



Libro de Resúmenes

Merida, Yucatan 2018



**I. FORO CIENTÍFICO EN SALUD, CIENCIA Y
TECNOLOGÍA DE LOS ALIMENTOS (7 DE NOVIEMBRE)**

**I. CONFERENCIA INTERNACIONAL LA VALSE-FOOD
(8 DE NOVIEMBRE)**

**IV. CONFERENCIA INTERNACIONAL CHIA-LINK
(9 DE NOVIEMBRE)**

Editores:

Maira Rubí Segura Campos

Claudia Monika Haros



**I FORO CIENTÍFICO EN SALUD, CIENCIA Y
TECNOLOGÍA DE LOS ALIMENTOS
I CONFERENCIA INTERNACIONAL LA VALSE-FOOD
IV CONFERENCIA INTERNACIONAL CHIA-LINK**

**07 AL 09 DE NOVIEMBRE DE 2018
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LIBRO DE RESÚMENES

Editores

Maira Rubí Segura Campos y Claudia Monika Haros

**Mérida, Yucatán, México
2018**



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Mérida, Yucatán, 2018.

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PRÓLOGO

Este libro reúne los resúmenes de los trabajos de investigación presentados en el I Foro Científico en Salud, Ciencia y Tecnología de los Alimentos (SCITEC), la I Conferencia Internacional LA Valse-Food y la IV Conferencia Internacional Chia-Link, evento organizado en el marco del quehacer científico de la Red Internacional Chia-Link y el grupo LA Valse-Food, a bien constituidas por los miembros del Comité Directivo: Prof. Dr. Francisco Millán Rodríguez (CSIC-IG-Sevilla, España), Dra. Loreto Muñoz Hernández (UCEN-Chile), Dra. Mabel Tomás (CIDCA-La Plata, Argentina), Dra. M^a Teresa Fernández Espinar (CSIC-IATA-Valencia, España), Dra. Maira Rubí Segura Campos (UADY, Mérida, Yucatán, México), bajo la coordinación de la Dra. Claudia M. Haros (CSIC-IATA, Valencia, España). En 2018, Mérida, Yucatán, México es el espacio de encuentro entre grupos científicos, técnicos e industriales que comparten el objetivo de crear un entorno de cooperación internacional y unir esfuerzos para promover alimentos inócuos, sostenibles, sabrosos, nutritivos y saludables entre el sector científico, industrial y la sociedad en general, siendo así la Universidad Autónoma de Yucatán (UADY) el espacio de encuentro de saberes. Por lo anterior, este libro recoge 54 trabajos de investigación en tres secciones. La primera de éstas, titulada “Salud, Ciencia y Tecnología”, recopila resúmenes de 6 presentaciones orales y 22 presentaciones en póster. La segunda y la tercera sección tituladas “Revalorización de Cultivos Latinoamericanos” e “Investigación, Desarrollo e Innovación en Chía” reúnen cada una, 7 presentaciones orales y 9 presentaciones en póster, haciendo un total de 14 trabajos en modalidad oral y 18 en póster. El Comité Organizador del I Foro SCITEC, I Conferencia Interacional LA Valse-Food y IV Conferencia Internacional Chia-Link, conformado por, quienes suscriben, Dra. Claudia M. Haros, Dra. Maira Rubí Segura Campos, así como la IB. Karla Stephanie Vázquez Encalada, agradecen las facilidades y apoyo otorgados por los directivos de la Facultad de Ingeniería Química (FI)-UADY, Dra. Marcela Zamudio Maya (Directora) y Dr. Cristian Carrera Figueiras (Jefe de la Unidad de Posgrado e Investigación), para acoger en el Campus de Ciencias Exactas e Ingenierías a científicos, industriales y público en general de países tales como Argentina, Brasil, Ecuador, España, Perú, Portugal, Túnez y por supuesto México. No menos importante, nuestro agradecimiento a todos y cada uno de los autores que con sus contribuciones además de generar un espacio enriquecedor de intercambio de experiencias y conocimientos, hicieron posible este manuscrito que a bien revaloriza y promueve cultivos ancestrales tales como la chía.

Atentamente
Dra. Claudia Monika Haros
Dra. Maira Rubí Segura Campos
Editoras



Sesión 1.
Salud, Ciencia y Tecnología de
Alimentos
Presentaciones Orales



1.1

BIOSÍNTESIS Y APLICACIONES DE LOS ALCALOIDES BENCILISOQUINÓLICOS DE *Argemone mexicana* (CHICALOTE). UNA PLANTA DE LA MEDICINA TRADICIONAL.

Felipe Vázquez Flota

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Argemone mexicana L (chicalote o cardosanto) es una planta de la familia Papaveraceae que produce cerca de 30 alcaloides bencilisoquinolínicos, derivados de la tirosina. Dos de estos alcaloides son la berberina y la sanguinarina que, en los tejidos de la planta, cumplen funciones de defensa química contra depredadores y patógenos, pero que también tienen aplicaciones médicas e industriales. La sanguinarina se utiliza como un suplemento alimenticio para animales de granja mientras que la berberina reduce la resistencia a la insulina en pacientes de diabetes tipo 2. De hecho, las hojas de esta planta se incluye en preparaciones médicas tradicionales para el tratamiento de la diabetes en Yucatán. Aunque otras plantas pueden producir estos alcaloides, en pocas ocasiones convergen en una misma especie, como es el caso de *A. mexicana*, en la cual se distribuyen de manera diferencial a través de sus tejidos. La berberina se puede encontrar en raíces, hojas, tallos y frutos, en tanto que la sanguinarina sólo se presenta en las raíces y semillas maduras. Dado que ambos alcaloides comparten las reacciones iniciales de su formación, nuestro interés se enfoca en conocer los mecanismos que definen la capacidad biosintética de los diferentes tejidos. Para este fin, se han aislado y caracterizado algunos de los genes involucrados en las reacciones iniciales, comunes para ambos, así como otros involucrados en la formación de berberina y sanguinarina, de manera específica. Los resultados obtenidos sugieren que el tipo de alcaloides acumulados en los tejidos no sólo depende de los patrones de expresión tisular diferencial, sino que puede involucrar mecanismos de transporte a distancia, así como la participación de alternativas catalíticas. También se han podido identificar algunos estímulos ambientales que conducen a la producción de estos alcaloides y las rutas bioquímicas encargadas de percibir, transmitir e interpretar dichos estímulos como una señal para desencadenar una respuesta de defensa química que incluye la formación *de novo* de los mismos. Estos resultados podrán incorporarse en programas biotecnológicos de selección, manejo y mejora de esta planta con el propósito de favorecer la producción de uno u otro alcaloide, con el fin de su aprovechamiento como recurso fitogenético.

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1.2

IMPACTO DE INTERVENCIONES EN SALUD PÚBLICA PARA REDUCIR EL CONSUMO DE BEBIDAS AZUCARADAS O AUMENTAR EL CONSUMO DE AGUA: RESULTADOS DE UNA REVISIÓN SISTEMÁTICA Y META-ANÁLISIS

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El aumento en el consumo de bebidas azucaradas (BA) ha sido evidenciado como un factor contribuyente a la carga de enfermedad derivada de la obesidad y comorbilidades relacionadas. Como una de las mayores fuentes de azúcares añadidos, se ha reconocido la importancia de disminuir el consumo de las BA para mejorar la salud pública. Sin embargo, hay poca evidencia disponible sobre los tipos de intervenciones más exitosas en distintos grupos de edad. En consecuencia, se realizó una revisión sistemática y meta-análisis para abordar esta brecha. Se incluyeron ensayos controlados aleatorios y no aleatorizados publicados después de Enero de 1990 y hasta Diciembre de 2016 que informaron sobre cambios diarios en la ingesta de BA o agua en mediciones volumétricas (ml/día). Las referencias se recuperaron a través de búsquedas en bases de datos electrónicas y la evaluación de la calidad siguiendo los principios Cochrane. Las técnicas de cambio de comportamiento (TCC) se identificaron y analizaron siguiendo una taxonomía establecida. Se calcularon las diferencias entre medias y los datos fueron sintetizados con modelos de efectos aleatorios. Cuarenta estudios con 16 500 participantes fueron meta-analizados. Las intervenciones redujeron significativamente el consumo de BA en niños en 76 ml / día (intervalo de confianza [IC] del 95%: -105 a -46; 23 estudios, $P < 0.01$), y en adolescentes (-66 ml / día, IC del 95%: -130 a -2; 5 estudios, $P = 0.04$) pero no en adultos (-13 ml / día, IC del 95%: -56 a 9; 7 estudios, $P = 0.16$). Las estimaciones sobre cambios en la ingesta de agua solo fueron posibles para intervenciones en niños y los resultados fueron indicativos de aumentos en el consumo (+80 ml / día, IC del 95%: 6 a 155; 6 estudios, $P = 0.04$). Para los niños, hubo evidencia que sugiere que modelar el comportamiento ayudó a reducir la ingesta de BA y que las intervenciones en el entorno familiar tuvieron mayores efectos que las intervenciones realizadas en escuelas. En conclusión, las intervenciones de salud pública, principalmente en educación nutricional han sido moderadamente exitosas en la reducción de la ingesta de BA y el aumento de consumo de agua en niños. Sin embargo, en promedio, solo se han logrado pequeñas reducciones en el consumo de BA en adolescentes y adultos. Es necesario implementar medidas complementarias para lograr mejoras más significativas en ambos comportamientos dietéticos en todos los grupos de edad.



1.3

EFFECTO TERAPÉUTICO DEL ZINC EN EL CIERRE DE HERIDAS CUTÁNEAS EN RATA CON DIABETES TIPO 2

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Introducción: La Diabetes Mellitus tiene como una de sus complicaciones la dificultad para reparar tejidos, situación que puede evolucionar a necrobiosis lipoídica, con el consecuente riesgo amputación, discapacidad, disminución de la calidad de vida e incluso la muerte. El zinc es un cofactor en procesos de replicación, transcripción e inmunidad relacionadas con la reparación tisular, su aplicación tópica puede mejorar algunos padecimientos cutáneos, pero su eficacia en heridas de pacientes diabéticos requiere más estudios. La suplementación con zinc en individuos con diabetes supone un efecto normoglucemiante. **Objetivo:** Evaluar el efecto de la suplementación oral con zinc en la cicatrización de heridas cutáneas en rata con DM2. **Metodología:** se realizó un estudio experimental con ratas sanas, alimentadas con dieta hiperglucémica e hipercalórica hasta desarrollar DM2, posteriormente se aleatorizaron en dos grupos ($n=15c/u$); el grupo experimental se suplementó vía oral con zinc (100mg/Kg) diariamente y el grupo control recibió solución azucarada. Ambos grupos continuaron la dieta hiperglucémica hasta el final del estudio. Una semana posterior, se realizó bajo anestesia, una herida cutánea de 2cm de longitud en el cuello de cada rata. Se mantuvo el esquema de alimentación y suplementación por 3 semanas más. Se midió glucemia, zinc y otros parámetros bioquímicos, en rata sana, al diagnosticarse DM2, el día de las heridas y previo al sacrificio. Se fijaron puntos de control a los 7, 14 y 21 días post-herida, para coleccionar muestras bioquímicas e histológicas de cada grupo y se evidenciaron los resultados con fotografías representativas. Se analizaron los resultados con una prueba t-Student pareada (intragrupo), no pareada (intergrupo) y ANOVA con prueba *post hoc* LSD. **Resultados:** Las ratas diabéticas del grupo suplementado con zinc, lograron la cicatrización de heridas en 9 ± 0.41 días comparado con el grupo control, en 12 ± 0.32 días ($p<0.001$). El grupo suplementado con zinc presentó glucemia menor que el grupo control desde los 7 días posteriores de iniciar la suplementación hasta el final del estudio. La concentración sérica de zinc se incrementó en el grupo experimental durante 21 días y fue mayor que el grupo control. Histológicamente, las heridas cutáneas en el grupo experimental evidenciaron mejoría morfológica, similar al tejido sano; El grupo control mostró aberraciones morfológicas. La evidencia histológica fue congruente con las evidencias macroscópicas encontradas. **Conclusiones:** La suplementación oral con zinc (100mg/Kg) diariamente, mejora la cicatrización de heridas cutáneas en ratas con DM2 y mejora los parámetros bioquímicos de la enfermedad.



