e-ISSN:2706-6800

Research Open Access

dborbor@uagraria.edu.ec

Correspondence:

Effect of chia seed (*Salvia hispanica L.)* on the utilization of shrimp (*Litopenaeus vannamei)* patty meat.

Efecto de la semilla de chía (*Salvia hispánica L.)* para la utilización de carne de hamburguesas de camarón (*Litopenaeus vannamei)*

Daniel Borbor Suarez
Master's Degree in Food Processing, Universidad Agraria del Ecuador, Faculty of Agricultural Sciences, Agroindustrial Engineering,
dborbor@uagraria.edu.ec
https://orcid.org/0000-0002-6611-4911

Abstract

This research made it possible to evaluate the effect of ground chia seed as a thickening agent in shrimp burger meat and whether its incorporation improves the product texture. Physical-chemical analysis of the chia flour showed values of water retention capacity (7.461 g/g), water binding capacity (9.369 g/g) and by means of rheology its gelation was characterized showing a pseudoplastic behavior, its viscoelastic modulus dependence with respect to frequency showed a characteristic pattern of a weak structure gel. By means of sensory and instrumental analysis carried out in the Brookfield texturometer, textural properties were compared in 3 different percentages of chia flour for the shrimp hamburger meat versus a conventional one, of which the T2 has greater hardness and elasticity compared to the conventional sample, while the properties of cohesiveness and chewiness were difficult to identify for tasters and the team, but were significantly different and better than the sample without chia. The rheological parameters showed that the elastic modulus (G') was higher than the viscous modulus (G"), there is a statistical difference according to their means which show that increasing flour concentrations induces an increase in the viscoelastic modulus, according to the panelists, T2 was the best accepted, the microbiological parameters are within the limits allowed by INEN 1338.

Key words: thickener, chia seeds, hamburger, textural properties, rheology.

Resumen

Esta investigación permitió evaluar el efecto de la semilla de chía molida como agente espesante en carne para hamburguesa de camarón y si en efecto su incorporación mejora la textura producto. Se determinaron análisis físico-químico a la harina de chía demostrando valores de capacidad de retención de agua (7,461 g/g), capacidad de ligazón de agua (9,369 g/g) y mediante reología se caracterizó su gelificación mostrando un comportamiento pseudoplástico, su dependencia del módulo viscoelástico con respecto a la frecuencia mostró un patrón característico de un gel de estructura débil. Por medio de análisis sensorial e instrumental realizado en el texturómetro Brookfield se compararon las propiedades texturales en 3 diferentes porcentajes de harina de chía para la carne de hamburguesa de camarón frente

http://centrosuragraria.com/index.php/revista, Published by: Edwards Deming Institute, Quito - Ecuador, October - December vol. 1. Num. 15. 2022,

Received June 11, 2022
Approved: September 22, 2022

a una convencional de las cuales coinciden que el T2 posee mayor dureza y elasticidad a comparación de la muestra convencional, mientras que las propiedades de cohesividad y masticabilidad fueron difícil de identificar, para catadores como el equipo pero fueron significativamente diferentes mejor que la muestra sin chía. Dentro de los parámetros reológico se obtuvo que el módulo elástico (G') fue mayor que el viscoso (G''), existe diferencia a nivel estadístico de acuerdo a sus medias donde muestran que al incrementar las concentraciones de harina induce un aumento en los módulos viscoelásticos, de acuerdo a los panelistas el T2 fue el de mejor aceptación, los parámetros microbiológicos se encuentran dentro límites permitidos por la norma INEN 1338.

Palabras clave: espesante, semillas de chía, hamburguesa, propiedades texturales, reología.

Introduction

In the study conducted by Ramos, Fradinho, Mata, & Raymundo, (2017). in Portugal. They evaluated the gelling effect of chia seed (*Salvia hispanica* L.) considered a promising food for the development of functional products due to its high nutritional value in lipids, proteins and fiber through the rheological characterization of 100, 130 and 150 g kg -1 of chia flour gels. Due to its technological capabilities of increasing volume by absorbing water and gel-forming properties, its addition to a food matrix can affect texture and rheological behavior, acting as a texturizing and stabilizing agent.

Likewise Riernersman , Romero , Doval , & Judis (2016) in Argentina. They studied the effect of the addition of chia flour and water in cooked fish patties on yield, water and fat retention, n-3 fatty acid content and oxidative stability.

Similarly Zaki, (2018) in Egypt. Investigated the impact of adding chia seeds (*Salvia hispanica* L.) on the quality properties of different camel patty formulations by analyzing pH, TBA (thiobarbituric acid) value, color measurements, microbiological analysis and sensory evaluation during storage at 4°C for 12 days.

Nowadays, new trends or lines of research are being developed using new functional ingredients with textural properties (thickeners, gelling agents, stabilizers, humectants, emulsifiers, etc.), among which chia stands out. This study involves evaluating its effect on hamburger meats, where the use of different percentages of chia seeds will affect the sensory characteristics.

As world producers of chia stand out, Argentina, Bolivia and Paraguay, where these three account for 80% of world production and concentrate almost two thirds of exports. Followed by Mexico, Nicaragua, Australia, Peru and Ecuador. (Fuentes M. 2017. p. 33).

In Ecuador, according to a study, the production of chia as an export product restarted in 2005. (PROECUADOR, 2014). This superfood as it has been called has had a worldwide impact due to its composition, however many in the country are unaware of this food, due to lack of information and has not tried to invest intelligently to massify the product, also because many of our producers do not have a specialized management of the crop because it is considered a non-traditional crop.

Chia is distinguished by its high nutritional and therapeutic potential, and as an ingredient in food, it improves many products in their formulation. Ecuador being a country with a high level of production of meat and fish derivatives, most of them are used for daily consumption, unfortunately there are no strategies in place to ensure that Ecuadorian families include chia in their daily diet.

From the technological point of view, if the research demonstrates its effectiveness as a thickening agent in meat destined for hamburgers, it could be taken into account by the state to create alternatives at the level of food industries that apply in their formulations the use of additives of natural origin, substituting a much lower rate of chemical additives. Because chia seed has nutraceutical properties that contribute to human nutrition. In addition, its high fiber content would facilitate digestion.

