Physicochemical and sensorial characterization of vegan mayonnaise using chia seed oil and mucilage (S*alvia hipanica L.*)

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RESUMEN: Las semillas de chía (*Salvia hispánica L.*) son una fuente importante de compuestos nutricionales como grasas poliinsaturadas, fibra (soluble e insoluble) y proteína. En el presente trabajo se extrajeron el aceite y la fibra soluble (mucilago) para desarrollar una mayonesa vegana. La mayonesa se comparó con dos productos comerciales, una mayonesa regular y una vegana. El prototipo fue analizado físicamente en cuanto a color, viscosidad y estabilidad de la emulsión y sensorialmente con una prueba de escala hedónica. Los resultados mostraron que la mayonesa de chía presentó una viscosidad similar a la muestra vegana control, pero menor a la convencional, el color mostró diferencias significativas para todas las muestras. Sin embargo, la estabilidad de la mayonesa de chía fue menor comparada con las muestras control. En cuanto a los atributos sensoriales (apariencia, color, olor y textura), la mayonesa de chía presentó mejores resultados que la muestra control vegana en sabor y aceptabilidad general de sabor.

Palabras clave: Aceite de chía, mucílago de chía, mayonesa.

ABSTRACT: Chia seeds (*Salvia hispanica L.*) are an important source of nutritional compounds such as polyunsaturated fats, fiber (soluble and insoluble) and protein. In the present work, oil and soluble fiber (mucilage) were extracted to develop a vegan mayonnaise. The mayonnaise was compared with two commercial products, a regular and a vegan product. The prototype was physically analyzed in terms of color, viscosity and stability of the emulsion and sensorial analysis using a hedonic scale test. The results showed that the chia mayonnaise had a similar viscosity to the vegan control sample, but was lower than the conventional one; there were significant color differences for all the samples. However, stability was significantly lower in chia mayonnaise compared to control samples. Regarding the sensory attributes (appearance, color, smell and texture), the chia mayonnaise present better results than the vegan control sample in taste and general taste acceptability.

Keywords: Chia oil, chia mucilage, mayonnaise.

Área: Desarrollo de nuevos productos

INTRODUCTION

Mayonnaise is one of the most consumed condiments in the world; it is an oil in water emulsion, traditionally stabilized by egg yolk lecithin and mustard (Fernandes & Mellado, 2017). Several compounds from different nature are used as emulsifiers, stabilizers and thickener agents in emulsion based products. Phospholipid structures such as lecithin, can create a layer on the surface of the droplets decreasing the attraction forces between oil particles and thus, enhancing the stability of the system. In the case of gums, it is due to its water affinity and the viscosity increase of the dispersant phase (Kostansek, 2012).

Chia (*Salvia hispanica L.*) is a native crop from southern Mexico and northern Guatemala. It is a rich source of essential fatty acids, especially α-linolenic acid, soluble and insoluble fiber, and proteins (Fernandes & Mellado, 2017; Julio *et al.*, 2018). The omega-3 polyunsaturated fatty acids (ω-3 PUFAs) are associated with numerous potential health benefits when consumed at adequate levels. Additionally, the mucilage (soluble fiber) has also been associated with several health benefits, such as risk reduction of diabetes (type 2) and prebiotic effect to enhance the gut microbiota by increasing *Lactobacillus* and *Bifidobacteria* strains (Fernandes & Mellado, 2017; Soukoulis *et al.*, 2018).

Mucilages are a heterogeneous branched and hydrophilic polysaccharides which form a thick and sticky solution when dissolved in water. It is located in different parts of plants, like seeds, leaves and

buds. Tamarind seed, mustard seed, chia seed, fenugreek seed, and flaxseed are recognized as good sources of mucilage (Razavi, 2019).
The objective of this work was to study the physicochemical and sensorial characteristics of a vegan mayonnaise rich in omega 3 fatty acids using chia seed (*Salvia hispanica L.*) oil. The final prototype showed similar sensorial qualities as commercial vegan mayonnaise, however, the emulsion was not stable during storage time and its formulation has to be improved to increase the stability and flavor.

MATERIALS Y METHODS

Chia seeds were obtained in a local supermarket located in San Andrés Cholula, Puebla. Commercial mayonnaise, standard (SM) and vegan (VM) were used as a control sample.

