Instrumental and sensory analysis of Antioquian type chorizo formulated with a fat substitute

Análisis instrumental y sensorial de un chorizo tipo antioqueño formulado con un sustituto graso

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Resumen

Las grasas naturales sin extensión, condicionan el alimento y tienen un comportamiento reológico y sensorial diferente al de las grasas extendidas con otros materiales. La presente investigación evaluó el efecto del uso de un extensor de grasa sobre algunas propiedades de calidad textural y sensorial de un chorizo tipo antioqueño. Se sustituyó la grasa de cerdo mediante el uso de alginato de sodio (E1) y alginato de sodio adicionado con fibra cítrica (E2), los cuales se usaron para sustituir parcial (70 %) y totalmente la grasa en una formulación de chorizo tipo antioqueño. Se realizaron pruebas instrumentales y sensoriales para medir algunos atributos de calidad del producto. El extensor graso a partir de alginato de sodio (E1), influyó positivamente en las características instrumentales y sensoriales del producto. La fuerza de corte arrojó valores de hasta 4,03 % por encima del testigo y, en relación al análisis sensorial, fue el mismo tratamiento el que obtuvo las mejores puntuaciones. En conclusión, el uso de E1 permite elaborar un producto con el requerimiento nutricional deseado.

Palabras clave: bajo en grasa; producto cárnico; sustituto de grasa; sensorial; fuerza de corte; alginato de sodio.

Abstract

The natural fats without extension, condition the food and have a rheological and sensorial behavior, different from the fats extended with other ingredients. The present research evaluated the effect of the use of a fat extender on some properties of textural and sensory quality of an Antioquian kind of chorizo. Pork fat was replaced by the use of sodium alginate (E1) and sodium alginate added with citrus fiber (E2), which were used to partially (70 %) and replace the fat in an Antioquian-kind of chorizo formulation. Instrumental and sensory tests were performed to measure some attributes of product quality. The Sodium alginate (E1) fat extender, influenced positively the instrumental and sensory characteristics of the product. The cutting force delivered values of up to 4.03 % above the control and, about the sensory analysis, it was the same treatment that obtained the best marks. In conclusion, the use of E1 allows producing a product with the desired nutritional requirement.

Keywords: low fat; meat product; fat substitute; sensorial; cutting force; sodium alginate.

Introduction

In response to variations in dietary patterns recommended mainly by health professionals and even by other trends, the food industry has not only been dedicated to producing but also contribute to product research and development, for the sake of meeting current market needs. Reducing the fat content in food is one of them. It is considered one of the ingredients with the highest risk to the health of consumers. The excessive intake of foods that are a source of fat and with high consumption of calories accompanied by sedentary lifestyles promote nutritional disorders that affect body weight and general health (Cabezas-Zábala; Hernández-Torres; Vargas-Zárate, 2016).

According to Mariné (2017), the safety of sausages is the limiting factor for their consumption. For this reason, they are currently the subject of debate due to the possible negative effects on health derived from their excessive consumption, this largely depends on the nature of the basic raw material (pork, bovine, poultry), the quantity and the nature of fats with a significant content of cholesterol and the additives incorporated for their elaboration. This is where the weaknesses of sausages lie, studies such as the one carried out by Ros et al., (2015), report that the consumption of diets with high-fat content, especially of animal origin, provide a large percentage of saturated fat, associated with cardiovascular diseases, diabetes, blood pressure, cancer, among others, that put people's lives at risk.

The World Health Organization in 2016, recommended the consumption of essential fats in the daily diet to obtain energy, which should include "heart-healthy" fats and, in the same way, stated the need to replace the Saturated fats. Thus, total fat consumption should not exceed 35% of the daily diet, of this total, polyunsaturated fats should be between 2.5% and 9.0%, while monounsaturated fats between 15% and 20 %. Finally, it mentions that the consumption of saturated fats should not be above 10%.

Regarding animal fat, the highest levels of cholesterol and saturated fatty acids are in pork, which is related to a series of diseases associated with its ingestion (Pacheco-Pérez; Restrepo-Molina; López-Vargas, 2011). For this reason, meat products made with this ingredient, including beef itself, have become a threat to the consumer, who due to this, has chosen to eat foods that are poorly processed or formulated with reduced levels of fat and cholesterol, improved fatty acids and with the incorporation of healthy ingredients (Olmedilla-Begoña; Jiménez-Francisco, 2014).

However, it is well known that fat conditions the sensory and instrumental texture characteristics of the product (Rivera, 2012). This is fundamentally based on the fact that fats provide very good sensory characteristics to products, but also, negatively impacts consumer health and makes them materials prone to being substituted in the various formulations, so the true problem the technician must solve is the elaboration of a material that looks like a fat, that grants the same characteristics of this with a lower caloric content and that does not represent a danger to public health. For this, both science and the meat industry have investigated the use of fat substitutes that allow the quality of the product to be maintained by using several protein materials, lipids, carbohydrates and even water as substitutes, to comply with the modern feeding strategies that improve the composition or quality of food of animal origin (Landero, 2015).