As for the contemporary relevance of the study, its results could serve as a frame of reference for other similar research. A healthy and nutritious food contributes to the prevention of degenerative diseases that nowadays affect the Ecuadorian population as well as diabetes.

Wong (2004) and Andrade (2000) report that farmed and marine shrimp have high protein and low lipid levels. Andrade (2000) reports that shrimp have a low fat content but moderate Omega-3 fatty acid content, which is considered an essential fatty acid because humans cannot synthesize it on their own, as well as being a rich source of calcium and phosphorus.(Table 2)

Table 1 *Caloric content and chemical composition of marine and farmed shrimp per 100g of edible portion*

Composition	Whole farmed shrimp	Whole marine shrimp
Energy (Kcal/100)	92	
Humidity % Humidity	76.5	76.1
Protein % Protein	20.1	20.3
Lipid %	0.9	0.9
Ash % Ash	1.6	1.3
Carbohydrate % Carbohydrate	1.0	1.4

*Proximal chemical composition values of whole marine and farmed shrimp.
(Andrade, 2000)

Table 2 *Table Substances used as texture modifiers and currently authorized as additives in the EU*

Name	Obtaining	Feature	Application	Effects and limits

Carrageenans	Algae (*Gigartina, Conduras, Furcellaria and others*),	Thermally reversible gels with a gelatin-like texture. Concentrations higher than 0.15% provide solid textures.	Dairy desserts Vegetable preserves, soups and sauces, Coating of meat and canned fish derivatives.	Low intestinal absorption. No cases of injuries have been reported due to its consumption. ADI: up to 50 mg / Kg
Pectins	From the remains of orange, lemon and apple pulp.	Forms viscous gels	Confectionery (jams). Canned vegetables, fruit juices.	About 10% is digested. High doses produce diarrhea ADI: not specified.
Modified starches	From corn and potato starch, which is chemically treated.	Formation of viscous gels, resistant to heat and acid media.	Yogurts and ice cream. Vegetable preserves and thick sauces sauces of the type of used in Chinese cuisine.	They are digested and metabolized like natural starch, providing the same calories. The modified fraction cannot be assimilated assimilated and are eliminated or utilized by intestinal bacteria.

*ADI: Acceptable Daily Intake.
(Ibáñez, Torre, & Irigoyen, 2003).

Materials and methods

The exploration was descriptive, explanatory, laboratory and documentary. Descriptive because it specified the properties and characteristics of a phenomenon that was analyzed. Hernández, Fernández, & Baptista, (2014). It was explanatory because it was aimed at answering the causes of the events on the effect of chia seeds in hamburger meat, and with its results it seeks to explain why the events occur and under what conditions they occur. It was laboratory because a sensory evaluation was carried out with the help of the panelists and the best treatment was selected and the physical-chemical and microbiological characteristics of the hamburger with the incorporation of chia seeds were evaluated. It was documentary since it was carried out relying on sources of bibliographic consultations of scientific documents both on the web and in the virtual library of the Agrarian University of Ecuador.

The present study, consisted of an experimental design since in this one variable is manipulated, and the random control of the rest of variables. (Durango, 2014. P. 123). Three different percentages of inclusion of ground chia seeds in hamburger meats were used.

Independent variable

Concentrations of chia seeds incorporated in the formulation.

Percentages of shrimp meat.

Dependent variable

Sensory properties, textural properties, microbiological characteristics (mesophilic aerobes, Escherichia coli, Staphylococcus aureus and Salmonella) of the best treatment of shrimp patty incorporating chia seed.

Treatments

Table 3 *Formulation of shrimp patties with chia seed incorporation 1000g*

Ingredients	Treatment 1		Treatment 2		Treatment 3	
	g	%	g	%	g	%
Shrimp meat	715,6	71,56	685,6	68,56	655,6	65,56
Chia seeds	30,0	3,00	60,0	6,00	90,0	9,00
Sodium chloride	14,7	1,47	14,7	1,47	14,7	1,47
White sugar	6,0	0,60	6,0	0,60	6,0	0,60
Monosodium glutamate	1,9	0,19	1,9	0,19	1,9	0,19
White Pepper	1,0	0,10	1,0	0,10	1,0	0,10
Onion	12,0	1,20	12,0	1,20	12,0	1,20
Albumin (Egg/Clara)	32,8	3,28	32,8	3,28	32,8	3,28
Tripolyphosphate	2,0	0,20	2,0	0,20	2,0	0,20
Vegetable oil	35,9	3,59	35,9	3,59	35,9	3,59
Bread crumbs	30,9	3,09	30,9	3,09	30,9	3,09
Powdered Milk	33,2	3,32	33,2	3,32	33,2	3,32
Garlic powder	4,0	0,40	4,0	0,40	4,0	0,40
Water (Ice)	80,0	8,00	80,0	8,00	80,0	8,00
Total	1000		1000		1000	

*Inclusion of ground chia seeds in three concentrations versus different percentages of shrimp meat.

Data collection

The sensory panel consisted of 30 untrained people with an average age of 18 to 25 years old. The tool used was a 5-category hedonic scale table, which was used to evaluate: color, smell, taste, texture and appearance. The card that allowed us to evaluate these aspects for each treatment. Additionally, a conventional hamburger and the different proposed treatments were evaluated, using another card exposed under another scale and then comparing the results with the data provided in the texture profile analysis (texturometer).

Methods and techniques

Raw materials and inputs :Ground shrimp meat, Chia (*Salvia hispanica* L.), Sodium chloride, White sugar, Monosodium glutamate, White pepper, Onion, Albumin (egg/clear), Sodium tripolyphosphate, Vegetable oil, Breadcrumbs, Garlic powder, Milk powder, Water (Ice), Refrigerator, KINEXUS PRO Rheometer, Brookfield Texturometer (PRO CT3, USA).

Description of the process of elaboration of shrimp burger incorporating ground chia seeds.

Raw material reception: A visual inspection of the quality of the raw material entering the process was carried out.

Selection and classification: The selection was done visually in order to separate the shrimp in optimal conditions from those that are not, as well as the rest of the raw material. Classification was carried out manually, taking into account characteristics such as size, texture, color, and odor in shrimp with decomposition incidence.