Chia mucilage extraction

Chia seeds were soaked with water in a 1:30 seed: water ratio and stirred for 2 hours at room temperature. Then, the mucilage suspension was frozen at -20 °C overnight. Frozen mucilage suspension was freeze-dried and then separated mechanically from the seed core using a 40 mesh screen (Tavares *et al.,* 2018).

Chia oil extraction

Chia seeds were pre-treated using a household microwave oven for 2 minutes at 2450 MHz of frequency and 700 W of output potency. Then, chia seeds were passed through a single screw press oil n machine (Imran *et al.,* 2016). The obtained oil was kept at 4 °C for 48 hours and then centrifuged at 500 rpm for 15 minutes to separate from sediments. The oil was stored at 4 °C until further use.

Chia oil mayonnaise (CM) preparation

15 ml of an aqueous solution was prepared by dissolving 0.5 % (w/v) of chia mucilage, after full hydration, 2 % of pea protein isolate and 2% of xanthan gum were added. Afterward, 1 ml of vinegar and 1 ml of lime juice were added under high speed stirring. Then, 35 ml of chia oil were added slowly while the system was under constant stirring at high speed for 30 seconds. Sugar, salt and pepper were added to the mixture, finally, it was stirred using a balloon whisk for 30 seconds (Cornelia et al., 2015; Fernandes & Mellado, 2017). The final product was sealed in a container and stored at 4 °C.

Physical properties

Viscosity was measured using a Brookfield viscometer DV II using a RV-4 spindle at 10, 20, 50 and 100 rpm for 45 seconds. The color was determined using a Konica Minolta CR400; the results were expressed as L* a* and b* values.

Emulsion stability

Emulsions were heated up to 80 °C for 30 minutes and centrifuged at 4000 rpm for 10 minutes. The original emulsion and separated phase were measured in cm and stability was expressed in % and calculated using the following equation **(**Bin Wang *et al.,* 2014).

$$ES\ (\%) = \frac{Height\ of\ phase\ separation}{Height\ of\ original\ emulsion} * 100$$

Sensory evaluation

The attributes analyzed were appearance, flavor, smell, texture, color, taste, general acceptability for texture, general acceptability for flavor and preference using a 9-point hedonic scale. Twenty-four untrained panelists from Universidad de las Américas (UDLAP) took part in the test.

Statistical analysis

Finally, all the obtained data were analyzed using Minitab 18 software. The color and the sensory evaluation results were analyzed using a one way ANOVA.

RESULTS AND DISCUSSION

Viscosity

The emulsions showed a non-newtonian pseudoplastic behavior, decreasing of viscosity with increasing the shear rates. It could be due to the deformation and disruption of the oil droplets by the mechanical force applied, contributing to the reduction of viscosity (McClements, 2015). As is shown in **Figure 1**, the highest viscosity observed was for the standard commercial mayonnaise, while, vegan control and chia mayonnaise, showed similar behavior. Similar results were reported by Fernandes & Mellado (2017), where the partial substitution of egg yolk with chia mucilage reduced significantly the viscosity compared to a regular mayonnaise, the phospholipids present in the egg yolk protect the oil droplets from coalescence giving a better stability to gravitational forces.

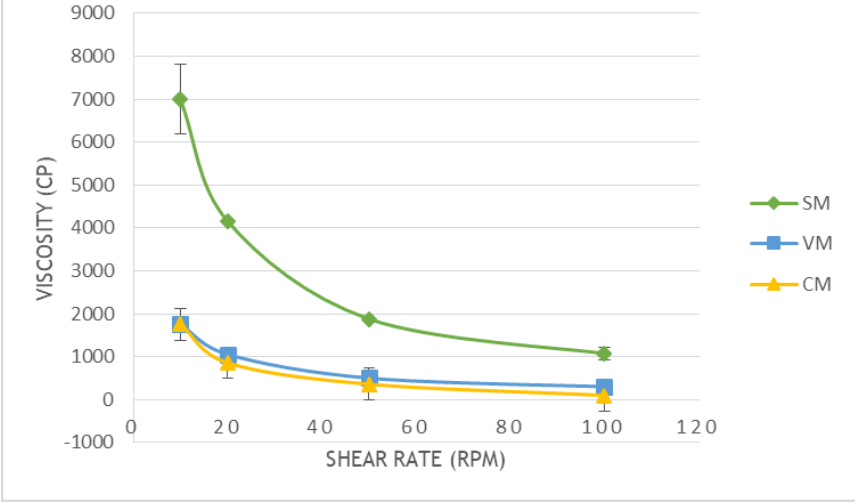

Figure 1: Viscosity from 10 to 100 rpm of standard mayonnaise (SM), vegan mayonnaise (VM) and chia oil mayonnaise (CM).