1.4

MODELOS EXPERIMENTALES DE OBESIDAD, DIABETES E HIPERTENSIÓN PARA LA EVALUACIÓN DE CULTIVOS IBEROAMERICANOS

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Las enfermedades crónico degenerativas asociadas a la obesidad representan un problema de salud pública. A nivel nacional, la hipertensión tiene una prevalencia del 31 % y mayor al 50 % en adultos mayores mientras que la diabetes se presenta en el 11 % de la población mayor a 20 años (ENSANUT 2016), ambas están relacionadas con el sobrepeso y la obesidad, los cuales se presentan en $\frac{3}{4}$ de la población. Actualmente son la 1ª causa de mortalidad debida a lesiones del corazón y complicaciones severas a órganos como el hígado, cerebro y riñón. La hipertensión puede ser tratada con inhibidores de la ECA, diuréticos, betabloqueadores y calcioantagonistas. Para la diabetes se incluyen inhibidores enzimáticos, inductores de la secreción y sensibilizadores de la insulina. Los modelos de obesidad se inducen con sacarosa 20 % durante 3-5 meses, la hipertensión se induce con L-NAME y para la diabetes se utiliza el aloxano. Las muestras evaluadas en los modelos experimentales se obtienen de leguminosas como *Mucuna pruriens* y de plantas como la chaya y la estevia. De la leguminosa *M. pruriens* se evalúan hidrolizados proteínicos mientras de chaya y estevia se utilizaron los extractos. Como controles se utilizan insulina y glibenclamida para el efecto antidiabético, captopril para el efecto antihipertensivo, acarbosa para el efecto antihiper glucémico por inhibición de las enzimas digestivas o empagliflozina para inhibir los transportadores de glucosa SGLUT intestinales. En cada una de las especies vegetales estudiadas se encontró actividad farmacológica significativa para al menos una de las enfermedades. Estos resultados sugieren una alternativa de tratamiento para la obesidad, hipertensión arterial, o diabetes a base de los derivados vegetales de plantas de la región.



1.5

DETECCIÓN E IDENTIFICACIÓN DE *Escherichia coli* O157:H7 Y *Listeria monocytogenes* EN PRODUCTOS CÁRNICOS CRUDOS

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Las enfermedades gastrointestinales son uno de los principales problemas de salud pública, anualmente se enferman millones de personas a causa de alimentos contaminados. Los principales agentes patógenos causantes de diarrea aguda incluyen: rotavirus y otros tipos de virus intestinales, *E. coli*, *Salmonella* spp, *Shigella* spp, *Campylobacter jejuni*, *Vibrio cholerae*, *Listeria monocytogenes*, *Entamoeba histolytica*, entre otros. Las ETA constituyen uno de los problemas más extendidos actualmente en el mundo, causando un alto impacto e interés para la salud pública. El objetivo del presente estudio fue determinar la presencia de *Escherichia coli* O157:H7 y de *Listeria monocytogenes* en productos cárnicos de mercados y supermercados de Mérida, Yucatán, mediante cultivo y la reacción en cadena de la polimerasa (PCR). Se estudiaron 300 muestras de carne, para el aislamiento, caracterización y serotipificación de *E. coli* O157:H7 se empleó la metodología FDA-BAM. Se seleccionaron 3-5 colonias sorbitol negativas para realizarles pruebas bioquímicas, y la aglutinación con el antisuero O157. La amplificación de los genes *stx1* y *stx2* de *E. coli* O157:H7 tenía como finalidad observar dos fragmentos, uno de 348 y otro de 584 pb, respectivamente. Y para el aislamiento de *L. monocytogenes*, se realizó mediante lo establecido en la NOM-143-SSA1-1995 Bienes y Servicios, Método de prueba microbiológico para alimentos. De las 300 muestras, se aislaron cepas de *E. coli* en 127 de ellas, a todas se les hizo aglutinación con el antisuero anti-O157, y sólo en 43 fue positiva, y de éstas, 4 fueron positivas con el antisuero anti-H7. Con la amplificación de *stx1* y *stx2* de *E. coli* O157:H7, se obtuvo que 8 (2.66%) muestras amplificaron ambos genes, 4 (1.33%) *stx1* y 4 (1.33%) *stx2*. Para *L. monocytogenes*, se obtuvieron un total de 240 cepas, aisladas de 128 muestras. A todas se les realizó la identificación bioquímica, extracción de ADN y la PCR. Un total de 40 cepas dieron amplificación del gen de la región rRNA 16S para el género *Listeria* spp (938 pb) y de éstas, 11 cepas amplificaron del gen *hlyA* (750 pb) que está asociado a la listeriolisina O para la especie *L. monocytogenes*. Mientras que, mediante las pruebas convencionales, únicamente una cepa presentó las características bioquímicas del microorganismo. Se concluye que existe contaminación con *E. coli* O157:H7 y *L. monocytogenes* en los productos cárnicos crudos comercializados en los mercados y supermercados de Mérida. Se sugiere que puedan estar circulando otros serotipos enterohemorrágicos de *E. coli*, y recomienda la incorporación de la PCR a las pruebas convencionales para el diagnóstico de ambos microorganismos-



1.6

UTILIZACIÓN DE *Salvia hispanica* EN LA ELABORACIÓN DE PRODUCTOS CÁRNICO

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La incapacidad de nuestro cuerpo para neutralizar los radicales libres que se originan a través de la respiración, nos obliga a recurrir a nutrientes con la propiedad de neutralizarlos. Estos nutrientes actúan liberando electrones en nuestra sangre que son captados por los radicales libres, convirtiéndose así en moléculas estables. Estos compuestos son los antioxidantes, pudiendo ser la protección más eficaz contra el envejecimiento celular y las enfermedades degenerativas. La fibra dietética presente en frutas y verduras contienen beneficios para la salud, que se atribuyen principalmente a los micronutrientes orgánicos, tales como los carotenoides, polifenoles, tocoferoles, vitamina C y otros (Schieber y col., 2001). La semilla de chía (*S. hispanica* L.), es una oleaginosa con alto contenido en ácidos grasos omega 3. La semilla de chía se constituye de alrededor de 25-40% de aceite, del cual el 60% es ácido α -linolénico (Segura-Campos y col., 2013). Asimismo, presenta un importante contenido de proteína (15-25%) y fibra en forma de mucílago (18-30%), ésta última reconocida por su efecto saciante para el tratamiento de la obesidad (Ixtaina y col., 2008). El objetivo de este proyecto fue evaluar la funcionalidad de productos cárnicos formulado con harina de *S. hispanica* L, entre otros. Se elaboraron diversos productos cárnicos (salami, pastel pimiento y otros) incorporando harina de chía y un producto control para su posterior evaluación. A los productos elaborados generalmente se les evaluó su potencial como alimento funcional mediante caracterización nutrimental, sensorial (pruebas afectivas) y biológica (actividad antioxidante-DPPH y ABTS). Los resultados pusieron de manifiesto el valor nutrimental de los productos; el análisis sensorial indicó el agrado de los productos al registrarse valores por arriba del punto de indiferencia de la escala hedónica; el valor funcional exhibió rangos adecuados de actividad antioxidante. Los resultados sugieren la funcionalidad de los productos; sin embargo, son necesarias futuras investigaciones para determinar sus efectos.

Cabe mencionar que la formulación de nuevos alimentos empleando como materia prima semillas de chía, es una alternativa en la búsqueda de nuevos esquemas de alimentación para la población con obesidad, considerando su alto contenido en ácidos grasos omega 3 que contribuyen a efectos benéficos e importantes en este grupo de enfermedades.



Sesión 1.
Salud, Ciencia y Tecnología
Presentaciones en Póster



1.7

DETERMINATION OF CAPSAICINOIDS AND PHENOLIC COMPOUNDS IN TWO VARIETIES OF HABANERO PEPPER (*Capsicum chinense Jacq*) GROWN IN THE STATE OF NUEVO LEON

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Habanero pepper contains phenolic compounds such as capsaicinoids, substances with antioxidant, anticancer and anti-inflammatory properties. To date, the chemical composition of habanero peppers grown in Nuevo Leon has not been reported. Therefore, the objective of this work was to establish the extraction conditions and quantification for capsaicinoids and phenolic compounds in habanero pepper (*Capsicum chinense Jacq*).

The chromatographic conditions were optimized and validated by HPLC with Fluorescence detector with Capsaicin and Dihydrocapsaicin standards. The extraction process was with 80% methanol, to later perform the quantification of capsaicinoids following the reported by Canto Flick et al. (2018) and phenolic compounds with the Folin-Ciocalteu method at a λ of 760 nm using gallic acid as standard.

The flow velocity was 0.5 mL/min and column temperature 27 ° C because it presented the best resolution of both chromatographic peaks. The validation results complied with the parameters of the ICH. The content of capsaicinoids for the Texcoco variety was $17,938.06 \pm 4.18$ mg/kg and Jaguar $20,087.52 \pm 5.85$ mg/kg ($p = 0.000$). The content of phenolic compounds was 19078.16 ± 14.11 μ g/g and 17725.52 ± 8.01 μ g/g ($p = 0.001$), respectively.

It was possible to establish the analysis conditions for the reliable quantification of capsaicinoids and phenolic compounds in habanero pepper extract. This fruit could be an alternative for the management and prevention of degenerative diseases.



1.8

ACRYLAMIDE MITIGATION POTENTIAL OF POLYPHENOLS EXTRACTS IN BREAD AND SUGAR RATIO

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Acrylamide is a carcinogenic contaminant produced during food processing at high temperatures., in the presence of asparagine and reducing sugar. The acrylamide occurrence study in foods led to a development of acrylamide mitigation strategies. The aim of the present work was to understand the effect of some mitigator extracts in acrylamide mitigation in bread. Also, it was developed a new and fast method to identify and quantify individuals' sugars in bread to make a relation between the sugar ratio and acrylamide mitigation. It was selected two types of matrix, dough, and bread with different formulations (extracts of lemon balm fennel and pine nuts). For the detection and quantification of acrylamide and sugars, an UPLC-MS/MS was used. It was accomplished the highest value of acrylamide mitigation in bread with addition of pine nuts extracts, around 70%, followed by the lemon balm extract, 20%. In the sugar, the method was used the following chromatographic conditions were then tested: mobile phase A with acetonitrile/water (0.1% ammonium hydroxide) and mobile phase B with acetonitrile/water (0.1% ammonium hydroxide) with a flow of 0.2 ml/min for 32 minutes. Comparing the two matrices (flour and dough bread) we can observe that in dough does not contain sucrose which can be related to the degradation process of the sucrose into glucose and fructose. In this study was observed that the pine nuts extract had the highest mitigation percentage in bread and also it was possible to make a relation between the acrylamide mitigation and sugar concentration.



1.9

IN VITRO ANTI-INFLAMMATORY POTENTIAL OF PHENOLIC EXTRACTS FROM *Phaseolus vulgaris* AND *Pisum sativum* sprouts

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Introduction: During germination a great variety of secondary metabolites are produced. One of the properties of secondary metabolites is antiinflammatory activity. Inflammation is caused by release of chemicals from tissues and migrating cells. **Objective:** Evaluate by in vitro assays the antiinflammatory activity of phenolic extracts from germinated seeds. **Methods:** For this investigation, phenolic extracts of *P. vulgaris* and *P. sativum* seeds were used, which were germinated for a period of 10 days. The in vitro antiinflammatory activity was evaluated: Inhibition of ovoalbumin denaturation (IOD), Proteinase inhibitory activity (PIA) and Membrane stabilization test (MST). **Results:** IC₅₀ was made comparing it with raw sedes (Table 1).

Table 1. IC₅₀ values (mg GAE/g) for raw sedes and sprouts.

Sample	IOD	PIA	MST
Raw seed <i>P. vulgaris</i>	3.24	2.72	0.34
Raw seed <i>P. sativum</i>	3.92	2.92	0.87
<i>P. vulgaris</i> (day 6)	1.95	1.93	0.30
<i>P. sativum</i> (day 7)	1.76	1.77	0.57

GAE = Gallic Acid Equivalents.