With the above, there is a constant need to generate consumption alternatives, based on the reformulation of products that contribute to healthy eating. The objective of the present investigation is the evaluation of the effect of the use of a fat extender on the quality properties in terms of texture and sensory of Antioquian type chorizo.

Materials and methods

The pork fat was taken and spread with water using the fat ratio: spreading agent: water (49: 2: 49), respectively, using two extenders. The first extender (E1) was made up of a mixture of sodium alginate, calcium sulfate, and tetrasodium pyrophosphate, while the second (E2) besides the prior was added citrus fiber. The fast spread was prepared with the help of a homogenizer (Sammic®, TR / BM350BN + BB) at speed 2 for 3 min. For this, the water was added first, then the extender and, finally, the fat. Both the water and the fat were at 3 ºC at the time of mixing. It was left in the refrigerator for 24 h and the mixture was incorporated, thus replacing 70 and 100% of the fat in the formula. Four treatments plus the control (fat without extender) were developed. Table 1 shows the base formulation of the Antioquian-style chorizo, which was then used to design treatments with different levels of pork fat and fat extender.

Table 1.

The formulation used to make a 1.5 kg pot of low-fat Antioquian style chorizo

Ingredients	%	g/
Pork Meat 90/10 x 5 mm	64,68	1000
Pork bacon x disco 12 mm	12,61	195
Antioquian chorizo flavor preparation	1,10	17
Refined salt	0,65	10
Monosodium glutamate	0,10	1,5
Nitral curing salt	0,29	4,5
Leek onion	1,16	18
Hydrated response 1:3	2,52	39
SPC (intense - taste)	0,52	8
Natural color anato	0,06	1
Ice water	15,98	130
Poly liquid smoke 8,5	0,32	5

Source: self-made.

Cooking loss

To determine cooking losses, the proposed methodology was used (Nollet-León; Toldra-Fidel, 2009), for this, each sample was weighed before and after it was cooked.

$$\%\text{cooking loss} = \frac{(\text{weight before} - \text{weight after})}{\text{Weight before}} * 100 \quad (1)$$

Where:

Weight before = weight of fresh chorizo without cooking.
Weight after = weight of the chorizo after cooking.

Purge loss

12 experimental units per treatment were obtained, these were packed in three samples for a total of four packages, with which their syneresis was determined during 10 days of storage in refrigeration 2 + 2 ºC. Regarding the measurement, each chorizo was initially dried with an absorbent towel, then it was weighed and packaging continued. After 10 days, each experimental unit was unpacked, dried, and reweighed. Finally, the difference between the two weights found for each treatment was calculated and the result was presented in a percentage based on the initial weight.

PH measurement

The potentiometer method was applied to determine the pH of the samples and a Schott brand Handylab pH11 pH meter was used.

Instrumental measurement of texture

The texture properties of the sausages were evaluated with the cut resistance test, through a model TA-XT2i Texture Analyzer (Stable Micro Systems®). The parameters used to measure the shear strength of the samples were: 3.0 cm high and 2.5 cm in diameter, a Warner-Bratzler probe with a 50 kg load cell and a speed of 2 mm / s was used, through which the maximum force (N) necessary to cut the sample was measured. All measurements were made on previously cooked sausage samples until reaching an internal temperature of approximately 78 ºC.

Sensory evaluation

The sensory evaluation of the sausages was made using a Quantitative Descriptive Analysis (QDA), in which the level of preference, external appearance, internal appearance, color, characteristic odor/aroma, characteristic flavor, and hardness was evaluated. For the sensory test, the samples were cooked on a grill for approximately 10 min, until reaching an internal temperature of 72 ºC. They were cut into 4 cm long portions and placed randomly with numbers from 1 to 5. The sensory evaluation was carried out by five trained panelists from one organization, who were provided with two formats; in the first, they were asked to organize from 1 to 5 the one they liked the least and the one they liked the most, respectively; in the second, they were asked which one they considered easier to bite and why not. The repetitions in this test were done as indicated by the statistical design. This measurement was made on day 1 and day 10 after its elaboration.

Statistical analysis

The data obtained in the different determinations were statistically analyzed using one-way analysis of variance (ANOVA), with a significance level of 0.05, while the means were compared using the Tukey HSD multiple range tests, with a level with a significance of 0.05. All analyzes were performed using the Statgraphics® Centurion XV statistical package (version 15.2.06). Three replicates were made of each treatment, with four repetitions each.

Finally, it was determined to work with different levels of inclusion of the extended fat, as shown in Table 2.

