material is required, which is usually performed by freeze-drying, and which can slow down the process especially when working with multiple samples.

Awarded Presentations

The following presentations were recognized for their scientific quality, originality, and contribution to research in the field of biotic products development:

Ana Guadalupe Fracchia-Durán: Evaluation of hydrocarbon and intracellular lipid extraction methods from *Botryococcus braunii.*

Karen Maybel Granados Vega: Morphological variability of *Pouteria campechiana* related to endogenous phytohormone content and environmental conditions.

Vareska L. Zárate-Córdova: Lentil flour feeding reduces body weight and intestinal inflammation in rats fed with high-fat and high-sucrose diet.

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