Conclusión. This study showed promising properties of phenolics extracts to be potentially used in relieving inflammation.



1.10

TECHNOLOGICAL AND BIOLOGICAL PROPERTIES OF RAMON SEEDS (*Brosimum alicastrum*) PROTEINS

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Introduction: In 1975, the National Academy of Sciences of the United States classified the Ramon tree as an underutilized species with potential economic value, likewise establishing the need to study the nutritional value of these seeds. Thus far, the research conducted with this seed is scarce, with very few published studies regarding its use and incorporation as food. Through the evaluation of the technological and biological properties of functionality, it is possible to generate knowledge that allows revaluing the sustainable use of underutilized species. **Objective:** The aim this research was to evaluate the effects of pH extraction on functional and biological properties of Ramón seed proteins. **Methods:** The properties of technological functionality were evaluated at different pH values (2-12). The anti-inflammatory and anti-inflammatory properties were determined by *in vitro* assays. **Results:** The chemical composition of Ramón seed flour is 13% protein, 65% carbohydrates, 15% fiber, and 1.3% lipids. Protein solubility, emulsifying activity and foam capacity showed highest values at pH 12. For antioxidant capacities, at pH 4 radical scavenging activity and reducing power reached highest values 21.7% and 28.4%, respectively. Chelating effect reached maximum value at pH 12 (33.0%). For anti-inflammatory properties, at pH 10 inhibition of protein thermal denaturation and inhibition of proteolytic activity reached highest values 62.3% and 28.1%, respectively. Cell membrane stabilization reached maximum value at pH 2 (57.1%). **Conclusions:** The results indicate that Ramon seed proteins have the potential to be incorporated into food systems to improve their functional and biological properties.



1.11

EFECTO INHIBIDOR DE LA ECA DE EXTRACTOS DE HOJAS DE CHAYA (*Cnidoscolus aconitifolius*)

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La hipertensión arterial sistémica (HAS) es la elevación sostenida de la presión arterial $\geq 140/90$ mmHg, es una enfermedad crónica que se produce por diversos factores, tales como; genética, sedentarismo, tabaquismo, alcohol, obesidad, dislipidemias y la diabetes mellitus. La ENSANUT 2016 reportó que, en México el 25.5% de la población padece de HAS, siendo las mujeres que presentan más este padecimiento. En la HAS el sistema de renina-angiotensina-aldosterona se ve afectado, teniendo como consecuencia cambios en el volumen del organismo y en la presión. La renina es una enzima proteolítica sintetizada por el riñón, que actúa sobre el angiotensinógeno y se obtiene angiotensina I. Posteriormente, actúa la enzima convertidora de angiotensina (ECA) y se obtiene angiotensina II, ésta se une a los receptores AT I y AT II. El exceso de angiotensina II, ocasiona vasoconstricción sistémica, elevando la presión arterial. La consecuencia principal de la HAS es la enfermedad renal crónica (ERC). El tratamiento farmacológico de esta enfermedad es extenso, de alto costo y con efectos secundarios en el organismo. Las alternativas naturales, son una opción al tratamiento de esta enfermedad, como los extractos con potencial efecto protector. Las hojas de *Cnidoscolus aconitifolius* es un alimento altamente consumido en la península de Yucatán, de bajo costo y gran accesibilidad. Los extractos de chaya, tienen potencial efecto biológico, sugiriendo un posible coadyuvante en la HAS. El objetivo de este estudio fue; evaluar el efecto inhibidor de la ECA de extractos de las hojas de chaya empleando seis diferentes disolventes; acetona, acetato de etilo, éter dietílico, hexano, etanol y acuoso. Se determinó la actividad inhibitoria de la ECA siguiendo la metodología de Hayakari *et al.*, 1978. Los resultados de los extractos se expresaron con el IC_{50} ; acetona 16.6, acuoso 29.0, éter dietílico 51.0, hexano 57.5, etanol 84.2, acetato de etilo 107.3 $\mu\text{g/mL}$. En conclusión, el extracto de acetona, es el que registró mayor porcentaje de inhibición (80.8%) de la ECA, lo que sugiere su actividad antihipertensiva.



1.12

EVALUATION OF *in vitro* ANTI-INFLAMMATORY ACTIVITY OF GERMINATION OF *Pisum sativum*

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Introduction: The protein are major components of *P. sativum* seed, when germinated a series of enzymes are activated that result in peptides with possible biological activity. **Objective:** Evaluate the *in vitro* anti-inflammatory effect of germinated *P. sativum* seed. **Methods:** The *in vitro* anti-inflammatory activity was evaluated using: **1)** Inhibition of ovalbumin denaturation. **2)** Proteinase inhibitory activity. **3)** Membrane stabilization test. **Results.** As shown in Table 1, germinated seed present best activity against the analyzes carried out to evaluate the anti-inflammatory activity with respect to raw seed.

Table 1. IC₅₀ values of the raw and germinated seed

	Inhibition of ovoalbumin denaturation	Proteinase inhibitory activity	Membrane stabilization test
Raw seed	2.9470	1.1486	0.0741
Germination (Day 7)	1.5948	0.7980	0.0214

The values are expressed in mg equivalents of BSA/mL of protein concentrate. BSA: Bovine Serum Albumin.

To verify the effect of the peptides generated during germination on the stability test of the red blood cell membrane a scanning electron microscopy (SEM) was carried out which will be include by the work to be presented. **Conclusions.** The results obtained show that the hydrolysis performed by germination can result in peptides that achieve activity against mechanism such as inflammation.



1.13

PHYTOCHEMISTRY OF HABANERO CHILI PEPPER FROM YUCATÁN

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Introduction: The habanero chili pepper (*Capsicum chinense*) of the Yucatan peninsula obtained a denomination of origin in 2010. This has prompted an interest in developing new varieties with different traits, besides high capsaicinoid contents, such as functional properties, including antioxidant capacity. **Objectives:** In this work we analyze the phytochemical content of six new varieties of habanero pepper, developed at the Centro de Investigación Científica de Yucatán (Yucatan Scientific Research Center), with a particular focus on phenolic contents and antioxidant capacity. **Materials and Methods:** Ten pepper pods were harvested from five registered varieties (Mayan Kisin®, Genesis®, Mayan Chac®, Mayan Baalché® and Mayan Chan®) and one not yet released (MR8). Pods were cleaned and lyophilized before acetone extraction [1:20] (M:V). Total phenolics were quantified by the Folin-Ciocalteu's method with some modifications. Antioxidant capacity of the extracts was estimated by the DPPH radical reduction method. Capsaicinoids content was analyzed by HPLC. **Results:** Significant differences in the content of phenolics were observed among the different varieties. Mayan Chac cultivar had the lowest quantities of capsaicinoids and phenolic compounds, which was directly related to the high EC_{50} value observed in the DPPH reduction antioxidant activity test. **Conclusion:** The new varieties of Habanero chili pepper present differences in their phytochemistry content and antioxidant capacity.



1.14

EFFECT OF THE TYPE OF ACIDIFICATION ON THE PHYSICOCHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF OAXACA CHEESE

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Introduction. Oaxaca cheese is a fresh pasta filata cheese of Mexican origin. It is elaborated mainly in a traditional way by means of natural acidification, which implies long manufacturing times. **Objective.** To study five types of acidification in the production of Oaxaca cheese and their effect on physicochemical, microbiological and sensory characteristics as well as processing times. **Method.** Five types of acidification were studied: 1) natural acidification of raw milk, 2) acidified and fresh raw milk mixture, 3) acidification of raw milk with acid whey, 4) pasteurization and direct acidification with citric acid, 5) pasteurization and addition of mesophilic lactic acid bacteria. Physicochemical, microbiological and sensory characteristics were evaluated on cheeses. During storage (4°C) pH, microbiology and proteolysis were evaluated on days 1, 8, 15 and 22. **Results.** The type of acidification did not affect the fat and protein content, but there were significant differences in moisture content and pH. The population of coliform bacteria (total and fecal) and mesophilic bacteria were high in cheeses where raw milk was used, while the populations of lactobacilli and streptococci were similar in all the cheeses. Consumers preferred the cheese obtained by direct acidification and with milk mixture (fresh and sour) but there were no significant differences among the five cheeses. During storage, a greater proteolysis was observed in cheeses made with raw milk. **Conclusion.** Production of Oaxaca cheese, which include milk pre-acidification help decrease processing time; however, that made from pasteurized milk has a longer shelf-life and no coliform bacteria.



1.15

EVALUACIÓN DE LA ACTIVIDAD INMUNOSUPRESORA DE DERIVADOS PROTEICOS DE *Mucuna pruriens* EN UN MODELO MURINO DE DIABETES MELLITUS TIPO 1

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Introducción. La Diabetes Mellitus tipo 1 (DM1) es una enfermedad autoinmune caracterizada por la destrucción de células beta del páncreas (C β P). En la inmunopatogénesis, los infiltrados linfoplasmositarios (ILP) y macrófagos (M Φ) activados son las primeras células en infiltrar los islotes de Langerhans y destruirlos, incrementando los niveles de glucosa, anticuerpos anti-insulina (IAA) e islotes pancreáticos (ICAb). La DM1 es tratada con insulina a múltiples dosis en combinación con ejercicio y alimentación saludable. Estudios *in vitro* en *M. pruriens*, demostraron que fracciones peptídicas presentaron actividad inmunosupresora en M Φ murinos los cuales son importantes para el desarrollo de la inmunopatogénesis de DM1. **Objetivo.** Evaluar el efecto inmunosupresor de derivados proteicos de *M. pruriens* en un modelo murino de DM1 inducido con Estreptozotocina (STZ). **Metodología.** Semillas de *M. pruriens* fueron molidas obteniéndose harina y un concentrado proteínico, el cual fue hidrolizado con pepsina-pancreatina. La fracción soluble se ultrafiltró obteniendo un hidrolizado proteico (HP) y cinco fracciones peptídicas (F >10 kDa, F 5-10 kDa, F 3-5 kDa, F 1-3 kDa y F < 1 kDa). Ratones Balb/C fueron administrados con HP y las fracciones peptídicas, por 14 días y posteriormente diabetizados con STZ (40mg/Kg) por 5 días. Se tomaron muestras de sangre los días 0, 15, 30 y 45. Se determinó la concentración de glucosa y anticuerpos IAA e ICAb. Los ratones fueron sacrificados siguiendo la norma NOM-062-200-1999 y se obtuvieron muestras de tejido pancreático los cuales fueron teñidos con hematoxilina y eosina (H&E). **Resultados.** Las F(3-5) y F(1-3) kDa tuvieron los mayores porcentajes de inhibición al día 45 tanto en glucosa, como en anticuerpos IAA e ICAb demostrando que a medida que las fracciones son más pequeñas, mayor es el porcentaje de inhibición. En cortes histológicos de páncreas las F(3-5) y F(1-3) kDa tuvieron los menores índices de daño, razón por la cual se encontró mayor inhibición de glucosa plasmática, y anticuerpos IAA e ICAb. **Conclusiones.** Resultados sugieren el efecto inmunosupresor de F (3-5) y F (1-3) de *M. pruriens*.



1.16

PREVALENCIA DEL VIRUS DE INMUNODEFICIENCIA HUMANA (VIH), EN PACIENTES QUE ASISTEN AL HOSPITAL DR. ROBERTO NETTEL FLORES, DEL ISSSTE, EN LA CIUDAD DE TAPACHULA, CHIAPAS, DURANTE EL 2017

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Introducción. El VIH/SIDA es una seria emergencia sanitaria mundial, que afecta a todas las regiones del mundo causando millones de defunciones. Hoy en día sabemos que el VIH/SIDA afecta a cualquier persona, sin importar su cultura, género, edad, situación económica, religión, tendencia política o grupo social. *Objetivo.* Conocer la Prevalencia del Virus de Inmunodeficiencia Humana (VIH), en pacientes que asisten al Hospital Dr. Roberto Nettel Flores, del ISSSTE, en la Ciudad de Tapachula, Chiapas durante el 2017. *Metodología.* el tipo de estudio fue, retrospectivo, transversal y descriptivo; la población de estudio fueron pacientes que asistieron a realizarse la búsqueda de anticuerpos contra el Virus de Inmunodeficiencia Humana (VIH) en el Hospital Dr. Roberto Nettel flores, ISSSTE; la técnica utilizada fue por determinación cualitativa del Virus de Inmunodeficiencia Humana (VIH Ac), en suero, plasma o sangre total humana por ensayo inmunocromatográfico. *Resultados.* de las 440 muestras de la población de estudio se encontró que 1 mujer (0.23%) y 6 hombres (1.36%) resultaron positivos, obteniendo una prevalencia del 1.59 %, 4 (0.85%) con edades comprendidas entre los 21 y 30 años y 3 (0.64%) en las edades de 31 a 40 años. *Conclusiones.* la prevalencia reactiva al virus de Inmunodeficiencia Humana en la población de estudio fue baja, siendo el grupo más afectado el de los hombres y adultos jóvenes.