Table 2.
Treatments evaluated

Treatment	% fat spread
Witness	0
Treatment A (extender 1)	70
Treatment B (extender 1)	100
Treatment C (extender 2)	70
Treatment D (extender 2)	100

Source: self-made.

Results and Discussion

Cooking and purging losses

Regarding cooking losses, no significant differences (p> 0.05) were found between days. However, on day 1 there was a significant difference (p <0.05) between treatments A and B formulated with E1 (without citrus fiber) and treatments C and D formulated with E2 (with citrus fiber), mentioned behavior was the same on day 10. The cooking stability of samples A and B was higher regarding those named C and D. This may be due to the interactions between the surfactant molecules that are located at the interface and the hydrocolloid that is dispersed in the aqueous phase, are greater retaining the fat particles, this way, losses during cooking were prevented, which did not happen with the mixture that contained citrus fiber. It seems that the fiber present in the last two mentioned treatments accelerated the cooking losses, also, the emulsion bonds did not reach sufficient ionic strength to retain water (Lupo-Bryshila, 2014).

Regarding purge losses, there were no significant differences between the samples, which showed that the incorporation of the extender stabilizes the fat phase in all cases and, therefore, increases the stability of the mixtures, as observed in Table 3.

Table 3.
Cooking and purging losses in the Antioquian-type chorizos made with and without a fat extender, days 1 and 10

	Treatments				
Parameters	**Witness**	**Treatment A**	**Treatment B**	**Treatment C**	**Treatment D**
Cooking losses% (day 1)	9,32 ± 0,041a	9,78 ± 0,02a	9,63 ± 0,05a	12,56 ± 0,02b	13,18 ± 0,02b
Cooking losses% (day 10)	9,41 ± 0,03a	9,64 ± 0,03a	9,69 ± 0,01a	12,23 ± 0,02b	12,72 ± 0,07b
Purge losses% (day 10)	1,76 ± 0,01a	1,87 ± 0,04a	1,91 ± 0,03a	1,94 ± 0,01a	1,97 ± 0,04a

All values are means ± standard deviation of four repetitions. In each row, the means with different letters indicate significant differences (p <0.05).
Source: self-made.

The results obtained in this investigation were confirmed with the study carried out by Saldaña-Erick *et al*., (2015), who substituted animal fat for vegetable fat and vegetable fat plus hydrocolloids. These found that the substitution of fat for vegetable fat without hydrocolloids caused an increase in the release of fluid when the product was subjected to heat treatment. This behavior generally occurs when the fat is replaced by water. They also mention that by having a decrease in the concentration of protein involved in the formation of the emulsion, the binding properties between water and fat are reduced in products with lower fat content. However, when sodium alginate and guar gum were included in the formulations, the liquid release decreased.

In another study by Pacheco-Pérez; Restrepo-Molina; López-Vargas (2011), the effect of a fat extender on the quality properties of chorizo was evaluated, where it was evidenced that concerning cooking losses there are significant differences (p <0.05) between the control and the treatment with the extender, the losses were greater for the last mentioned. Meanwhile, in the losses due to purging, there were no significant differences (p> 0.05).

PH measurement

Table 4 shows the results obtained from the pH measurement, for days 1 and 10 respectively.

Table 4.
pH of the Antioquian-type chorizos made with and without a fat extender, days 1 and 10

	Treatments				
Parameter	**Control**	**Treatment A**	**Treatment B**	**Treatment C**	**Treatment D**
pH (day 1)	5,72 ± 0,02a	5,76± 0,01a	5,80± 0,03a	5,66± 0,02 a	5,56± 0,04 a
pH (day 10)	5,73 ± 0,01a	5,75± 0,01a	5,77± 0,02a	5,71± 0,01 a	5,73± 0,04 a

All values are means ± standard deviation of four repetitions. In each row, the means with different letters indicate significant differences (P <0.05).
Source: self-made.

Regarding the measurement of this parameter, no significant differences (p> 0.05) were found between days and also between treatments. Both the alginate mixture and the one added with citrus fiber behaved similarly in the meat matrix and even did not modify the pH of the treatments. This result was corroborated by Rather-Sajad; Massodi-F .; Akhter-Rehana; Rather-Jahangir; Amin-Furheen (2017), who studied the effect of guar gum as a fatty substitute in low-fat meat emulsions. For their research, they designed four treatments plus one control; three of them contained guar gum in different percentages and found that only the treatment with the highest levels of this hydrocolloid was significantly different (p <0.05) for the texture variable.

However, Lupo-Bryshila (2014) states that pH between 5 and 10 does not alter the viscosity characteristics, due to a repulsive effect of negatively charged carboxyl groups, which keep the polymer chains extended and increase their ability to bond with water molecules. Furthermore, it adds that at a pH between 3 and 3.5, alginate is insoluble and precipitates as alginic acid, while an increase in pH above 10 would cause depolymerization.

