Contemporary Engineering Sciences, Vol. 10, 2017, no. 30, 1473 - 1483
HIKARI Ltd, www.m-hikari.com
https://doi.org/10.12988/ces.2017.7886

Development of a Scalded Meat Product Added with Modified Bean Starch Zaragoza (*Phaseolus lunatus*) Red Variety

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Abstract

A sausage type food was elaborated including different levels of modified starch of Zaragoza bean (*Phaseolus lunatus*) red variety. We applied analysis of variance, Tukey test and descriptive statistics. The results indicate that the levels of modified starch did not affect the nutritional quality of the sausages, presenting on average 57.003 ± 0.639% of moisture, 17,073 ± 0.385% of protein, 12,791 ± 0.217% of fat and 3,678 ± 0.297% of starch. In the texture profile analysis, no significant differences were found, but it was found that when the modified starch concentration increased, the product presented an increase in its elasticity and adhesiveness, for the firmness an equal relation was not obtained, since the treatment 4 (2.5% modified starch) obtained the lowest values, while treatment 3 was the one that obtained the highest values. Sensory analysis revealed a slightly greater acceptance as to the taste by the panelists towards treatment 3 (2% modified starch).

Keywords: legumes, low calorie, modified starch, sausages, sensory analysis

Introduction

Global trends in food indicate a marked interest of consumers towards certain foods, which in addition to the nutritional value are as healthy as possible, i.e., do not generate serious health risks because of frequent consumption, an example of this, Are foods low in fat [1, 2]. Meat products, such as sausage are widely consumed, among its disadvantages is the high content of saturated fat and cholesterol, posing a challenge for the food industry [3, 4].

There is a great demand for raw materials for the production of foods with high nutritional value and that can be obtained at a moderate cost [5, 6]. Legumes are one of the most directly consumed food groups and it has been suggested that they are one of the most important alternatives for solving the problem of food dependence. It can be used in the development of a wide variety of foodstuffs [7, 8]. Within the group of legumes that have edible seeds, highlights Lima beans (*Phaseolus lunatus*), due to its nutritional properties: protein content close to 29%. According to biological research, the quality of the cooked bean protein can be up to 70% compared to a control protein of animal origin (100%). Considering the above, the legume *Phaseolus lunatus* can be considered as an option for the elaboration of products with high protein content, which makes it a possible ingredient for industrial use [9, 10].

In the industrial sector there are few food formulations that use Zaragoza bean, since it is considered as an unconventional source [11, 12], Sausages constitute one of the oldest forms of food processing, and have excelled by their Nutritional, sensorial and functional characteristics with respect to other meat products. Different researches have shown the potential of using different types of meat in their elaboration in order to diversify the presentation to the consumer, especially to the infant that represents an important sector that consumes this type of food [13, 14]. Therefore, it is important to highlight the research carried out by Huerta et al. (2009) [15], where they incorporated mixtures of *Phaseolus lunatus* protein with cassava and maize starches in Frankfurt type sausages, obtaining positive results regarding the rheological and organoleptic properties of the product final.

Given the scarce scientific information associated with meat products added with legumes and seeking to give rise to a greater technological development of these raw materials, this work had as main objective to elaborate a low fat sausage type food added with modified starch of Zaragoza bean (*Phaseolus lunatus*) Red variety. For this purpose, we initially sought to standardize the preparation of the product, with the ideal concentration of modified starch. The quality of the final product was then evaluated through physicochemical, microbiological and texture profile analyzes. Finally, the acceptance of the product obtained through sensory evaluation was verified.

Materials and Methods

The research is of experimental type, the legume samples *Phaseolus lunatus* red variety, coming from the Caribbean coast of Colombia. The ratio per sample was 2 kilograms totally random of the legume and 10 kg of meat.

Experimental design

In the research, a totally random experimental design was handled. The determinations were done in triplicate and the results were expressed as the mean ± standard deviation. The program GraphPad lnstats version 3.1 was used. For analysis of the data, a variance analysis (ANOVA) and the means analysis were applied using a Tukey-Kramer test. The level of significance was set at $p < 0.05$, with a confidence level of 95%. Three treatments with three replicates were studied in a completely randomized experimental design; Each sample was analyzed in triplicate [16].

Standardization

Different samples were prepared with varying concentrations of modified starch of red bean Zaragoza of 1.5% (Treatment 2), 2% (Treatment 3) and 2.5% (treatment 4)% of modified starch, in addition to white (Treatment 1, 2.5% Of wheat flour), to determine which was the most appropriate in terms of the organoleptic and texture characteristics imparted to the sausage [16].

Quality analysis

To estimate the physicochemical composition of the sausage, the methods described by the AOAC 1990 and 1997 were used. For the microbiological analysis of the sausage the tests indicated in the NTC 1325, such as total count of aerobic mesophiles, plate count Coliforms and mold and yeast counts. The shear strength, cohesiveness and adhesiveness were determined with a TA-XT2 texturometer from Stable Microsystems; A P / 25 probe with 25 mm diameter aluminum cylinder was used, with a test speed of 1 mm / s at a distance of 8 mm and a compression ratio of 40-60% [17,18].