1.17

PROPIEDADES ANTIMICROBIANAS DE *Moringa Oleifera*

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La *Moringa oleifera* es un árbol pequeño y de crecimiento acelerado que usualmente alcanza de 10-12 metros de altura, es originario del Himalaya, pero ha sido introducido en diferentes lugares de América. Las hojas, las flores, los frutos y las raíces son apreciados por su valor nutritivo. El uso de *Moringa oleifera* para el control de diversas infecciones provocadas por microorganismos es bien conocido, y en años recientes se han generado resultados científicos que confirman su actividad antimicrobiana. Debido a lo anterior el objetivo de esta investigación consiste en determinar la actividad antimicrobiana de extractos etanólicos de *Moringa oleifera*. Se seleccionó hojas de la planta de *Moringa oleifera*, fueron lavadas, secadas a 65 °C durante 25 minutos y posteriormente se molieron hasta obtener un tamaño uniforme, después se diluyó en etanol al 96%. Se dejó reposar por 15 días para después concentrarlos. La evaluación antimicrobiana del extracto se realizó usando el método estandarizado de disco, el cual consiste en medir el halo de inhibición, provocado en cultivos bacterianos después de 24 horas. El efecto antimicrobiano fue evaluado en cepas de *Echerichia coli*, *Enterococcus faecalis*, *Staphylococcus epidermidis* y *Staphylococcus aureus*. Se utilizaron extractos puros y con dos diluciones (1:10 y 1:100). Los cultivos fueron incubados durante 24 h a 35°C y posteriormente se midió el diámetro de inhibición. Se observó un halo de inhibición en las cepas que corresponden a *Enterococcus faecalis* (1.5cm) y *Staphylococcus epidermidis* (8mm). En todos los casos la inhibición fue causada por los extractos etanólicos puros, los extractos diluidos no tuvieron un efecto inhibitorio. En la cepa *Staphylococcus aureus* y *Echerichia coli*, no se observó inhibición, sin embargo, en otros estudios se ha reportado inhibición de extractos etanólicos obtenidos de las raíces de plantas de *Moringa oleifera*.



1.18

CALLOGÉNESIS A PARTIR DE SEGMENTOS NODALES DE *Brosimum alicastrum* EN PRESENCIA DE ÁCIDO NAFTALENCÉTICO Y 6-BENCILAMINOPURINA

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En la actualidad, *Brosimum alicastrum* se ha vuelto importante para la investigación científica y aplicada, debido a que sus semillas son una fuente de nutrientes que pueden ser utilizadas para elaborar derivados alimenticios, inclusive puede ser una alternativa que reemplace el exceso de consumo del *Zea mays* en el país. En el presente trabajo se llevó a cabo la evaluación de 6-bencilaminopurina y ácido naftalenacético con la finalidad de inducir la formación de callos a partir de segmentos nodales. Si se lograra la formación de callos bajo estas condiciones, podrán ser utilizados en un futuro para investigaciones relacionadas en el establecimiento de protocolos para propagar y obtener plantas idénticas, así como establecer líneas clonales con las características fenotípicas y genotípicas idénticas a la planta madre. En este estudio, se evaluaron 20 diferentes combinaciones de BAP (6-Bencilaminopurina) y ANA (Ácido Naftalenacético) utilizando el medio de cultivo MS publicado por Murashige y Skoog en 1962. Para el primer regulador de crecimiento se usaron concentraciones de 1, 1.5, 2.5, 5 y 7.5 mg/l; mientras que, para el otro, las concentraciones de 1, 1.5, 2.5 y 3 mg/l. A los 30 días, se logró determinar que de los 20 tratamientos evaluados, el único que indujo la formación de callos fue el de 2.5 mg/l de BAP y 3 mg/l de ANA. De acuerdo al resultado se concluye que para inducir el proceso de callogénesis de *Brosimum alicastrum* se requiere de determinadas concentraciones de tanto de 6 bencilaminopurina como de Ácido naftalenacético.



1.19

EFFECTO DE LA TIAMINA Y LA PIRIDOXINA EN LA FORMACIÓN DE RAÍCES DE BROTES DE *Stevia rebaudiana* MORITA II

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La *Stevia rebaudiana* Morita II es una planta de suma importancia en el área de la salud; sus hojas se pueden utilizar para el tratamiento de la diabetes y de la hipertensión. En el presente trabajo se evaluaron dos vitaminas, esto con la finalidad de conocer la función de cada una, en la formación y crecimiento de raíces de Morita II. El diseño experimental consistió en colocar brotes de *Stevia* en presencia de tiamina nombrado como T1, y en presencia de piridoxina nombrado como T2; en cada tratamiento se utilizó 8 réplicas y en cada una, se colocaron 4 brotes. Después de los 20 días se observó que la tiamina favoreció la formación de las raíces; así mismo, indujo la formación de un número de raíces de 6 a 7, en promedio. Mientras que aquellos brotes que estuvieron en presencia de la piridoxina formaron raíces de menor tamaño y con un número mucho menor a comparación de lo observado en el T1, con un promedio de 4 y 5; sin embargo, en este tratamiento cada una de las raíces formadas presentó pelos radiculares más alargados.



1.20

FORMACIÓN DE CALLOS DE *Stevia rebaudiana* MORITA II CON ALTO GRADO DE FRIABILIDAD EN PRESENCIA DE 6-BENCILAMINOPURINA Y ÁCIDO NAFTALENACÉTICO

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La *Stevia rebaudiana*, tanto la variedad Bertoni como la Morita II se utilizan para el tratamiento de la diabetes y de la hipertensión. Desafortunadamente la Morita II no cuenta con un protocolo para la producción masiva de plantas a partir de embriogénesis somática. Por este motivo el propósito del presente trabajo, fue la búsqueda de condiciones para inducir la formación de callos friables que permitan la aparición de embriones somáticos. En esta investigación se evaluó una matriz de 20 tratamientos, en cada uno se colocó un segmento de callo no friable. Se logró observar que al evaluar el BAP independientemente del ANA el aumento del tamaño de los callos fue de acuerdo al incremento de la concentración de este regulador (1.5 mg/L-2.5 mg/L), esta respuesta también fue similar cuando se evaluó el ácido naftalenacético de manera individual (1.5 mg/L-3 mg/L). Sin embargo, los callos en presencia de BAP o de ANA fueron poco friables. Mientras que cuando las diferentes concentraciones de BAP y ANA fueron combinadas, se observó que todos los tratamientos de estas combinaciones, favorecieron la formación de callos con un alto grado de friabilidad. De acuerdo a lo antes mencionado se concluye que la combinación de ambos reguladores de crecimiento es primordial para producir callos altamente friables y no así, si se utilizaran dichos reguladores de forma individual, al menos es lo que se observó en este trabajo de investigación.



1.21

EFFECTO DE LA TIAMINA Y EL ACIDO NICOTÍNICO EN LA FORMACIÓN DE RAÍCES DE BROTES DE *Stevia rebaudiana* MORITA II

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La *Stevia rebaudiana* Morita II se utiliza para el tratamiento de la diabetes, de la hipertensión y para el tratamiento de la caries dental. En el presente trabajo se evaluaron dos vitaminas, con el propósito de saber la importancia que puedan tener en la formación y crecimiento de raíces de Morita II. Para la evaluación se colocaron brotes de *Stevia* en presencia de tiamina nombrado como T1, y en presencia de Acido nicotínico nombrado como T2; en cada tratamiento se usó 8 réplicas y en cada una, se colocaron 4 brotes. Después de los 20 días se observó que la tiamina indujo la formación de un número de raíces de 6 a 7, en promedio. Mientras que aquellos brotes que estuvieron en presencia del Ácido nicotínico formaron raíces de menor tamaño y más delgado, con un promedio de 2 a 3.



1.22

CHEMICAL COMPOSITION AND ANTIOXIDANT ACTIVITY OF PROPOLIS ETHANOLIC EXTRACT FROM MEXICAN SOUTHEASTERN

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Propolis, a honeybee product, has come popular as a food and alternative medicine. Its constituents have been shown to exert pharmacological effects and antioxidant activity. Chemical composition, antioxidant activity *in vitro* of three propolis ethanolic extract (PEE) from Maxcanu, Tizimin and Huhi, Yucatan in the Mexican Southeastern were determined. The PEE studied in this research contained significant amount of phenols and total flavonoids. Phenols and total flavonoids content ranged between 1.270 ± 0.028 and 19.530 ± 0.483 mg equivalent of Gallic acid/g of PEE and 62.812 ± 2.397 and 83.604 ± 2.397 mg equivalent of catechine/g of dry extract, respectively. Due Propolis contains high concentrations of polyphenols and flavonoids, the Mexican Southeastern propolis exhibit high 1,1-diphenyl-2-picrylhydrazyl (DPPH) and 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid (ABTS^{•+}) radical-scavenging activity and reducing power of Fe (III). The most active ethanolic extract was the Huhi sample, which showed the highest evaluated values techniques with higher power as determined by the assay values of $67.32 \pm 2.76\%$ of radical scavenging DPPH, 64.29 ± 29 mM TEAC/g of ethanolic extract and $19.99 \pm 1.06\%$ of reducing power inhibition respectively. Despite differences in composition, the PEE samples of Yucatan exhibited significant antioxidant activity. Finally, given non-toxic and natural origin of PEE, is that, besides their potential pharmaceutical and nutraceutical value, propolis of three vegetation types from Mexican Southeastern are attractive candidates as natural antioxidant.



Sesión 2.
Revalorización de Cultivos
Latinoamericanos
Presentaciones Orales



2.1

SEGURIDAD ALIMENTARIA Y BIODIVERSIDAD: NECESIDAD DE RECUPERAR CULTIVOS LATINOAMERICANOS

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2.2

MICROENCAPSULATION OF SACHA INCHI OIL, *Plukenetia huayllabambana* WITH THE EXTRACT ANTIOXIDANT FROM CAMU CAMU (*Myrciaria dubia* (H.B.K.) Mc.Vaugh) FRUIT SKIN BY SPRAY DRYING

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In the Peruvian Amazon, there is Sacha Inchi seed (*Plukenetia huayllabambana*). It has a high concentration of unsaturated fatty acids (approximately 90%), with high content of ω 3 fatty acids (60% α -linolenic acid (Ln), along with a particular sterol composition (stigmasterol>campesterol), and high amounts of γ - and δ -tocopherols. However, the major problem with these compounds lies in oxidation during storage or food processing, which can lead to the rancidity and defective nutrition. The pulp of the Camu camu fruit is rich in ascorbic acid and antioxidants, and they were obtained from the communities of *Chingana*, *Bagazan*, *Flor de Castaña* and *Sapuenta*, from the region of Loreto-Peru. The aim of this work was to microencapsular Sacha Inchi oil with the extract antioxidant from Camu Camu fruit skin by spray drying. The microcapsules obtained with different wall materials, presented a high encapsulation efficiency (from 72 to 95%) a high inhibition percentage (39-81%), smooth and concave surface with size polydispersity and an increase in the oxidative stability of the encapsulated compounds was also observed. With the microcapsules obtained, functional foods are being developed with fruits, chia and quinoa. This research is part of the project 020-2015-PNIA/UPMSI/IE "Microencapsulation of Sacha inchi (*P. volubilis* and *P. huayllabambana*) oils and antioxidants of the Peruvian biodiversity. Contribution for the development of functional foods containing omega 3 to prevent non communicable diseases" - National Program of Agricultural Innovation (PNIA) and Lima University-Peru.