Shell removal and peeling: This was done manually at a refrigerated temperature of 4ºC. The process should be carried out with latex gloves to avoid cross contamination in this process and to speed up the process, the external part (shell) was removed. This stage was important for the optimal consistency of the hamburger and facilitated the grinding stage.

Extraction of the digestive tract: Manual process that consisted of making a cut in the upper part of the shrimp, this process ensured the quality of the final product.

Washing: The raw material (shrimp) was placed in a plastic tray in a solution of ice plus water and 0.3 to 1.5 ppm of chlorine to rinse them.

Grinding: The shrimp was ground using a meat grinder. The desired amount of shrimp was placed in the grinder and the auger exerted pressure to pass through the screws to obtain a grind of the size of the sieve.

Crushing: The objective of this stage was to reduce the size of the chia seeds into smaller particles using a blender.

Weighing: We quantified the raw materials (shrimp, NaCl, white sugar, monosodium glutamate, white pepper, onion, albumin, tripolyphosphate, vegetable oil, bread crumbs, ice and the amounts of chia for the three treatments).

Mixing: Stage in which the other ingredients are blended to create a homogeneous mass.

Cutting and shaping: It was the one that gave the shape and weight of the hamburger. It was done with a stainless steel cutting instrument with the width required for its realization.

Packaging: It was made with a high density polyethylene material and sealed so that air and oxygen do not affect its quality.

Labeling: To identify what it is composed of and to take to laboratories for analysis.

Storage: Storage was carried out at a temperature of 4º C (4º F).

Table 4. Variance scheme

Sources of variation	Degrees of freedom
Total	
Panelists	
Treatments	
Experimental error	58

The treatment that presented the best sensory acceptance was subjected to microbiological analysis (mesophilic aerobes, Escherichia coli, Staphylococcus aureus, Salmonella), as well as the rheology of the three treatments under development.

Result

Water binding, water retention capacity, and gelation characteristics of chia flour

Table 7 shows the characteristics of the functional properties of chia flour.

The water holding capacity of chia flour was 7.461 g water/g fiber, the water binding capacity property analyzed in flour was 9.369 g water/fiber.

Table 5 *Results of water retention capacity and water binding capacity analyses*

Parameter	Unit	Results	Reference Method
Water holding capacity	g/g	7,461±0,810	Gularte&Rosell;2011
Water binding capacity	g/g	9,369±0,785	Gularte&Rosell;2011

Figure 2 shows that chia flour has high viscosity moduli in the frequency range, but as the strain rate increases, the dispersion decreases. Therefore, this indicates that the flour sample presents a pseudoplastic behavior, because as the strain rate increases, the chains of the polymer molecules arranged randomly intertwine in the direction of flow, generating a solution of lower viscosity, causing a lower interaction between adjacent polymer chains.

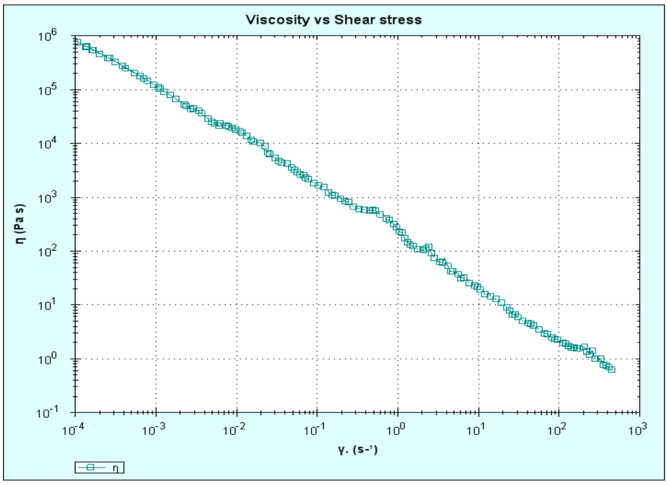

Figure 1 Strain rate on the apparent viscosity at 25ºC of chia flour dispersions

To characterize the gelation of the flour, it was subjected to sweep frequency tests within the linear viscoelastic region as shown in Figure 3, when analyzing the mechanical specifications obtained, it is found that the elastic modulus (G') shows higher values than the viscous modulus (G"), in which a dependence of the viscoelastic modulus with respect to frequency can be observed, showing a pattern generally associated with a weak gel-like structure.

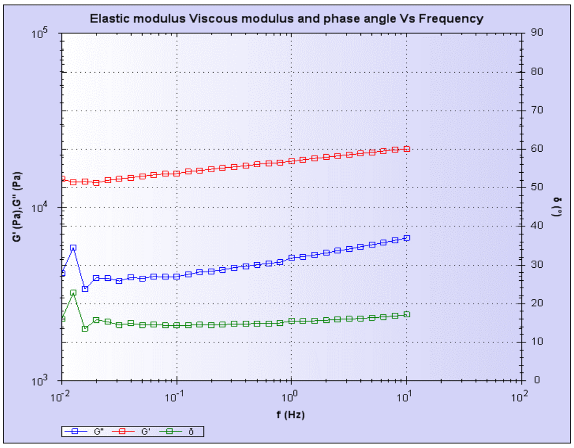

Figure 2. Frequency sweep test of chia flour obtained after being cooled to room temperature

Comparison of the use of three percentages of chia flour inclusion in the preparation of shrimp burger with a conventional burger .