Color

The color parameters obtained are summarized in **Table I**. L a b parameters of CM were significantly different ($p<0.05$) in comparison to both control samples. CM showed lower L*, a* values and higher b* values. These results indicated that CM is more opaque with predominant yellowness (b*) color, probably related to the intense yellow color of the raw chia oil. These results are in accordance to values reported in the literature where the color ranged from 70.05 to 86.43, -3,25 to 1.05 and 20.80 to 28.46 for L, a* and b* respectively (Fernandes & Mellado, 2017).

Table I: Color of standard mayonnaise (SM), vegan mayonnaise (VM) and chia oil mayonnaise (CM).

Mayonnaise	L*	a*	b*
SM	75.32 ± 0.10^{A}	-4.06 ± 0.08^{A}	17.09 ± 0.18^{A}
VM	78.56 ± 0.96^{B}	-1.01 ± 0.31^{B}	12.15 ± 0.55^{B}
CM	69.20 ± 1.59^{C}	-3.14 ± 0.28^{C}	19.70 ± 1.23^{C}

Same letter in the same row indicates no significant difference ($p>0.05$)

Emulsion stability

The CM prototype showed the lowest stability (49.16 % ± 1.1) compared to ($p<0.05$) control samples SM (99.37 % ± 0.7) and VG (99.1 % ± 0.9). This behaviour was expected due to commercial products have more additives in its composition in contracts to the natural CM prepared. However, CM in the present work showed higher stability than a previous report with a similar product and raw material (38-40 %). (Fernandes & Mellado, 2017).

Sensory evaluation

Sensorial results are shown in table II. No significant difference was obtained ($p>0.05$) in appearance and color between samples. In contrast, the attributes of texture and flavor (individual and general) were higher for SM than for VM and CM, nevertheless, both vegan versions were equally evaluated. Despite that the product did not show the scores of general acceptability as the control standard sample, it was better than the vegan control. These results were expected, because in general the population is accustomed to standard mayonnaise taste, however, the target sector market is focused on non-animal derivatives products consumers.

Table II. Results of sensory evaluation of standard mayonnaise (SM), vegan mayonnaise (VM) and chia oil mayonnaise (CM).

	SM	CM	VM
Appearance	6.375 ±1.715^{A}	5.958±2.095 ^{A}	6.083±1.692 ^{A}
Color	6.125±1.963^{A}	6.292±1.546 ^{A}	6.417±1.886 ^{A}
Smell	6.167±2.353^{A}	5.792±1.444 ^{A}	5.083±1.998 ^{A}
Texture	6.667±1.736^{A}	6.292±1.732 $^{A, B}$	5.333±2.099 ^{B}
Flavor	6.750±2.005 ^{A}	6.042±1.601 ^{A}	4.042±2.116 ^{B}
Texture general acceptability	7.000±1.668 ^{A}	6.333±1.373 $^{A, B}$	5.125±2.133 ^{B}
Flavor general acceptability	6.917±1.742 ^{A}	6.083±1.717 ^{A}	4.125±2.092 ^{B}
Flavor IA (%)	76.85	67.58	45.83
Texture IA (%)	77.77	70.36	56.94

Same letter in the same row indicates no significant difference ($p>0.05$)

CONCLUSION

A vegan mayonnaise using different components of chia seed was developed. The product obtained substituted the egg yolk that is used in traditional mayonnaise by both mucilage and oil from chia seed. In this work, was studied the opportunity to develop an added value product from chia crop with high nutritional quality by eliminating the use of saturated fats and animal ingredients. This initial study is one step for improving a potential commercial product with higher acceptance and better stability.

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