2.3

EFFECT OF STEEPING CONDITIONS ON QUINOA STARCH ISOLATION BY WET MILLING

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The primary sources of carbohydrates for the global population are cereals and pseudocereals. Pseudocereals are essentially starch crops; however, they may contain significant quantities of protein and oil, and these constituents frequently determine their suitability for a specific end use. Cereal starches play an important role in the food and non-food industries for their low cost, availability and ability to impart a wide range of techno-functional properties.

The main objective of this research was to isolate starch, germ, proteins and fiber components from quinoa by wet milling procedure. It was investigated the effect of steeping time and temperature on starch recovery and its quality.

The quinoa steeping conditions as the time (1, 5 and 9 hours) and temperature (30, 40 and 50°C) in SO₂ solution with lactic acid have been investigated using a factorial design 3² in order to optimize the starch separation/quality. The effect of steeping conditions on starch was evaluated in terms whiteness, protein, lipid, amylase and damage starch contents, as well as, the thermal and pasting properties.

Results showed how the different steeping times and temperature affected the fraction yields and starch recovery/quality. The optimization wet-milling process used in this study caused a highest starch recovery level and better starch quality after 6.5 hours of steeping at 30°C. Experimental values were close to the predicted ones, with an error below 2% for all tested attributes.

The quinoa wet-milling process resulted to be as a potential procedure to obtain different valuable components of quinoa grains. The factorial design showed that the variables steeping time and temperature significantly affect, increasing or decreasing their values depending on the parameter analyzed.

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2.4

APLICACIONES TERAPÉUTICAS DE FRACCIONES PEPTÍDICAS: EL CASO DE LA LEGUMINOSA *Mucuna pruriens*

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Las Enfermedades Crónico No Transmisibles (ECNT) son aquellas enfermedades que no se transmiten de persona a persona, son de larga duración y por lo general evolucionan lentamente. Algunos datos y cifras de la Organización Mundial de la Salud (OMS) ponen de manifiesto que, las ECNT matan actualmente a más de 36 millones de personas cada año. Al respecto, se ha enfatizado la importancia que tiene el consumo de alimentos funcionales en la salud, ya que estudios epidemiológicos han demostrado que existe una buena relación entre la dieta de las personas y la baja incidencia de enfermedades. Hoy en día, existen fórmulas nutrimentales enriquecidas con péptidos resistentes a la digestión y, que además presentan actividades biológicas beneficiosas para la salud; pero el tipo y la cantidad de éstos dependen de la fuente proteica utilizada, así como del grado y tipo de hidrólisis empleado. México tiene una amplia biodiversidad de plantas y alimentos incluyendo granos de leguminosas, que pueden ser factibles de emplear como materia prima para la generación de biopéptidos encontrando las condiciones adecuadas para ello. Tal es el caso de *M. pruriens* la cual, por su contenido de proteína representa una fuente poco convencional y alternativa de péptidos con actividad biológica. Así, el presente tiene como objetivo proponer a los péptidos de *M. pruriens* como potenciales nutraceuticos e ingredientes funcionales, como alternativa dietoterapéutica de la ECNT. Por lo anterior, se presenta el potencial antihipertensivo, antioxidante, antitrombótico, hipocolesterolémico, hipoglucemiante e hipolipemiante de derivados proteínicos obtenidos por hidrólisis enzimática del concentrado proteínico de frijol terciopelo (*Mucuna pruriens*), bajo un enfoque dietoterapéutico en pro de la prevención y tratamiento de las enfermedades del siglo XXI, las ECNT.



2.5

***IN VIVO* ANTI-INFLAMMATORY ACTIVITY OF A PROTEIN DERIVATIVE ISOLATED FROM *Salvia hispanica* L. SEEDS**

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Introduction. Inflammation has been defined as an immune response triggered during an infection or injury. Several types of drugs are used for the treatment of inflammatory disorders, but they present side effects and high cost. The scientific community has found in natural products a source of anti-inflammatory agents. Among these natural products is *Salvia hispanica* L. (chia), whose seeds are a source of proteins and peptides with biological activity.

Objective. The objective of this study was to determine the *in vivo* anti-inflammatory properties of a protein derivative isolated from *S. hispanica* L. seeds.

Methodology. Protein isolate were produced by an alkaline extraction and acid precipitation method. Moisture and protein content was determined. Protein hydrolysate was done using Pepsin[®]-Pancreatin[®] system and degree of hydrolysis was determined. An ultrafiltration step was performed, obtaining the >10, 5-10, 3-5, 1-3 and <1 kDa peptide fractions. The 1-3 kDa fraction exhibited the highest activity on previous *in vitro* studies and was selected for its evaluation on *in vivo* models.

Results. The protein isolate presented moisture content of 7.84% and protein content of 90.29% (dry basis). The protein hydrolysate showed a hydrolysis degree of 38.31%, classifying it as an extensive hydrolysate. The 1-3 kDa fraction exhibited inhibitory effects on TPA-induced ear edema and DNFB-induced delayed hypersensitivity assay.

Conclusions. The results support the fact that *S. hispanica* L. is a good natural resource for obtaining extensive protein hydrolysates and a potential source of bioactive peptides. Also, the 1-3 kDa fraction demonstrated significant effects on the inflammatory assays.



2.6

BIOACTIVE COMPOUNDS IN MEXICAN FINE FLAVOR COCOA

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Fresh cocoa beans contain methylxanthines (around 4%). Theobromine (3,7-dimethylxanthine) is the main cocoa alkaloid (2 to 3%). Caffeine (1,3,7-trimethylxanthine) is found only in small amounts (0.1-0.8%), and theophylline (1,3-dimethylxanthine) and teacrine (1,3,7,9- tetramethyluric acid) as traces. Caffeine and theobromine belong to a group of bioactive compounds that provide health benefits and influence the quality and sensory profile of cocoa. The amount, proportion and behavior of methylxanthines vary by genetic, environmental and, by postharvest processes. The objective of this work was to study the effect of fermentation and drying on the content of caffeine and theobromine in fresh, fermented and dried cocoa beans from two types of Fine Flavour Cocoa from Chiapas, Mexico. Harvested healthy and physiologically mature pods of cacao (*Theobroma cacao*) criollo: type Rojo Samuel, and, Trinitario: type Regalo de Dios; immediately opened and shelled. The cocoa beans were fermented for five days. Then, they were dried in the sun until reaching a humidity of 7%. From the harvest until the end of drying, samples were taken for the determination of caffeine and theobromine. The determination of the methylxanthines was carried out by the official method 980.14 of the AOAC (1990) by high performance liquid chromatography (HPLC). Statistical analyses were performed using STATGRAPHICS Centurion XV.II. For calculations of statistical significance, two-sided testing was used and $p < 0.05$ was considered as significant. One-factor analysis of variance (ANOVA) was applied for data comparison between groups and the Tukey post-hoc test was applied to determine the relationships between the groups. For Rojo Samuel, the caffeine and theobromine content were 1.51 and 19.27 mg/g of fresh cocoa, 0.79 and 11.53 mg/g at the end of fermentation and 1.71 and 17.86 mg/g of dry cocoa. In the case of the Regalo de Dios, the content of caffeine and theobromine was 2.92 and 18.89 mg/g of fresh cocoa, 6.09 and 21.29 mg/g at the end of the fermentation and, 4.06 and 14.89 mg/g at the end of drying. In conclusion, the cocoa bean samples investigated showed different quantification of healthy substances as theobromine and caffeine. These substances should be considered by industries that produce food supplements and nutraceuticals.



2.7

***In silico* CHARACTERIZATION OF THE POTENTIAL OF COCOA PROTEIN AS SOURCE OF BIOACTIVE PEPTIDES AGAINST MOLECULAR TARGETS RELATED TO OBESITY**

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Introduction. Obesity in Mexico is a serious public health problem due to its association with chronic non-communicable diseases. Cocoa is a traditional Mexican fruit, rich in bioactive compounds with health benefits. The food proteins play an important role in metabolic regulation. Considering the boom of bioactive proteins and peptides, it is relevant to evaluate the effect of cocoa proteins (CP) on the inhibition of molecular targets associated to obesity.

Methodology. The CP sequences were obtained from UniProt database. The potential biological activity of the proteins was predicted using BIOPEP database. *In silico* digestion of 21kDa albumin and globular vacillin proteins was performed using PeptideCutter. The crystalline structures of seven molecular targets related to lipid metabolism were downloaded from Protein Data Bank.

Results. Cocoa albumin had a higher probability of DPP-IV inhibitor with an occurrence frequency of 0.62. Globulins showed higher antioxidant potential of 0.1 and ACE inhibition with 0.39 frequency of occurrence. During *in silico* digestion 71 peptides were generated. The sequence CSTSTV from the albumins, has higher coupling to HMG-CoA reductase with -8.8 (kcal/mol), even greater than the statin Lovastatin with -7.2 (kcal/mol). The sequence AISQQATSPR of vicilin showed better affinity to the enzyme acetyl-CoA carboxylase than the Soraphen A with -8.5 and -8.0 respectively.

Conclusion. CP possesses peptides with biological potential against diabetes and hypertension. The peptide sequences showed potential to interact with molecular targets involved in the synthesis of fatty acids and the rate-limiting for cholesterol synthesis.



Sesión 2.
Revalorización de Cultivos
Latinoamericanos
Presentaciones en Póster



2.8

DEVELOPMENT OF BREAD WITH HIGH TECHNOLOGICAL AND NUTRITIONAL QUALITY BASED ON THE INCLUSION OF WHOLE AMARANTH FLOUR

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In the present study, was investigated the effect of replacing wheat flour by whole amaranth flour of the pseudocereals *Amaranthus spinosus* (AS) and *Amaranthus hypochondriacus* (AH) grains in order to evaluate its potential as a bread-making ingredient. Different amaranth flour levels (0, 25 and 50%) were used in bread dough preparation. The quality of the final products was analyzed by the loaf specific volume, width/height ratio of the central slice, crust and crumb color, crumb structure and firmness, sensorial analysis, and nutritional parameters. Thermal properties were recorded in DSC; they were the enthalpies of gelatinization and amylopectin retrogradation. The loaf specific volume was significantly decreased when compared with the control sample, therefore a significant increase of the crumb firmness was observed with amaranth inclusion. There was a statistically significant increase in protein, dietary fibre, and ash contents with a decrease of the acceptability of consumers. Nevertheless, the bread with AH flour showed higher acceptability than bread made with AS flour. The inclusion of amaranth into bread formulation allowed positive changes in the starch thermal properties delaying and decreasing the amylopectin retrogradation.

The whole amaranth flour could make possible the wheat flour replacement in formulations of bread increasing the product nutritious value with the slight depreciation of bread quality when wheat flour is replaced at 25% of substitution.

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2.9

DEVELOPMENT OF A BREAD PRODUCT ADDITIONED WITH SEED FLOUR OF *Brosimum alicastrum* Sw. (ramón) FOR THE ELDERLY PEOPLE

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Elderly population has increased worldwide and with it a frequent condition such as sarcopenia. One strategy to prevent or delay this condition is the consumption of nutritive foods, rich in protein. The seed of *Brosimum alicastrum* Sw. (ramón) has nutritional properties of interest. The aim of this study was to develop a bread product added with ramón seed flour (RF) for the prevention and / or control of sarcopenia in elderly people (EP). A food was developed according to HACCP principles. Linking for product was evaluated by acceptance test in 120 EP consumers (9-point hedonic scale). Physicochemical characteristics (AOAC methods), total phenols (Folin-Ciocalteu method), total flavonoids (AlCl₃ method), identification of phenolic compounds (PFC) (HPLC-QTOF method) and the antioxidant capacity (AC) (FRAP, ABTS and DPPH methods) were evaluated in RF and the final product. The RF showed high content of protein, dietary fiber, copper, potassium and iron. The RF had higher CPF content and AC (ABTS method) 48 times higher than commercial wheat flour. The food for EP was a muffin additioned with RF (43% from flours), with 27% less calories, 3.4 times more protein, 4 times more dietary fiber, 5 times less carbohydrates and reduced sugars content compared to a similar commercial product. The bread product was accepted by consumer and this food is gluten-free, lactose-free and low sugars content. This new product has nutritive properties suitable for special feeding of EP.