An analysis of the textural properties of shrimp burger meat prepared with different percentages of chia flour concentration was carried out with a conventional one by sensory analysis and with a Brookfield texturometer (PRO CT3, USA), the results of which were compared with each other as shown below:

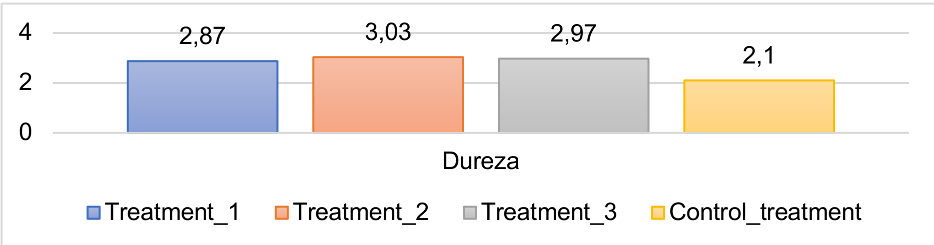

Figure 3. Hardness characteristic determined by sensory analysis

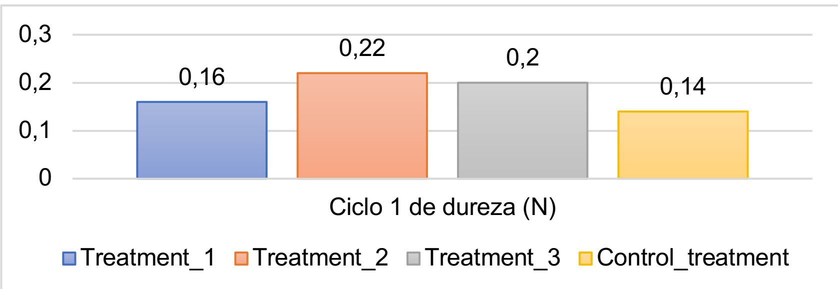

Figure 4. Hardness characteristic determined with Brookfield texturometer.

A comparison between Figures 3 and 4 shows that in both methods of analysis, treatment 2 (with 6% chia flour) has a higher hardness, showing a difference with the sample without chia (conventional).

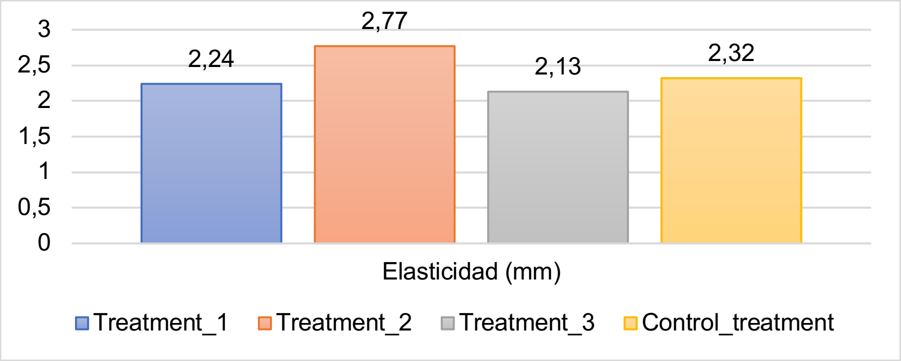

Figure 5. Elasticity characteristic determined by sensory analysis.

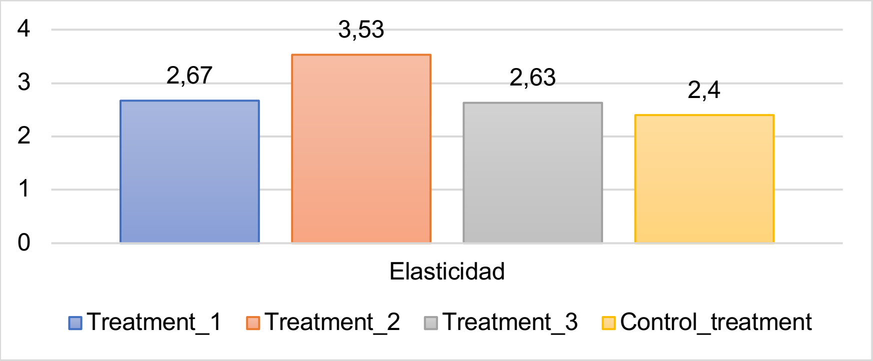

Figure 6. Elasticity characteristic determined with the Brookfield texturometer.

Similarly, we can see in Figure 5 and 6 that in the elasticity characteristic, both methods of analysis agree that treatment 2 (with 6% chia flour) is more elastic compared to the conventional sample.

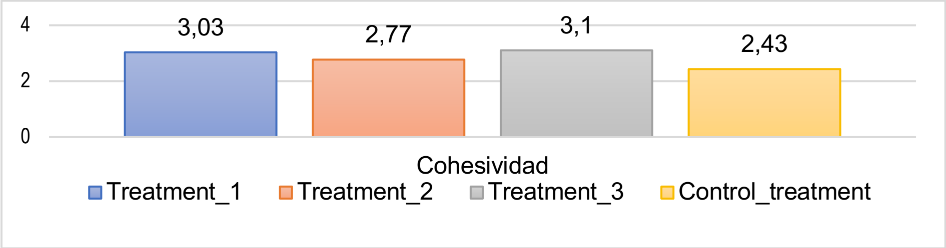

Figure 7 Cohesiveness characteristic determined by sensory analysis

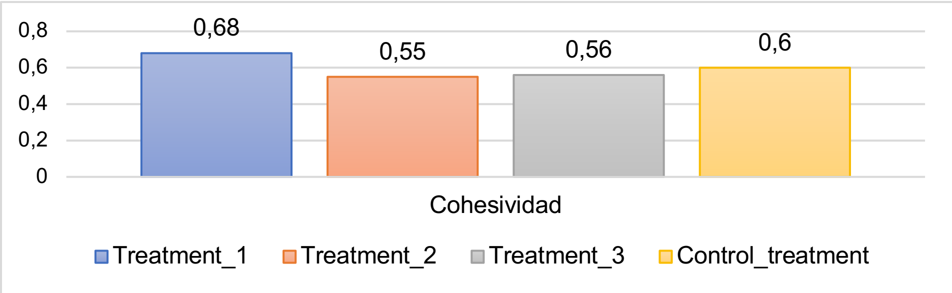

Figure 8 Cohesivity characteristic determined with the Brookfield texturometer

In Figure 7 and 8 according to the tasters and the Brookfield team. Treatment 2 (with 6% chia flour) presents a lower cohesiveness in comparison with the rest of the treatments with chia but not in the conventional one tasted sensorially, on the other hand there is discrepancy in that same characteristic since the tasters consider that treatment 3 (with 9% chia flour) is the most cohesive while in the one used by the equipment treatment 1 (with 3% chia flour) obtained better weighting.