Instrumental texture analysis

The measurement of the cutting force for days 1 and 10 did not show significant differences (p> 0.05). Regarding the treatments, significant differences (p <0.05) were prepared between the samples made with E1 (A and B) and E2 (C and D). For treatments A and B, the cutting force was greater than in treatments C and D, apparently, the mixture of alginate plus fiber with which the last two were made, forms weaker meat networks, as observed in the Table 5.

Table 5.
Instrumental texture parameters of the Antioquian-type chorizo made with and without a fat extender, days 1 and 10

	Treatments				
Parameters (%)	**Control**	**Treatment A**	**Treatment B**	**Treatment C**	**Treatment D**
Cutting force (day 1)	79,18± 0,04a	73,41±0,05a	83,21± 0,02a	64,10±0,02b	69,54± 0,02b
Cutting force (day 10)	79,23± 0,01a	72,28±0,03a	81,32± 0,04a	67,18±0,02b	70,02± 0,01b

All values are means ± standard deviation of four repetitions. In each row, the means with different letters indicate significant differences (P <0.05).
Source: self-made.

In general, the cut resistance was associated with the hardness of the material, due to the strength of the gel. The composition and structural form of E1 was influenced by the levels of alginate and calcium inclusion, which allowed the union between water and fat and thus dispersed in crystalline areas.

In turn, in the study carried out by Ramírez; Marulanda; Orrego (2016), in which a mixture of fibers and starches was developed as a fat substitute for sausage-type fine pasta products, it was found that the variables associated with the hardness of the product improve concerning the control treatment and it seems that They achieve better results by using only the fibers without the need to mix with another product such as hydrocolloids. It should be noted that not every polysaccharide by itself behaves ideally, as in the case of Rather-Sajad; Massodi-F .; AkhterRehana; Rather-Jahangir; Amin-Furheen (2017), where they used guar gum as a fatty substitute in meat products and found that the treatments with the lowest cutting force are those that contained the highest percentage of this extender.

Sensory evaluation

Significant differences ($p < 0.05$) were found in all the parameters that make up the sensory profile of this investigation. Treatment A obtained the highest averages in attributes, such as color, odor, taste, and external appearance; even, above the control. The internal appearance of the control was the best-rated, while treatment B was evaluated as the hardest sample, a result that agrees with that found in the instrumental analysis. This means that this same formulation required a higher cutting force, due to factors such as the components and the inclusion percentages of the extender and the stability of the meat matrix as a cause of the formation of strong ionic bonds.

On the other hand, the lowest scores for attributes such as odor, taste, hardness, internal and external appearance, were those of treatment D and very close to this was C, which obtained the lowest score in terms of color. The treatment that consumers preferred was the one that was formulated with the partial inclusion (70%) of the alginate-calcium mixture (see Figure 1).

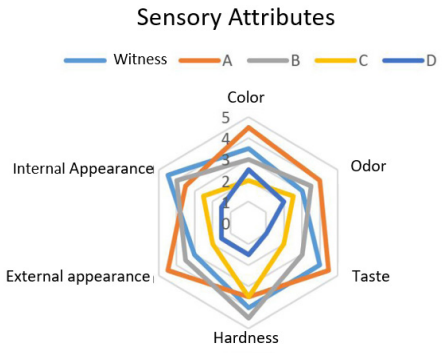

Figure 1. Results of the quantitative descriptive analysis carried out on the Antioquia type sausage for treatments A, B, C, D
Source: self-made.

The study carried out by Pacheco-Pérez; Restrepo-Molina; López-Vargas (2011) highlighted the flavor behavior and herbaceous characteristics and determined that both attributes obtained scores very close to control. Despite the few studies carried out that show that the sensory characteristics of food improve with the presence of alginates, authors such as Avendaño-Romero; López-Malo; Palou-E (2013); Díaz-Juan; Pérez-María; Vera-Norma; Soto-Sergio; Totosaus-Alfonso (2017) affirm that the sensory characteristics in food are favored by the presence of this hydrocolloid.

This statement was verified in the investigation, where it was evidenced that the sensory panel has a preference for treatments formulated with the extender that contains the alginate mixture. For their part, Saldaña-Erick *et al.*, (2015) found that the treatments formulated with the replacement of animal fat by hydrocolloids were very similar and that, in general, the reduction of fat and the addition of hydrocolloids did not affect the sensory characteristics studied here.

Conclusions

The elaboration of the Antioquian-type chorizo replacing 100% of the fatty pork bacon, with fat extended to 50% from sodium alginate, calcium sulfate, and pyrophosphate, generates sensorially acceptable products and with texture characteristics adjusted to the traditional one. The label of such meat may well carry the proclamation "reduced-fat", as permitted by law. This development shows viable and important results for the meat industry that seeks to generate healthy alternatives for the consumer.

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