2.10

STUDY OF HIGH QUALITY MEXICAN CACAO VOLATILE COMPOUNDS DURING SPONTANEOUS FERMENTATION

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Introduction. Mexico is the center cacao domestication and the origin of chocolate. Criollo and Trinitario cacao beans are utilized in the production of Fine Flavour Cocoa because of the unique aromatic notes that are generated during the fermentation process.

Objective. The aim of this study was to identify and evaluate the different volatile compounds produced during fermentation process of high quality Mexican cacao: Criollo and Trinitario, from the Soconusco region in Chiapas, Mexico.

Methods. For the fermentation phase, healthy and physiologically mature fruits of the Criollo and Trinitario varieties were harvested randomly. Cacao beans were transferred to a fermentation box and covered with banana leaves. Volatile compounds were determinate using SPME-HS/GC-MS. PCA statistical analysis and ANOVA was applicated for the results.

Results and conclusion. 50 and 40 volatile compounds were identified by SPME-HS/GC-MS, for Criollo and Trinitario beans, respectively; some of these compounds have been reported to produce the desirable notes and off-flavor. The relations between volatile compound and varieties and time fermentation and drying days were associated with evolution of these compounds using the principal component analysis (PCA). Acetic, propanoic and 2-methylbutanoic acid; tetramethylpyrazine, 2-propenoic acid, 3-phenyl-methyl ester, 3-ethylbenzaldehyde, phenylethyl alcohol and mequinol were the compounds with the highest levels at drying.



2.11

DEVELOPMENT OF NEW STARCH FORMULATIONS FOR INCLUSION IN THE DIETOTHERAPEUTIC TREATMENT OF GLYCOGEN STORAGE DISEASE

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The Glycogen storage disease (GSD) is a group of metabolic diseases characterized by a disorder in glycogen metabolism. Among the different types, the presence of hypoglycemia is characteristic of GSD type I and type III. Both types are treated with crude corn starch preparations which usually have associated gastrointestinal problems. In this study, formulations of different sources of starch were developed to obtain an alternative to commercial corn starch. Different thermal treatments were applied taking in account the starch thermal (DSC) and pasting properties (RVA) and chia flour was added in order to obtain a more progressive glucose release by the action of the mucilage present in this seed. This study evaluated the different starches on *in vitro* kinetics of starch hydrolysis for simulation of the digestion. The starches studied were from corn, potato, rice, quinoa and wheat. The results were compared with a reference sample of white bread. Raw quinoa resulted in a progressive glucose release compared to the other raw starches. This gradual release could increase the effect time of the starch hydrolysis as well as reduce the dose decreasing the intestinal adverse effects. Furthermore, the addition of chia flour reduced by 20% corn starch glucose index. These results obtained *in vitro* should be confirmed by *in vivo* tests.

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2.12

EVALUATION OF THE CYTOTOXIC AND ANTIPROLIFERATIVE ACTIVITY OF CHIA SEED OIL (*Salvia hispanica* L.) IN BREAST, COLON AND PROSTATE CANCER CELLS (PROTOCOL)

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Cancer is one of the main public health problems worldwide and represents the third leading cause of death in Mexico. The medical treatment of cancer does not offer a cure and has a large number of side effects. On the other hand, a large and growing number of *in vitro*, *in vivo* and clinical studies have demonstrated the anticancer potential of omega 3 fatty acids, through the regulation of inflammatory processes, division, growth, differentiation and cell death. In turn, chia seeds oil is an important source of omega 3 fatty acids whose anticancer potential has not been widely evaluated. The aim of the study is to evaluate the cytotoxic and antiproliferative potential of Chia seed oil (*Salvia hispanica* L.) in three different cancer cell lines. The seeds of *Salvia hispanica* obtained from producers of the state of Yucatan will be processed, for the extraction of its oil, the latter will be hydrolyzed to obtain its free fatty acids using the chemical method of hydrolysis with KOH-ethanol. The free fatty acid profile of the hydrolyzate of the oil will be determined by gas chromatography. Lastly, the cytotoxic and antiproliferative activity of the hydrolyzed oil of *Salvia hispanica* L. will be determined in breast cancer cell lines MCF-7 (ATCC: HTB-22), colon CaCo-2 (ATCC: HTB-37) and prostate PC3 (ATCC: CLR-1435), through the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-tetrazolium bromide (MTT) bioassay. The results will contribute to the promotion of chia seeds or their oil as a potentially anticancer food, as well as to promote further *in vivo* and clinical studies.



2.13

ANTI-INFLAMMATORY EFFECTS OF PROTEIN DERIVATIVES ISOLATED FROM *Salvia hispanica* L. SEEDS

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Introduction. The inflammatory process is universally associated with diabetes, cancer and other inflammatory diseases, whose treatment involves a wide range of drugs. Nevertheless, these drugs have demonstrated side effects and high cost. Then, research groups have searched the plants for molecules with potential anti-inflammatory activity. *Salvia hispanica* L. (chia) is one of these plants, which are a functional food whose seeds have been shown to contain a high amount of proteins and peptides.

Objective. The objective of this study was to evaluate the anti-inflammatory effect of the protein hydrolysate and the peptide fractions from *S. hispanica* L. seeds.

Methodology. The seeds were processed for the preparation of a protein isolate. The protein hydrolysate was obtained and was submitted to ultrafiltration process, obtaining peptide fractions (>10, 5-10, 3-5, 1-3 and <1 kDa). The cytotoxic effect and *in vitro* anti-inflammatory activity of protein derivatives was evaluated on macrophages isolated from BALB/c mice. The 1-3 kDa fraction was choose for evaluation on *in vivo* models of carrageenan-induced paw edema, TPA-induced ear edema and DNFB-induced delayed hypersensitivity.

Results. The protein derivatives did not show significant cytotoxic effects, but they caused a decrease in the NO, H₂O₂, IL-1 β , IL-6 and TNF- α production, while an increase in the release of IL-10 was observed. Finally, the 1-3 kDa fraction showed significant inhibitory effects on ear edema and induced-edema on delayed hypersensitivity assay.

Conclusions. The results demonstrated that protein derivatives from *S. hispanica* L. present anti-inflammatory effects at the evaluated concentrations, highlighting the effect of 1-3 kDa fraction.



2.14

***Salvia hispanica* L PROVIDES IMMUNONUTRITIONAL AGONISTS EFFECTIVE TO INFLUENCE THE NEUROIMMUNE AXIS**

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Introduction. Neurobehavioral functions as well as effector functions of immune cells are inextricably linked to lipid homeostasis. A growing body of evidence suggests that hypothalamic neurons, via accumulation of fatty acids (FA) or FA metabolites, may signal nutritional sufficiency, particularly aberrations in lipid homeostasis, in metabolic disorders such as obesity and type 2 diabetes mellitus, risk causes for hepatocarcinoma (HCC) development.

Objectives. The present work tested a role for an immunometabolically active fraction obtained from *Salvia hispanica* L to influence the neuro-immune axis in a preclinical HCC model fed with high fat diet (42%).

Methods. 6 weeks old C57BL/6 mice were treated with diethylnitrosamine (20 mg/kg twice per week, 2 weeks) and thioacetamide (10 mg/kg three times per week, 8 weeks) to induce the non-metastatic HCC. These animals were fed with immunonutritional TLR4 agonists (5 mg/kg three times per week, 8 weeks) from *Salvia hispanica* L.

Results. Oral administration of serine-type protease inhibitors (SETIs) from *S. hispanica* L significantly reduced food intake and body weight in mice. Intestinal innate immunity stimulation shaped gut microbiota favoring increased numbers of beneficial *Bifidobacterium* spp and *Lactobacillus* spp. Hepatic GM-CSF production was increased together with brain proportions of M1/M2 macrophages to a favorable ratio promoting tissue repair and improvement of the functional activity.

Conclusions. Administration of SETIs from *S. hispanica* L could be effective increasing microglial activation to ameliorate sub-acute phases of brain injury caused by hepatic metabolic dysfunction in HCC.

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2.15

EVALUATION OF THE BIOLOGICAL POTENTIAL OF TOASTS FORMULATED WITH *Salvia hispanica*. A PROTOTYPE OF FUNCTIONAL FOOD

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The non-communicable diseases kill over than 71% people every day, the factors that can increase these risks are oxidative stress and the glucose high level in blood. The consumption of fiber, protein and omega-3 on the diet can be improve the health; in this sense, the chia seeds have a high biological activity due to fiber, protein and omega-3 fatty acids content that is capable to health care. The aim of present work was to evaluate the biological activity *in vitro* of toasts formulatated with chia (*Salvia hispanica*) degummed and non-degummed, as a potential functional food. Therefore, the dough was elaborated with nixtamalized corn flour, water and salt as a control; to incorporate the chia degummed and non-degummed, the corn flour was replaced with 10 and 20% of chia, then the dough was molded and baked at 170 °C for 20 min. The antioxidant activity (DPPH and ABTS), antidiabetic activity (α -amylase) and angiotensin converting enzyme inhibitory activity (ACE) was studied. The radical DPPH inhibition was 85.12–91.55% for 20% chia degummed and control, respectively; Trolox equivalent was 1.02–1.74 μ g/mL that represent among 30.17–50.00% radical ABTS inhibition for control and 20% chia degummed, respectively; α -amylase inhibition was 18.34–28.28% for 10 and 20% chia degummed, respectively; the ECA inhibition was 44.78 – 69.74%. The study showed that the toasts substituted with chia had higher biological activity than control; due to this, toasts substituted with chia can be considered as an alternative in the prevention of non-communicable diseases.

Keywords: chia oil, omega-3, functional food, nutritional value



2.16

EVALUATION OF NUTRITIONAL VALUE OF CORN TOASTS FORMULATED WITH *Salvia hispanica*

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The cardiovascular diseases represent more than 31% of globally deaths and, the blood cholesterol plays an important role in the pathology of disease. The consumption of fiber and omega-3 can to reduce the cholesterol levels. Chia (*S. hispanica*) is a vegetable source of omega-3, fiber and protein; due to this, chia can be used to formulate functional foods. The aim of the present study was to evaluate the nutritional value of corn toasts elaborated with chia flour as a prototype of functional food. Two products were made substituting corn flour by 10 and 20% non-degummed chia (NDG10 and NDG20). Two products were made also substituting corn flour by 10 and 20% of degummed chia (DG10 and NDG20). Products without chia were used as control. The humidity, protein, fat, ash, fiber, the nitrogen-free extract (NEF), as well as the α -linoleic content were determined. The humidity was in a range of 1.92-2.94% for DG20 and NDG10, respectively; the protein was between 8.40–10.83% for the control and DG20, respectively; fat was from 2.47 to 8.15% for the control and DG20, respectively; fiber was in a range of 2.25–6.74% for the control and DG20, respectively; ash content was from 3.25 to 3.59% for control and NDG10, respectively; the NFE was 69.88–80.70% for the NDG20 and control, respectively. The α -linolenic was no detected in the control while in the sample incorporated with chia were more than 36.28%. In conclusion, toasts with chia had higher nutritional value than control, so it can be considered as a potential functional food.



Sesión 3.

*Investigación, Desarrollo e Innovación
en Chía*

Presentaciones Orales



3.1

NEUROPROTECTIVE EFFECTS OF CHIA PROTEIN HYDROLYSATES

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Introduction. Recent studies have shown that Chia (*Salvia hispanica* L.) extensive hydrolysates contains a high concentration of bioactive peptides with wide functions such as antihypertensive and inhibitory of cholesterol synthesis. On the other hand, *in vitro* studies with cells and *in vivo* with animals indicate that food protein peptides are safe, without any deleterious side effects and are well recognized for their potential as anti-inflammatory agents. Chronic neuroinflammation is characterized by prolonged activation of central nervous system-resident macrophages, the microglia, and subsequent sustained release of pro-inflammatory mediators.