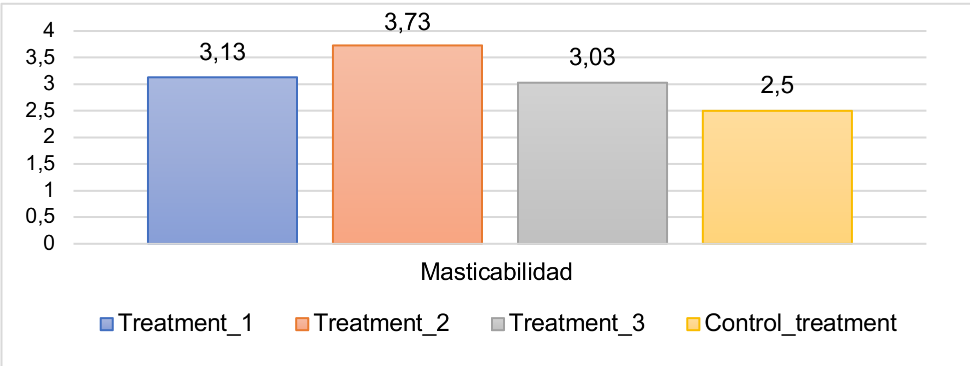

Figure 9 Chewiness characteristic determined by sensory analysis

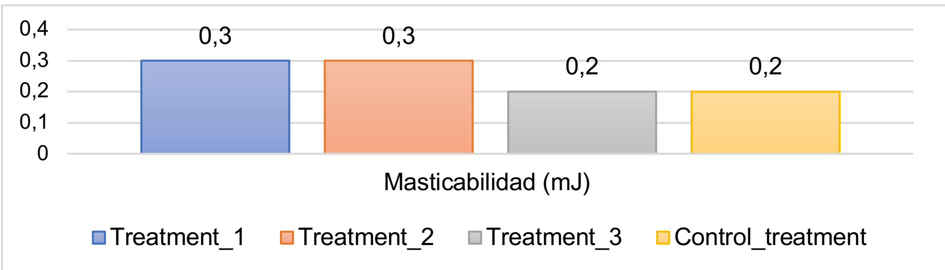

Figure 10 Chewiness characteristic determined with the Brookfield texturometer

According to Figure 9 and 10, the chewiness characteristic shows a tie between treatment 1 (with 3% chia flour) and treatment 2 (with 6% chia flour), while for sensory evaluation the most chewy is treatment 2 (with 6% chia flour) followed by treatment 1 (with 3% chia flour), i.e. there is a difference between the shrimp meat sample without chia (conventional) with the one that included the different percentages of flour.

Analysis of the most acceptable product, rheology of the three treatments and microbiological (mesophilic aerobes, Escherichia coli, Staphylococcus aureus, Salmonella) to the one with the best sensory acceptance .

Sensory evaluation of color in shrimp burger

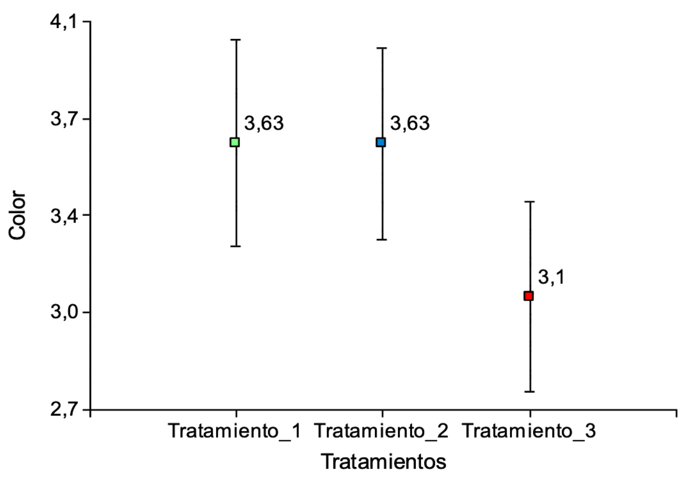

Figure 11 Color evaluation in the three shrimp patty treatments.

The data shown in the graph show that for the color parameter, both treatment 1 and treatment 2 obtained the same mean of 3.63, compared to treatment 3 with a value of 3.1.

Sensory evaluation of flavor in shrimp burger.

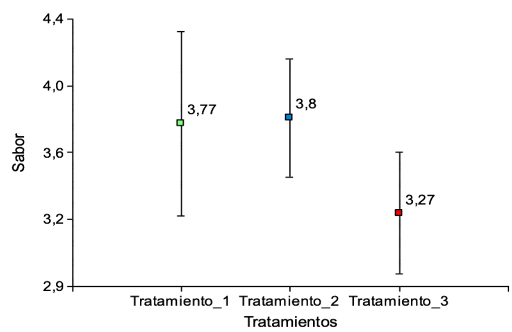

Figure 12. Flavor evaluation in the three treatments of shrimp burger.

The statistical analysis showed no significant difference for both treatments and replicates, comparing with the mean in the flavor parameter the one that obtained a higher acceptability range was treatment 2 with a mean of 3.8, in relation to the treatment with a value of 3.77 and treatment 3 with a value of 3.27 acceptability.

Sensory evaluation of odor in shrimp burger

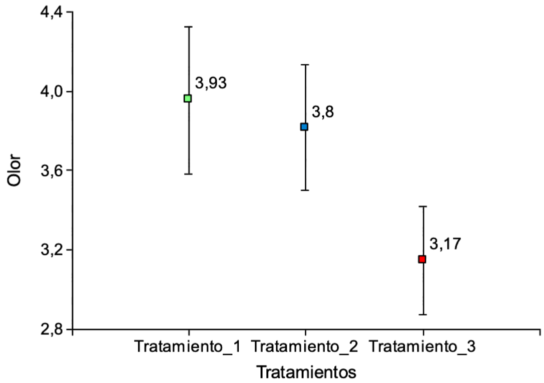

Figure 13 Evaluation of odor in the three treatments of shrimp patty.

