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Effect of texture improvers on the organoleptic characteristics of a vegan product type of thick pasta sausage.

Efecto del uso de mejoradores de textura sobre las características organolépticas de un producto vegano tipo embutido de pasta gruesa.

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Abstract
The growing vegan population in the world makes it necessary to develop better food products. The objective of this research is to produce a vegan thick pasta sausage product with acceptable organoleptic properties and high protein content. For this, vegan sausage formulas were prepared where the meat of animal origin was completely replaced with textured soy protein, using potato starch, carboxymethylcellulose (CMC) and wheat gluten as texture improvers; additionally, ingredients such as spices, vegetable, glutamate, nutritional yeast, etc. were used. For its evaluation, descriptive and hedonic sensory analysis was applied, the maximum shear force was determined using a texturometer and the protein content was quantified by proximal analysis. It was determined that the ideal proportion of additives is 20% wheat gluten, 0-3% potato starch and 0-0.3% CMC, since in this way the highest organoleptic acceptance values were obtained, without differing too much from an existing sausage type vegan commercial product as control sample. In addition, it was possible to improve the texture to values of 911.50 + 93.00g (F1) and 861.89 + 66.17g (F4), superior to other developments of vegan sausages from bibliography. Finally, it was determined that the protein content of the two formulas developed (F1 21.99%, F4 19.57%) is higher than that of a commercial vegan product (16%) and that of the original Manabí sausage (16%). In conclusion, the elaboration of a vegan product type sausage of thick pasta is feasible maximizing its organoleptic properties thanks to the use of the three texture improvers, especially wheat gluten.

Key words
textured soy, veganism, sausage, potato starch, carboxymethylcellulose, wheat gluten.

Resumen
La creciente población vegana en el mundo hace necesario el desarrollo de mejores productos alimenticios. El objetivo de la presente investigación fue elaborar un producto vegano tipo embutido de pasta gruesa, con propiedades organolépticas aceptables y contenido de proteínas elevado. Para ello, se prepararon fórmulas de embutido vegano donde se sustituyó en su totalidad la carne de origen animal con proteína de soya texturizada, empleando almidón de papa, carboximetilcelulosa (CMC) y gluten de trigo como mejoradores de textura; adicionalmente se emplearon especias, vegetales, glutamato, levadura nutricional, etc. Se aplicó análisis sensorial descriptivo y hedónico, se determinó la fuerza máxima de corte mediante un texturómetro y se cuantificó el contenido de proteína. Se determinó que la proporción ideal de aditivos es de un 20% gluten de trigo, 0-3% almidón de papa y 0-0,3% CMC, ya que así se obtuvieron los más altos valores de aceptación organoléptica, no existiendo diferencia significativa con un producto vegano tipo embutido comercial usado como control. Se logró mejorar la textura hasta valores de 911,50 + 93,00g (F1) y 861,89 + 66,17g (F4), superiores a otros desarrollos de embutidos veganos de la literatura. Por último, se determinó que el contenido de proteína de las dos fórmulas desarrolladas (F1 21,99%, F4 19,57%) es superior al de la muestra control (16%) e inclusive al de la longaniza manabita original (16%). En conclusión, la elaboración de un producto vegano tipo embutido de pasta gruesa es factible maximizando sus propiedades organolépticas gracias al uso de los tres mejoradores de textura.

Palabras clave
Soya texturizada, veganismo, embutido, almidón de papa, carboximetilcelulosa, gluten de trigo.

1. Introduction

Today the food industry represents a considerable negative impact on the animal kingdom, preying on and exploiting a wide variety of farm animals for human consumption, in addition to generating large amounts of CO2 into the environment, for which this system needs changes according to the current socio-environmental reality [1, 2]. One of the food trends with the greatest impact in recent years, called "Veganism", emerges as a moral lifestyle, dedicated to becoming aware of animals and the environment, replacing meat foods with products made from plant-based sources [1, 3, 4]. Despite its benefits, consumers of vegan foods face limitations such as the limited variety in product offerings and the need for special skills to prepare according to the composition of the ingredients to be used [5].

One of the ingredients used for the development of meat substitutes is textured soy protein, as it provides a large amount of nutrients such as high quality protein, amino acids, lipids, carbohydrates, fiber, iron, calcium, zinc and vitamin B [6]. This raw material is extremely flexible and appreciated, because when subjected to hydration processes, it provides a fibrous texture very similar to meat, which benefits its acceptance among all types of consumers [7]. According to Chiang et al. [8], la the implementation of wheat gluten in formulations based on textured soy protein allows complementing and

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enhancing the fibrous sensation of food, getting even closer to the original texture of a meat product. Another remarkable additive that allows replacing saturated fats and providing positive organoleptic properties, water retention and texture, is carboxymethylcellulose (CMC) in small amounts [9, 10]. Starches, especially potato, corn and cassava, also represent important starch supplies for the industry, thanks to their flexibility in harvest time and availability in the market [11].