Objectives. The present study demonstrates that Chia protein hydrolysates (CPHs) contain peptides with anti-neuroinflammatory activity and therefore it could prevent the onset of neurodegenerative diseases such as Alzheimer's, Parkinson's, or multiple sclerosis.

Methods. Viability studies with MTT, gene expression and protein release by RT-qPCR and ELISA, respectively, were analyzed in BV-2 cells after 24 hours of treatment with CPHs at 50-100 µg/mL.

Result & Conclusion. In BV2 microglia cells, the incubation of CHPs for 24 h showed anti-inflammatory activity on cells, down-regulating pro-inflammatory genes expression (TNF-α, IL-1β, IL-6) and up-regulating the expression of anti-inflammatory cytokines such as IL-10. These results were corroborated by the levels of proteins determined by ELISA procedures. These exciting findings open opportunities for developing nutraceutical strategies with CHPs to prevent development and progression of neuroinflammation-related diseases.



3.2

NUTRACEUTICAL EFFECTS BY PEPTIDES AND METABOLOMIC SIGNATURES FROM DIFFERENT CHIA CULTIVARS—THE GOLDEN CROP OF THE 21ST CENTURY

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Chia is an annual plant of the Lamminae family which grows in semiarid climates¹. Nowadays, chia popularity has been increasing due to its several nutraceutical compounds such as polyunsaturated fatty acids, phenolic compounds and bioactive peptides encrypted in proteins^{1,2,3}. The main protein fractions are globulins, followed by albumins, glutelins and prolamins^{2,3}. Many studies have focused to obtain peptides with biological functions against important diseases in human health. Angiotensin I-converting enzyme (ACE) plays an important physiological role in the regulation of blood pressure and control of hypertension; treatments are based on the inhibition of this enzyme. Proteins of chia seeds are well-known precursors of a range of biologically active peptides which have been used by other researchers to block the activity of ACE⁴. Phenolic compounds from chia seeds possess excellent antioxidant capacity^{5,6}. The aim of this research was to fractionate protein fractions, evaluate the inhibitory activity of peptides against ACE, and describe the metabolic phenotyping variation of phytochemicals of cultivars grown in different geographical area, which were analyzed by mass spectrometry. Protein fractions revealed differences in SDS-PAGE, and were similar between cultivars. Peptides confronted against ACE enzyme showed that globulin and albumin peptides inhibit in a similar manner the ACE; these functions were corroborated by sequentiation. Phytochemical compounds showed differences between chia cultivars and polyphenol contents. These results show that chia peptides could be a good alternative for the treatment of hypertension and their metabolites may be considered functional ingredients with a high antioxidant potential in foods with remarkable benefits for human health.

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3.3

REDUCTION OF CARDIOVASCULAR RISK MARKERS IN PATIENTS WITH TYPE 2 DIABETES AFTER INTAKE OF HEALTHY SNACK WITH FLOUR OF *Salvia hispanica* L: A DOUBLE-BLIND RANDOMIZED CONTROLLED TRIAL

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Introduction: Type 2 diabetes mellitus (T2DM), or non-insulin dependent diabetes, is a complex disease characterized by the alteration of oxido-reductive and proinflammatory mechanisms, which leads to disorders in the insulin receptor and consequent chronic hyperglycemia. To represents an important public health problem worldwide. The nutrition perform a crucial role in prevention cardiovascular risk factors of T2DM. Chia seed (*S. hispanica* L) is an oil whose composition of omega 3 (21 g / 100 g) and dietary fiber (41.2 g / 100 g), makes it a potential food in the treatment of the T2DM.

Objective: Evaluate the effect of the consumption of *snacks* added with chia flour (*S. hispanica* L) on cardiovascular risk markers in patients with type 2 diabetes.

Subjects and methods: Double-blind randomized controlled trial in persons with T2DM of 25 to 50 years of age, without the presence of complications. The persons was distributed in two groups (control and treatment), those who consumed a *snack* made from wheat flour and flour of *S. hispanica* L 10%, respectively. For 4 weeks samples were obtained of cardiovascular risk markers. All patients signed a letter informed consent.

Results. After 4 weeks, the treatment group showed a decrease in the levels of glucose, blood pressure and percentage fat, significant with respect control group. Not difference significant in neck and waist circumference, between groups.

Conclusions. The consumption of healthy snacks added with flour chia is an option in the T2DM treatment.



3.4

DEVELOPMENT OF A POTATO-AMARANTH-CHIA SPREAD FERMENTED FOOD

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Introduction. Research on vegetable fermented foods, selection of adequate matrices as vehicles for beneficial bacteria delivery and validation of their positive sensorial, technological and nutritional features are of great interest for the functional foods industry.

Objectives. The aim of the current study was to evaluate the incorporation of chia flour seeds in a potato-amaranth spread fermented product in terms of bacterial growth, nutritional, structural and textural improvement.

Methodology. A spread product was formulated with: Andean potato, amaranth flour, chia flour, sunflower oil, water, salt and cheese flavoring by high shear emulsification. A control without chia was studied. They were fermented for 8 h with log 6 CFU/g of *Lactobacillus sakei* CRL 2210, a folate producer strain. Samples were taken after fermentation and kept 28 days in cold storage. Determinations of microbial counts, acidity, folate content, fatty acids distribution, texture, viscosity and a sensorial analysis were performed.

Results. In both matrices –product and control- strain concentrations were log 8 CFU/g after 8 h fermentation and were maintained for 28 days. Fermentation did not produce changes in texture and viscosity throughout cold storage. Chia flour incorporation improved folate production, fatty acids profile, texture and viscosity compared with control without chia. Control reached significantly higher acceptability scores, related with color and taste preferences.

Conclusions. In conclusion, even though chia addition enhanced technological and nutritional features of the spread product, the sensorial profile is a commercial disadvantage that must be upgraded.



3.5

PRODUCTION SYSTEMS OF CHIA IN MEXICO

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Chia (*Salvia Hispanica* L.) is a native crop of Mesoamerica and was one of the staple foods of various Central America populations. In the last years, it has gained a great attention due to the high content of Ω -3 fatty acids, which have outstanding health benefits, becoming an important crop in Mexico. The objective of this study was to evaluate the production systems used in Mexico for the cultivation of chia. Based on field information, bibliography and own experience, the different production systems are described. The most important production regions in Mexico are the State of Jalisco where "Pinta" variety is grown, and the State of Puebla with a small cultivated area, where the "Black" variety is used. In Mexico, the cultivation of chia is mainly seasonal by using industrial machinery for sowing and farming; although, there are also areas where traditional systems are still used. Most of the crops are cultivated using conventional methods and only small fields are organic. There are areas of Mexico where some semidomesticated varieties are grown with similar characteristics to the wild crops. It can be concluded that chia cultivated in Mexico is mainly seasonal, the most important variety is "Pinta", and the main production system is the conventional. It is worth to mention that a technological package has been elaborated for the cultivation of chia in most of the growing areas of Mexico.



3.6

INFLUENCE OF CHIA OIL IN PHYSICOCHEMICAL AND SENSORIAL PROPERTIES OF MUFFINS

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Introduction: Nowadays the fat profile in foods has a great impact on the cardiovascular health. Therefore, there is an increasing interest for reformulating traditional foodstuffs rich in fats, such as muffins, using new components with a better composition in lipids. Among the different possibilities found in the market, the chia in their different formats (seeds, flour, oil...) may contribute to improve nutrient profile of these products.

Objectives: The aim of this study was to assess how total or partial replacement of sunflower oil by chia oil (100, 75, 50 and 25%) would affect the technological characteristics of muffins.

Methodology: For that, height during baking was recorded in order to model this stage. Besides, optical, mechanical and sensorial properties were measured to compare the differences with a muffin prepared with sunflower oil.

Results: Height evolution during baking was fitted to a Gompertz model, showing a decrease in final height when chia oil was used. In terms of color, the main changes took place in the surface of muffins where luminosity and b* coordinate were lower when chia oil was used. Levels of sunflower replacements higher than 50% decreased the hardness and cohesiveness of muffins. The tasting panel gave the highest scores to control muffins, since they preferred their color and flavor, but even though values in the hedonic scale were higher than 5.5 in all cases.

Conclusions: Up to 50% of chia oil may be used in muffins to improve their lipidic profile. However, further studies should be performed in order to compensate the changes in external color.



3.7

MATRICES POLIMÉRICAS MIXTAS: MUCÍLAGO DE *Salvia hispanica* COMO ENCAPSULANTE DE COMPUESTOS BIOACTIVOS

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La incorporación de ingredientes funcionales a sistemas alimentarios y el procesamiento de dichos alimentos están asociados con obstáculos tales como la estabilidad y biodisponibilidad. La extrema sensibilidad de algunos componentes provoca una pérdida significativa de la calidad del producto, el valor nutricional y la aceptabilidad general del producto final. La encapsulación es una tecnología con el potencial de enfrentar el desafío de incorporar y liberar con éxito ingredientes funcionales. Como tecnología la encapsulación es un campo interdisciplinario que requiere conocimiento de polímeros, emulsiones y una comprensión profunda de la estabilización de compuestos bioactivos. El uso de nuevos polímeros como materiales de recubrimiento es un área de estudio aun en desarrollo. Tal es el caso del mucilago extraíble de las semillas de *S. hispanica*, cuyas características tecnofuncionales, podrían ser aprovechadas en conjunto con polímeros convencionales para el desarrollo de matrices poliméricas mixtas. Las cuales plantean oportunidades para el desarrollo de vehículos estabilizadores y de liberación controlada para la industria de alimentos. Por lo anterior, el objetivo del presente es proponer al mucilago de *S. hispanica* como agente encapsulante de compuestos bioactivos y coadyuvante de la biodisponibilidad de nutraceuticos y sistemas alimentarios.

Palabras clave: Matrices poliméricas, encapsulación, chía.



Sesión 3.

*Investigación, Desarrollo e Innovación
en Chía*

Presentaciones en Póster



3.8

CHIA (*Salvia hispanica* L.) FLOUR STABILITY: STUDY ON THE EFFECT OF PACKAGING CONDITIONS

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The production of chia oil generates a press-cake as process waste, which is rich in bioactive compounds. This by-product consists mostly of insoluble dietary fiber with at least 5% of soluble fiber (mucilage) and presents a high residual oil content (~12%), therefore could be considered as a new product with potential use in the food industry. The objective of this work is to study the effect of temperature (4 and 20°C) and different types of packaging on the storage stability of chia flour during a period of 240 days. The chia flour was packaged in different packaging materials: triple kraft (K) polyethylene (PE), polypropylene (PP) and metallized biaxially oriented polypropylene films (BOPP). Oxidative stability and Microbiological analysis were evaluated periodically during storage. Peroxide values of the oil present in chia flour were lower than the threshold limits (10 meq O₂/Kg Oil) during the storage period for both temperatures assayed. The free fatty acids content of chia flour stored at 4±1°C was < 2%, while samples maintained at 20±2°C overpassed this level after 120 days. Chia flour showed low microbial activity, which could be due to the presence of tocopherols and phenolic compounds. Assessment of quality parameters demonstrated the resistance of chia flour to oxidative deterioration. Thus, these results suggest that chia flours stored at different conditions and packaging materials can be stored without noticeable changes in oxidative stability during 8 or 4 months at 4±1°C or 20±2°C, respectively.



3.9

DEVELOPMENT OF BI-LAYER EMULSIONS WITH CHIA SEED OIL

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New trends for enriching, protecting and releasing bioactive lipids in foods involve the development of delivery systems. Modified sunflower lecithins, obtained by fractionation process, present good O/W emulsifying properties. Multilayer O/W emulsions with sunflower phosphatidylcholine-enriched fraction (PCF) and chia oil (high omega-3 content) would be an interesting option. Mono (PCF) and bilayer chia O/W emulsions (PCF+chitosan-Ch) were prepared homogenizing 5%wt chia oil with 95% wt aqueous solution and stored ~1 month at 4.0±0.5°C. Emulsions were evaluated by confocal microscopy, ζ-potential, apparent viscosity, the evolution of backscattering profiles, particle size distribution, mean diameter (D[3,2]) and peroxide value (PV). The inversion charge from -36 to +54mV was observed with the addition of chitosan. The particle size distribution was monomodal for the two-layer whereas the mono-layer emulsions presented a very little shoulder. D[3,2] was 0.24 and 0.33μm for mono and bi-layer emulsions, respectively. Some signs of destabilization by creaming was detected after 2 weeks of storage for mono-layer emulsions, while the bi-layer emulsions were physically stable during this period. In terms of lipid oxidation, PCF+Ch systems were more stable than those with PCF alone. This information suggests that bilayer (PCF-Ch) O/W emulsion constitute a good alternative to protect and deliver chia oil into functional foods.