Sensory evaluation of appearance in shrimp burger

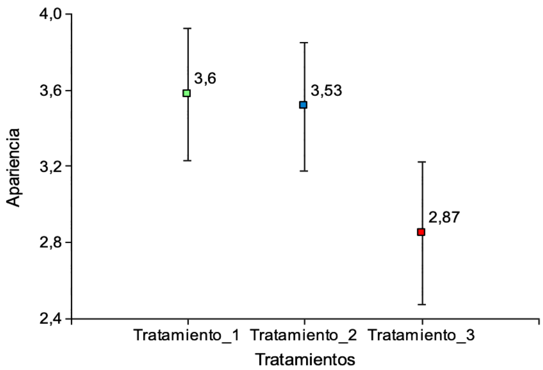

Figure 14 Evaluation of appearance in the three shrimp patty treatments.

For the appearance parameter it can be observed that there was a significant difference in relation to the treatments but not in terms of panelists, but graphically we can see in comparison to their statistical means that treatment 1 had a higher range of acceptability with a value of 3.6 as opposed to treatment 2 that obtained a value of 3.53 and treatment 1 with 2.87 of acceptability.

Sensory evaluation of texture in shrimp burger

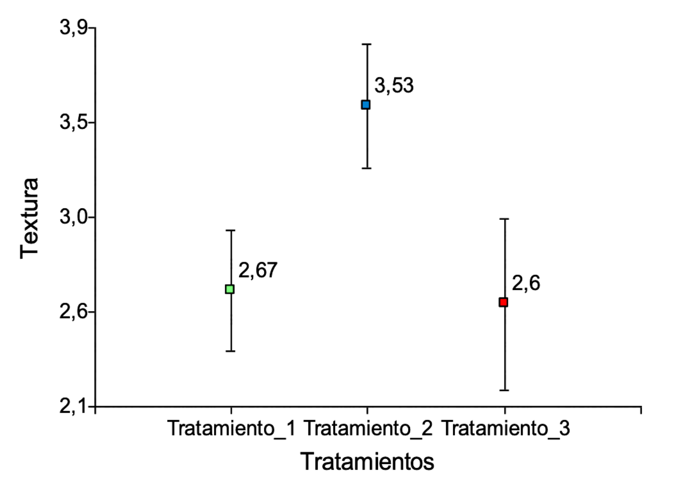

Figure 15 15 Evaluation of texture in the three treatments of shrimp patty

Interpretation of the best treatment with the best acceptance

Once each of the results had been obtained statistically, it is considered that the behavior of the inclusion of chia flour in the formulation of treatment 2 was the one with the highest range of acceptability by the panelists in the odor parameter.

Table 6 *Interpretation of acceptability results*

Treatments	Color	Taste	Odor	Appearance	Texture	Average
Treatment_1	3,63	3,77	3,93	3,6	2,67	3,52
Treatment_2	3,63	3,8	3,8	3,53	3,53	3,66
Treatment_3	3,1	3,27	3,17	2,87	2,6	3,00
Average	3,45	3,61	3,63	3,33	2,93	

Rheology analysis of three shrimp burger formulations with the addition of chia flour for texture evaluation

The incorporation of ground chia seeds for the formulation of shrimp patties of the three concentrations was evaluated against three different percentages of shrimp meat mixed with other ingredients in constant amounts for the three treatments, then they were subjected to a rheological test in which they were evaluated by means of a Kinexus PRO rheometer to determine their elasticity and viscosity:

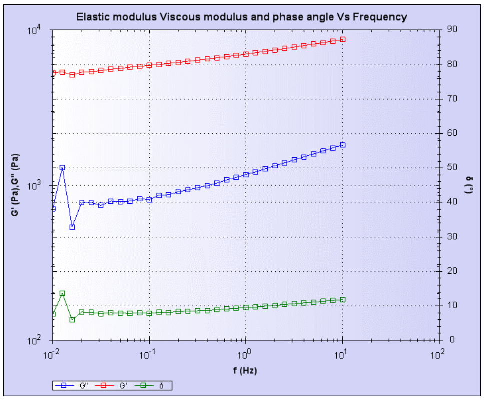

Figure 16 Storage or elastic modulus (G') and loss or viscous modulus (G") of treatment 1(3% chia flour)

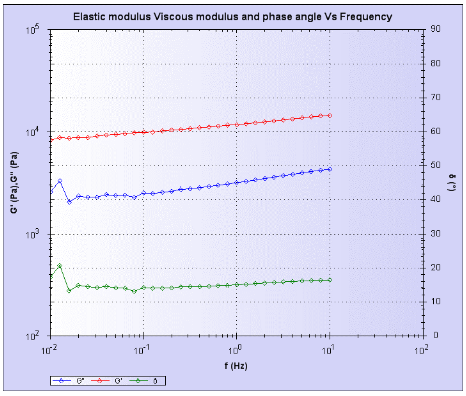

Figure 17 Storage or elastic modulus (G') and loss or viscous modulus (G") of treatment 2 (6% chia flour)

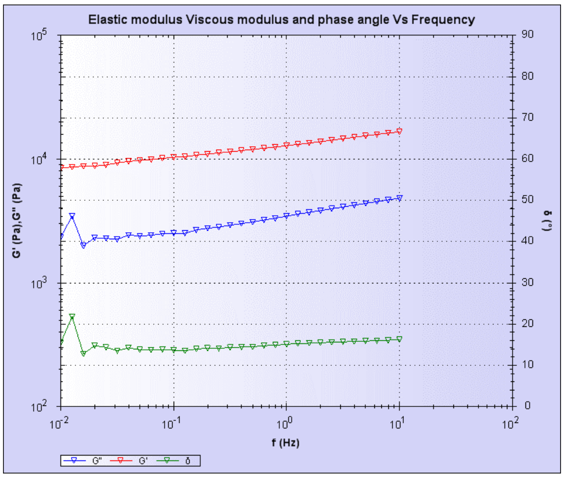

Figure 18 Storage or elastic modulus (G') and loss or viscous modulus (G") of treatment 3 (9% chia flour)

In figure (16-18) the rheological properties, both the storage or elastic modulus (G') and the loss or viscous modulus (G") were evaluated as a function of frequency (0.01 to 10 Hz), all the results obtained show elastic values (G') higher than viscous values (G"), indicating that the shrimp burger samples with the inclusion of chia flour present more elastic than viscous characteristics, This indicates in terms of rheology, that the mixture behaves as a semi-solid (gel), with the elastic component predominating over the viscous one and also showing a phase angle independent of the frequency, that is, as the speed increases, the values of G' and G" increase, in comparison with the three concentrations to determine their effect, the results were evaluated by means of an analysis of variance.