The development of non-meat foods that resemble their nutritional and organoleptic properties is no easy task, since the elasticity of meat cells provides a characteristic texture, which is not easily matched when using plant raw materials [12]. That said, the acceptance of meat substitutes by the average omnivorous consumer tends to be compromised because their sensory characteristics and textures are usually poor compared to meat [13, 14, 15]. According to Singh et al. [16], the growing trend of vegan consumption is due not only to awareness of animals and the environment, but also due to an economic aspect, since basic ingredients for these products, such as soy and mushrooms are less expensive [17].

In this work, formulations of substitutes for meat sausages are analyzed, based on the implementation of textured soy protein as the main ingredient, in the development of a vegan sausage, which is pleasing to all consumers. The main purpose of the study is to define a vegan product, which has pleasant organoleptic characteristics and an optimal texture to approximate the bite and consistency corresponding to a thick pasta sausage based on meat.

2. Materials and methods

2.1. Ingredients

The development of the vegan sausage was based on the formula of the traditional Manabí sausage (Ecuador), in which the animal protein was completely replaced with textured soy. The other ingredients were: base sauté (red onion, fresh garlic, chillangua, cilantro, mint, annatto paste, oil, black pepper), spice mix (salt, pepper, cumin, oregano, garlic powder, paprika, glutamate and vegan pork flavor), vinegar, coconut oil, liquid smoke and nutritional yeast. To these ingredients potato starch, CMC and wheat gluten were added as texture improvers in combined percentages by experimental design.

2.2. Experimental design

In preliminary tests it was defined that the maximum percentage to be used of potato starch is 3%, since at a higher percentage a too rigid and pasty product is obtained. The experimental design carried out was a 23 factorial design, where the three treatments correspond to the three texture improving ingredients: potato starch, CMC and wheat gluten, each varying their participation at two levels: 0 - 3%, 0 - 0.3% and, 20 - 25%, respectively.

Table 1. 23 factorial design for application of texture improvers in vegan sausage.

Formula	Potato starch (%)	CMC (%)	Gluten (%)
1	0	0	20
2	3	0	20
3	0	0,3	20
4	3	0,3	20
5	0	0	25
6	3	0	25
7	0	0,3	25
8	3	0,3	25

2.3. Sensory evaluation

The organoleptic evaluation of the formulas was carried out in two phases. Phase 1, with the participation of three expert judges through a descriptive test, where the adequacy of the attributes flavor, color, smell, juiciness, fiber and chewiness was evaluated, on a scale from 1 (less suitable) to 5 (more suitable); The objective of this test was to select the two best formulas out of a total of eight. Phase 2 corresponds to a hedonic test to assess the level of liking, with the participation of 30 untrained judges; The scale used corresponded to seven levels: I extremely dislike it, I dislike it a lot, I slightly dislike it, I neither like nor dislike it, I slightly like it, I really like it and I extremely like it. In this test, a commercial vegan product, chorizo grill type, was also used as a control.

2.4. Texture analysis

To evaluate the texture profile, a Perten TVT 6700 model texturometer was used, using the 45-01.01 Sausages Firmness-Cutting profile, through which pressure tests are performed in a single cycle. In this test, the samples are placed on a support, on which a force is exerted by means of a cutting probe, the maximum force required to cut the samples is quantified by the equipment in grams (g) units. To carry out this analysis, five samples were used for each formulation (four replicates) each weighing 30g.

2.5. Proximal protein analysis

A proximal protein analysis was performed at an accredited external laboratory, using the Kjendal AOAC 21st 920.87 method. This analysis was performed with one replicate.

2.6. Statistical analysis

The responses of the different experiments were analyzed with the Statgraphics Centurion statistical program, with which optimization was applied for

descriptive sensory analysis, analysis of variance for hedonic sensory analysis and comparison of means for texture results.

3. Results

3.1. Descriptive analysis

The evaluation of the experts of the different attributes of the vegan sausage allowed defining the optimal value to use by means of the statistical program. Below are the optimization results for each attribute.

Table 2. Optimal percentage values of texture improvers based on expert rating

Factor	Taste	Color	Juiciness	Fiber	Chewiness
Potato starch	3	0	0	3	0
CMC	0	0,3	0	0	0,3
Gluten	20	20	25	20	25

Source: Authors. Optimization values obtained with Statgraphic Centurion

As we can see in Table 2, each attribute has different values for the three ingredients evaluated, for this reason, the criterion of the importance of the attributes taste, juiciness, fiber and chewiness in the product developed is applied. Considering this, formulas 1 (F1) with 20% gluten, 0% potato starch and 0% CMC and, formula 4 (F4) with 20% gluten, 3% potato starch and 0.3% CMC are chosen for the following evaluations.

3.2. Acceptance analysis

Figure 1 shows the acceptance results of the two chosen formulas (F1 and F4) as well as the control product (commercial vegan product, chorizo.