3.10

CHIA OIL MICROENCAPSULATION IN SOY PROTEIN ISOLATE-GUM ARABIC COMPLEX COACERVATES: FORMULATION AND SPRAY DRYING

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Introduction: Application of complex coacervation between two biopolymers, followed by spray drying for microencapsulation purposes, offers several advantages: through a flexible, economical and scalable operation, a product with high encapsulation efficiency, good thermoresistance and controlled release properties is obtained. **Objectives:** First, to determine the process conditions (pH, total biopolymer concentration, protein/polysaccharide ratio and ionic strength) that optimize the complex coacervation between soy protein isolate (SPI) and gum arabic (GA) as wall materials for chia oil microencapsulation. Second, to analyze physicochemical properties of the powder obtained by spray drying. **Materials and Methods:** zeta potential, turbidity and coacervation yield analyses were carried out at different total biopolymer concentrations (4, 8, 12, 16 % w/v), SPI:GA ratio (2:1, 1:1, 1:2) and ionic strength (0, 0.1, 0.5 M KCl) to optimize complex coacervation conditions. Chia oil emulsions were prepared through complex coacervation between wall materials under optimized conditions. The spray-drying process was performed in a laboratory-scale Mini Spray Dryer Büchi B-290 (air atomizing pressure: 4.4 L/h; air inlet and outlet temperature, 130 °C and 80 ± 1 °C, respectively; atomization air flow rate: 538 L/h; pump and aspirator setting, 10% and 100%, respectively). Moisture content, surface oil content, oxidative stability (Rancimat analysis), omega-3 fatty acids profile and final particle size was determined. **Results:** The optimized conditions for SPI and GA complex coacervation were the following: pH= 3.15, 12 % w/v biopolymer concentration, 2:1 SPI:GA ratio, 0 M KCl, stirring during 30 min at 40 °C. In addition, the physicochemical properties of the final powder were: moisture content, 3.42 ± 0.01%; surface oil: 2.74 ± 0.18 %; oxidative stability: 2.18 ± 0.04 h and 5.86 ± 0.15 h for pure and microencapsulated oil, respectively; no statistical differences were found in fatty acids profiles for both bulk and microencapsulated oils (p<0.05); final particle size: 58.230 µm, *span number* = 1.624. **Conclusions:** According to the above results, microencapsulated products with enhanced oxidative and with low surface oil content may be obtained through the complex coacervation between SPI and GA.



3.11

MICROENCAPSULATION OF CHIA OIL USING MALTODEXTRIN AND ARABICA GUM

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Introduction: Chia seed is valued for its oil content (30-40%), which is composed mainly of polyunsaturated fatty acids omega-3 and omega-6. Because they present a high degree of insaturation, these are more susceptible to oxidation, so the encapsulation can be used as an alternative for the preservation of these.

Objective: The objective of this work was to encapsulate chia oil through Spray Dryer and to evaluate the obtained capsules.

Material and methods: First, suspensions of 10% of Maltodextrin and Arabic gum (1:3) were prepared. The suspension was homogenized with chia oil (2:1) in ultraturrax for the formation of the emulsion that was applied in a Spray Dryer, varying the outlet temperature and the feed rate. The yield of the process was determined and the capsules were evaluated for morphology, encapsulation efficiency and moisture.

Results and discussion: Among the treatments tested, the lowest temperature (100°C) and the higher feed rate (0.3 mL.min⁻¹) resulted in the lowest yield (40.3%), and the other treatments obtained yields of 50%. The encapsulation efficiency varied between 87-88%, evidencing that the spray drying technique is efficient for the encapsulation of chia oil. The capsules had a spherical regular morphology with a tendency of oil concentration in the center of the particle. In relation to moisture, all treatments presented moisture less than 4%, which is the indicated for storage. **Conclusion:** Therefore, chia oil capsules obtained by Spray Drying using maltodextrin and Arabic gum as wall materials have been found to have excellent characteristics indicating that they can be applied to foods in order to reduce lipid oxidation.



3.12

EVALUATION OF *Salvia hispanica* MUCILAGE-ALGINATE PROPERTIES AS ENCAPSULATION MATRIX FOR CHIA SEED OIL

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The cardiovascular diseases are the principal disorders killing people over the world; the cholesterol and the chronic inflammation play an important role in the pathologic disorder. The chia oil has a high content of omega-3 that improve the health reducing the cholesterol in blood and improving the inflammation response. However, the chia oil is susceptible to a rapid oxidation by environment conditions or by food processing conditions. In this sense, encapsulation is a technique capable to protect omega-3 fatty acid against environmental conditions, during the storage or by food processing. The aim of this study was to evaluate the potential of *S. hispanica* mucilage combined with alginate as alternative material for encapsulation of *S. hispanica* oil by external ionic gelation. A factorial model of 2^3 was used to measure the effect of polymer concentration, calcium chloride concentration and crosslinking time. The response variables were the encapsulation efficiency, the average diameter, the glass transition temperature, the oxidative stability and the shape of the capsule. The best encapsulation efficiency was obtained with a polymer concentration of 2% (w/v), calcium chloride concentration of 2% (w/v) and crosslinking time of 20 min. The capsules obtained were spherical and with an average diameter of 1.83 cm. The glass transition temperature was 82.42 °C and the total oxidation value of the oil was 8.7. With these results, it is feasible to encapsulate *S. hispanica* oil using a matrix of mucilage-sodium alginate by ionic gelation method to protect the *S. hispanica* chia oil against oxidation.



3.13

CHARACTERIZATION OF CHIA MUCILAGE FILMS

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Introduction. Chia mucilage (CM) is a transparent mucilaginous gel exuded when chia seed is immersed in water, being composed essentially by soluble fiber. Aiming to reduce the waste generated by synthetic packaging, a possible application of CM as raw material for biodegradable films is studied.

Objective. The objective of this work was to determine the characteristics of chia mucilage films.

Material and methods. Three formulations were developed: 1% with oven-dried CM, 1% with lyophilized CM and with 1% lyophilized CM and the addition of 1% chia oil. They were produced at pH 9 using glycerol as plasticizer (25% based on CM weight). The films were evaluated for thickness, tensile strength, elongation at break, color properties and water contact angle.

Results and discussion. The film developed with lyophilized mucilage presented lower thickness (0.047 mm), higher tensile strength (12 MPa) and higher elongation at break (6.7%) than the others. Regarding the color, the film with oven-dried mucilage presented a more pronounced color, being darker ($L^* = 72.54$), as well as showing higher values of a^* (5.54) and b^* (28.24) parameters and opacity (16.4%). The incorporation of chia oil led to the decrease in the hydrophilicity, indicated by the decrease in the water contact angle of the film.

Conclusion. Thus, the characteristics presented by the films suggest that CM is an interesting raw material for the production of food packaging. It brings together the environmental advantages of being a non-polluting and sustainable alternative, as well as the important nutritional composition if used for edible materials development.



3.14

COMBINED EFFECT OF CHIA FLOUR AND SOJA LECITHIN INCORPORATION ON NUTRITIONAL AND TECHNOLOGICAL QUALITY OF FRESH BREAD AND DURING STALING

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Many attempts have been made to increase the functional value of bread by incorporating dietary fibers in the formulations. However, fibers enrichment penalizes usually the sensory quality of the final product. The objective of the present investigation was to study and optimize the blend composition of flour of grinded Chia seeds, source of fibers and nutrients, combined to Soya lecithin, a bread making improver, in a way to enhance the nutritional/functional value of bread, without impairing its technological quality. Nine formulations were prepared following a Central Composite Design. Technological attributes were evaluated both for fresh and stored bread. In the Response Surface Methodology (RSM) a desirability function identified for fresh and stored bread the optimum doses of chia and lecithin incorporation to obtain the highest specific volume and the lowest crumb hardness. Compared to the control, samples with chia and lecithin significantly increased the nutritional value of bread. An interesting synergy was found between lecithin and chia combination to enhance the specific volume and the initial crumb softness of fresh bread and to delay bread staling by retarding crumb firmness and reducing the crumb water loss during storage.

Using the RSM, the blend containing 4.04% Chia/1% Lecithin showed a fresh bread with maximum specific volume (3.46 cm³/g) and minimum crumb hardness (3.3 N). Whereas, the bread combining 3.4% Chia/1% Lecithin and stored for two days at room temperature showed the minimum crumb hardness (10.2 N). Experimental values were close to the predicted ones, with an error below 10% for all tested attributes.

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3.15

CHARACTERIZATION OF A YOGURT GELATIN ADDED WITH DIETARY FIBER FROM CHIA SEEDS (*Salvia hispanica*)

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The adequate consumption of dietary fiber helps in the serum control of glucose and lipids, increases the sensation of satiety and regulates intestinal transit. Making foods added with fiber is important to help achieve the recommended daily fiber intake. The aim of this research was to characterize physicochemical, sensory and biologically a yogurt gelatin added with dietary fiber obtained from chia seeds (GF). For the methodology, a GF and a control gelatin (GC) were developed. The GF was characterized through proximal analysis, total dietary fiber (FDT), insoluble fiber (FDI) and soluble fiber (FDS), pH, titrable acidity, Aw, color, firmness and syneresis. For both treatments, ideal test and level of taste were applied. Biological activity was also measured at a concentration of 10 mg/ml. The results for GF reported a protein content of $24.07 \pm 0.12\%$ and $0.65 \pm 0.07\%$ for fat, FDT 13.31%, FDS 2.98% and FDI 2.66%. In the taste level test, the values were found above the point of indifference. In the TEAC it was observed that the GF (13.34%) was statistically higher than the GC (11.37%). In the antidiabetic activity, a value of 59.705% was obtained for the GF and 83.06% for GC. In conclusion, the consumption of GF is recommended due to its sensorial acceptance and FDT contribution given to the addition of chia and mucilage seeds, providing a potential product with nutritional value, antidiabetic and antioxidant effects in the people who consume it.



3.16

BROMATOLOGICAL CHARACTERIZATION OF CHIA GERMLASM (*Salvia hispanica*) FROM JALISCO AND MORELOS FOR BREEDING PURPOSES BY MUTAGENESIS

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Introduction. Chia (*Salvia hispanica*) is a crop with high nutritional value that is currently underutilized and its genetic diversity is decreasing.

Objective. The objective of this research is to characterize the seeds of chia genotypes of different origin, making an evaluation of the genetic variability regarding bromatological composition, fatty acids and minerals.

Methods. Physical characterization (weight and size), viability (physical and physiological quality); the bromatological analysis, the profile of fatty acids and the content of minerals of importance in nutrition; of five chia seed genotypes from Jalisco (J1, J2 and J3) and Morelos (M1 and M2).

Results. Bromatological composition of the 5 genotypes analyzed refer genotype and major value: humidity (J1 8.21%); lipids, (J2 34.24%); protein and crude fiber (J3 32.67%), M2 ash 6.02% and carbohydrates 8.88%.

Fatty acid profile for the 5 genotypes, alpha-linolenic acid (Omega-3) J3 59.57% was found in greater abundance; average values of saturated fatty acids, 8.0% palmitic acid and 4.27% stearic acid, except M2 with higher values. Similar contents of oleic acid 8.86% and linoleic, 20.39%. Mineral content, the five genotypes presented more than 500 mg/100g of macro minerals (Ca and K) and less than 20 mg/100g of micro minerals (Fe, Mn, Zn and Cu), except for the M2 genotype with 150.02 mg /100g of Fe.

Conclusion. The J3 genotype will be included in the breeding program for mutagenesis due to its high content of crude fiber, protein and linolenic acid (Omega-3).





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