Loss modulus or viscous modulus analysis

The results of the analysis of variance (see appendix, table #29) indicate that there is a significant difference between treatments, which was less than 0.05 and a coefficient of 26.22% as indicated:

Table 7 *ANOVA analysis*

Variable	N	CV	p-value
G'' (viscous component)		26,22	<0,0001

Table 10 indicates that treatment 3 had a better range with a value of 3180.65 Pa as opposed to treatment 2 with 2994.52 Pa following treatment 1 with 1088.42 Pa.

Table 8 *Evaluation of statistical means*

Treatments	Stockings	n	E.E.	
Treatment_3	3180,65		114,04	A
Treatment_2	2994,52		114,04	A
Treatment_1	1088,42		114,04	B

*Means with a common letter are not significantly different (p>0.05)

Storage or elastic modulus analysis

The results of the analysis of variance (see appendix, table -30) indicate that there is a significant difference between treatments, which was less than 0.05 and with a coefficient of variance of 19.13% as indicated:

Table 9 *ANOVA analysis*

Variable	N	CV	p-value
G' (elastic component)		19,13	<0,0001

The evaluation in comparison to their statistical means in Table 12 indicates that treatment 3 had a higher range with a value of 11849.35 Pa in relation to treatment 2 with 11031.61 Pa and treatment 1 with a value of 6595.81 Pa.

Table 10. *Evaluation of statistical means*

Treatments	Stockings	n	E.E.	
Treatment_3	11849,35		337,54	A
Treatment_2	11031,61		337,54	A
Treatment_1	6595,81		337,54	B

*Means with a common letter are not significantly different (p>0.05).

Microbiological analysis to best sensory treatment

For this analysis, the treatment with the best acceptance by untrained panelists was the winner of treatment 2, as follows is a table with the microbiological parameters evaluated:

Table 11. *Results of microbiological analysis of shrimp patty with inclusion of ground chia T2 (6%).*

Parameter	Unit	Results	Limit of Quantification
Mesophilic aerobes	cfu/g	<10	
Escherichia coli	cfu/g	<10	
Staphylococcus aureus	cfu/g	<10	
Salmonella	/25 g	Absence	Aus/Pres

As for mesophilic Aerobes the result was <10 cfu/g, the limit in the Ecuadorian technical standard is of $1{,}0\ x10^{7}$ cfu/g, Escherichia coli gave <10 i.e. $< 1{,}0\ x10^{1}$The permitted limit is <3 cfu, Staphylococcus aureus was <10 and the limit is <3 cfu/g, finally Salmonella presented <10 cfu/g, i.e. the limit is <3 cfu. $1{,}0\ x10^{4}$Finally, Salmonella was absent, these parameters were based on INEN INEN 1338.

Currently the trends or lines of research have used functional ingredients for the modification of food texture, one of these is chia, a source rich in soluble fibers, which present hydrocolloid properties, according to our study:

The analysis carried out to characterize the water retention capacity of chia flour was 7.461 g of water/g of fiber compared to the results obtained by Fuentes (2012) in which he reported a value of 6.2 g of water/g of fiber, likewise in the study conducted by Espinoza (2017) indicates us that to determine the techno-functional properties of chia seeds and its defatted extract was 5.63 g of water/ g of fiber in the flour extracted from chia seed as opposed to the defatted chia flour of 3.29 g of water/ g of fiber. In the water binding capacity analysis the flour in this research showed a value of 9.369 g water/ g fiber, on the other Espinoza (2017) observed a value of 2.033 g water/ g fiber and in the results reported by Segura, Ciau, Rosado and Betancur (2014) in their study on the chemical and functional properties of chia gum (*Salvia hispanica* L), in partially defatted gum had a binding capacity of 0.84 g water/g fiber a relatively low value when compared to this study and that of Espinoza (2017). To characterize gelation, according to the study presented by Ramos, Fradinho, Mata and Raymundo (2017) and Capitani (2013), according to the mechanical spectrum, both researches and the present study agree that chia flour gels by rheological characterization present structures similar to weak gels.

The second objective was to compare the addition of three percentages of chia flour for the preparation of meat for shrimp burgers with a conventional one through sensory analysis and using a texturometer in which it was found that in the sensory evaluation there is a difference for hardness, cohesiveness, elasticity and chewiness compared to the conventional sample that showed lower values than those of the treatments in which chia flour was incorporated, while with the Brookfield texturometer there is a notable difference for hardness, In the study presented by Avila and Carbajal (2018) for the preparation of anchovy pulp hamburger using defatted sesame seed cake, it indicates that the incorporation of additives modifies the textural properties of meat products, due to the effect they have on the meat products, In our research, we can notice a difference if we compare the attributes of hardness and elasticity between analyses, which agree with each other to indicate a winner in this case treatment 2 (6% chia flour), but also discrepancy in the cohesiveness attribute, but the one that differentiates them as such is the chewiness property although the texturometer indicates that treatment 1 and 2 are similar in comparison with treatment 3 and the conventional sensory test gives the winner to treatment 2, so we can confirm that the study to characterize the sensory and instrumental texture of the Litopena shrimp culture. of cultured shrimp *Litopenaeus vannamei* by Tamarit (2008) indicates that humans are the only ones capable of fully and descriptively perceiving the sensations related to texture; however, instrumental tests allow us to define and quantitatively study textural properties.