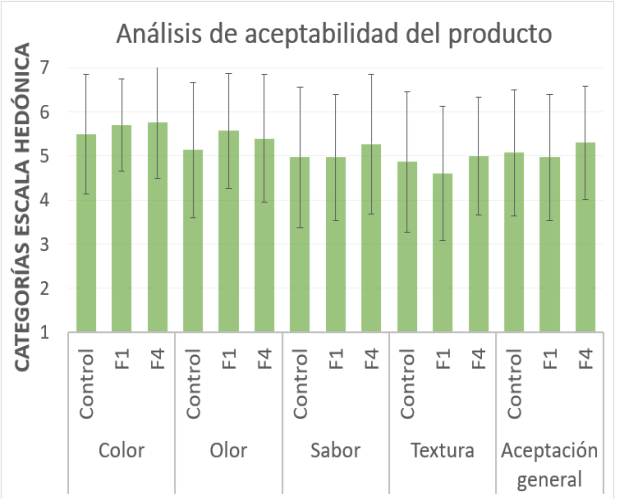

Fig. 1. Acceptance analysis results. Use of hedonic scale: 1. I extremely dislike it, 2. I dislike it a lot, 3. I slightly dislike it, 4. I neither like nor dislike it, 5. I slightly like it, 6. I really like it and 7. I extremely like it

By performing the analysis of variance of all the attributes, it is determined that there is no significant difference between the control samples and the two developed formulations (p-value > 0.05) in any of them. This result implies the fact that if the control product is already commercially established, there is a high probability that the products developed in this study will be accepted by the consuming community of this type of products. In fact, it should be noted that the average acceptance values of all attributes are higher in the two products developed compared to the control, with values between the categories I slightly like it (5) and I really like it (6). Finally, in this section, note that formula F4 obtains the best results.

3.3. Texture analysis

The texture results show that there is no significant difference between the two formulas in terms of the maximum cutting force required, which represents the consistency of the vegetable sausage. F1 obtained a value of 911.50 + 93.00 g and for F4 861.89 + 66.17 g. This result is striking because F1 contains 0% potato starch, 0% CMC and 20% gluten, while F4 has 3% potato starch, 0.3% CMC and 20% gluten, which implies that the most important texture enhancer is gluten to achieve good consistency. The cutting force results obtained are superior to that obtained by Chaijan and Panpipat [18] of 540g in a sausage made from tilapia.

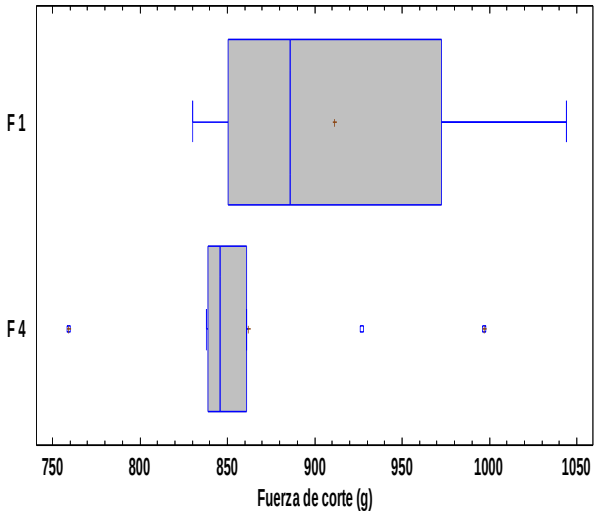

Fig. 2. Texture cutting force box plot for two vegan sausage formulas
Source: Authors

3.4. Protein analysis

The results of the proximal protein analysis are shown in Table 3. It can be seen that the two developed products exceed the commercial vegan sausage and even the original Manabí sausage.

Table 3. Proximal protein analysis

Evaluated product	Protein content (%)
Original Manabí sausage	16,00
Commercial vegan sausage	16,00
F1	21,99
F4	1957

Source: Authors

4. Conclusions

Developing vegan sausages with textured soy protein as a total substitute for animal protein is fully feasible with the use of texture improvers, especially wheat gluten, in a percentage of 20 to 25%, which allows obtaining a product acceptable in all organoleptic attributes. The other two ingredients evaluated (potato starch and CMC) allow obtaining better overall acceptability results.

Among the organoleptic results, the most challenging was the texture due to the difficulty of obtaining the fiber and consistency provided by animal meat. The maximum cutting force values (g) obtained in the texturometer were higher than those reported in the literature for other similar developments, indicating better firmness of the sausage.

In the nutritional aspect, the developed product, in its two formulas, exceeds protein content expectations since containing 21.99% (F1) and 19.57% (F4) significantly exceeds the protein content of the control sample and even the original sausage of animal origin.

With all the results obtained, it can be concluded that the two developed formulas of vegan product based on textured soy thick pasta sausage type, meet the nutritional and organoleptic requirements to be accepted among vegan and vegetarian consumers.

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