Regarding the rheology analysis of the hamburger using chia flour it was shown that it presents more elastic than viscous characteristics therefore in rheological terms the mixture between the shrimp meat incorporating chia flour in three different percentages (3%-6% and 9%) behaves semi-solid, the curves were shown in increase of the storage or elastic modulus and the same as the loss in all treatments this is due as the speed increases, but presented differences in the concentrations; resulting that when comparing their means the treatment 3 pressed a higher value in function of the others, in the study presented Ramos, Fradinho, Mata and Raymundo (2017) showed that when increasing higher concentrations of chia there was a considerable increase in the viscoelastic modules similar to our research. On the other hand Mehta and Nayak (2017) conducted a comparative study to evaluate the biochemical composition, functional and rheological properties of fresh fish, squid and shrimp meats which indicates that the gelation of muscle proteins produces the transformation of an amorphous viscous phase to a three-dimensional elastic network, According to the test done on fresh shrimp meat (*Litopenaeus vannamei*), the pattern of the loss or viscous modulus was found to have low values in relation to the storage or elastic modulus, which also clarifies that this modulus drops when heated but stabilizes, even suggesting that the temperature range differs from one species to another.

Conclusions

During the study of the effect of ground chia seed incorporated as a thickening agent in the preparation of shrimp burger meat, the following conclusions were obtained:

The analysis of the functional properties such as water retention and binding capacity of chia flour allows concluding its potential use as a functional ingredient, besides helping to stabilize products destined to freezing, helping them to avoid liquid loss. To characterize the gelation of the flour, it is concluded that it presents a viscoelastic behavior, it has properties to form weak gels because the elastic modulus (G') was higher in relation to the viscous modulus (G''), a similar behavior was observed in another study, its incorporation allows improving the physical stability due to its role as thickener.

According to the comparison of using three different percentages of chia in the preparation of meat for shrimp hamburger with a conventional one analyzed in a sensory and instrumental way, it is concluded that there is a difference in the texture properties, an important attribute that allows us to determine the quality and acceptance of products with higher commercial requirements such as seafood.

The information obtained from the corresponding study on the effect of the variables chia flour concentration on rheological properties showed a significant increase in the storage or elastic modulus when the shear rate is increased; in all cases the elasticity is greater than the viscosity, so it presents more solid characteristics, therefore it is possible to use chia flour in meat technological processes such as hamburgers, improving the texture, through the use of a panel it was concluded that the treatment that presented the best sensory acceptance was treatment 2 (with 6% chia flour) which was submitted to microbiological analysis, The results obtained showed that the parameters of mesophilic aerobes, Escherichia coli, Staphylococcus aureus and Salmonella were within the ranges allowed by INEN 1338, thus demonstrating that the project was carried out under strict sanitary control, washing materials and utensils in the process.

References

Fuentes, G. (2012). Functional properties of chia seed flour (Salvia hispanica L.) and its effect on physicochemical and microscopic properties in a meat smoothie. *Doctoral thesis.* Universidad Autónoma Metropolitana Unidad Iztapalapa, Mexico City.

Andrade, G. (2000). *Shrimps and their importance in food.* Venezuela: Fonaipa divulga Nº65.

Avila, C., & Carbajal, J. (2018). Preparation of anchoveta (engraulisringeus) pulp patties and defatted sesame (sesamumindicum) cake. *undergraduate thesis.* University of SANTA, Nuevo Chimbote.

Capitani, M. (2013). Characterization and Functionality of chia (*Salvia hispanica* L.) by-products. *PhD Thesis.* National University of La Plata, La Plata.

Durango, V. (September 24, 2014). *Slideshare*. Retrieved on 11/7/2017, from https://es.slideshare.net/jatavier/tipos-de-investigacin-segn-el-objeto-de-estudio

Espinoza, A. (2017). Physicochemical and technofunctional properties of chia and its defatted extract. *Undergraduate Thesis.* Miguel Hernández University of ELCHE, Orihuela.

Espinoza, A. (2017). Physicochemical and technofunctional properties of chia (*Salvia hispanica* L) and its defatted extract. *Undergraduate Thesis.* Miguel Hérnandez University of Elche, Elche.

Fuentes, M. (2017). *Chia in the USA market.* Buenos Aires: Smart Business for a globalized world. Retrieved from http://www.sbntrade.com/?p=551&lang=es

Hernández, R., Fernández, C., & Baptista, P. (2014). *Metodología de la investigación.* Mexico DF, Mexico: McGRAW-HILL.

Ibáñez, F., Torre, P., & Irigoyen, A. (2003). *Food Additives.* Navarra: Nutrition and Bromatology Area.

Mehta, N., & Nayak, B. (2017). Bio-chemical composition, functional, and rheological properties of fresh meat from fish, squid, and shrimp: A comparative study. *International Journal of Food Properties, S707-S721*, 20(sup1).

PROECUADOR (April 9, 2014). *Boletin de Analisis de Mercado*. Retrieved from Ministry of Foreign Trade: https://issuu.com/pro-ecuador/docs/boletinmar_abr_88ad81c61e0353

Ramos, S., Fradinho, P., Mata, P., & Raymundo, A. (2017). Assessing gelling properties of chia (*Salvia hispanica* L.) flour through rheological characterization. *Journal of the Science of Food and Agriculture, 97(6)*, 1753-1760.

Riernersman , C., Romero , A., Doval , M., & Judis , M. (2016). Whole Chia flour as yield enhancer, potential antioxidant and input of n-3 fatty acid in a meat product. *In Food Nutr Sci, 7*, 855-865.

Segura, M., Ciau, N., Rosado, G., & Betancur, D. (2014). Chemical and Functional Properties of Chia Seed (*Salvia hispanica*L.) Gum. *Segura-Campos, M. R., Ciau-Solís, N., Rosado-Rubio, G., Chel-Guerrero, L., & Betancur-Ancona, D. (2014). Chemical and Functional Properties of Chia International Journal of Food Science*, 1-5 .

Tamarit, Y. (2008). Characterization of the sensory and instrumental texture of farmed shrimp Litopenaeus vannamei in the Tunas de Zaza shrimp farm. *Master's thesis.* University of Havana, Havana City.

Wong , C. (2004). *Technical research report.* Habama City. Cuba: Centro de Investigaciones Pesqueras.

Zaki, E. (2018). Impact of Adding Chia Seeds (Salvia hispanica) on the Quality Properties of Camel Burger "Camburger" during Cold Storage. *Int. J. Curr. Microbiol. App. Sci, 7(3)*, 1356-1363.