Sensory evaluation

Sausage modified red bean Zaragoza variety was submitted to a sensorial evaluation, with the participation of 50 untrained consumers of sausage. This group of panelists was tested with a 5-point hedonic scale for sensory evaluation of color, odor, taste and texture attributes [19].

Results and Discussion

Obtaining starch and degree of substitution

A yield of 18% native starch of the dry weight of *P lunatus* seeds was obtained,

lower percentage compared to those of *Okenia hypogaea* with 75% and those of *Mucura pruriens* with 82% [20]. The low yield of the seed starch could be due to the extraction method, since the residue was washed many times which could cause losses. The yield of acetylated starch from the native starch was 87%. The percentage of the acetyl groups and the degree of substitution were 2.15 ± 0.2 and 0.08 ± 0.02, respectively. Similar values have been obtained by Betancour et al. (2003) [21] with acetyl group contents between 0.94 and 2.48% for acetylated starches from unconventional sources.

Physicochemical Analysis

Protein content: The use of modified bean starch Zaragoza in the production of the sausages did not affect its protein content, since values between 16.53 and 17.57% were registered among all the treatments, which are statistically similar (P> 0, 05), so it was established that this type of sausage contained a protein average of 17.07 ± 0.07%, as shown in Table 1. The percentage did not vary significantly between the two samples since the same proportion of Meat for the different treatments, the protein content was due to the percentage of meat used in the formulation, according to García et al. (2007) [22] percentages above 50% imply an increase in protein content ranging from 15% or more according to the percentage and type of meat used.

Starch content: In determining the starch content in the sausages, the mean value was 3.678 ± 0.56%, the results obtained were recorded in Table 1 and are between 2.51 and 4.38% for the different samples, which Showed a significant difference (P <0.05) with respect to treatment number 2, which was mainly due to the fact that this treatment had the lowest percentage of modified starch in its formulation, so the other treatments showed no significant difference since their percentage Of starch in the formulation was more similar, which again demonstrates that the treatments were performed homogeneously and with standardized formulations, likewise Jiménez et al. (2010) [23] indicate that depending on the amounts used in the initial formulation of a meat emulsion, in the same proportion their constituents must be found in the final product after the proximal analysis.

Moisture content: In the low-fat meat sausages it was determined that when using different levels of modified Zaragoza starch as a binding agent, the moisture contents were not affected statistically (P> 0.05), since the determined values varied between 55.92 and 58.11%, corresponding to the control group sausages (without modified starch) and in which different concentrations of modified starch were used, with a general average of 57 ± 0.57%, shown in Table 1, indicating that The product was made homogeneously, although it should be noted that the treatment 4 had a slightly higher amount of moisture, due to the higher percentage of inclusion of modified starch, which allowed it to achieve a greater capacity of water retention to the final product, According to Mallika et al. (2009) [24], carbohydrate-based fat replacers are able to mimic fat in such a way that they achieve lubricity and moisture

similar to that of high fat products due to the addition of water in a gel matrix, Another part Ruusunen and Puolanne (2005) [25] establish that a gel-forming agent can be added to improve water binding and heat stability in cooked sausages by retaining added water. The moisture values obtained were always found within the norm NTC 1325, which contemplates a maximum of 86% along with the fat.

Fat content: The average fat content of the sausages is illustrated in Table 1 and was 12.79 ± 0.2%, with variations between 11.51 and 13.08%, found in the different treatments analyzed, which were not statistically different (P> 0.05). The fat content observed in the sausages obtained was below the maximum limit allowed by the NTC 1325 which is together with the humidity of 86%, in addition the data agree with the stipulated by García et al. (2007) [22] who observed that in fat-free meat emulsions, the final percentage of fat should not exceed 5% of the initial percentage in the formulation, which in this case was 10%.

Table 1 Physicochemical analysis of sausages

Sample	Protein (%)	Starch (%)	Humidity (%)	Fat (%)
Treatment 1	17.183 ± 0.3669[a]	3.976 ± 0.1484[a]	57.213 ± 0.3787[a]	12.540 ± 0.9110[a]
Treatment 2	17.026 ± 0.5706[a]	2.900 ± 0.3387[b]	56.380 ± 0.5862[a]	12.713 ± 0.3329[a]
Treatment 3	17.063 ± 0.3550[a]	3.660 ± 0.1044[a]	57.606 ± 0.7376[a]	12.976 ± 0.3066[a]
Treatment 4	17.023 ± 0.2994[a]	4.176 ± 0.2346[a]	56.813 ± 0.5590[a]	12.936 ± 0.1193[a]
Overall mean	17.073 ± 0.385	3.678 ± 0.297	57.003 ± 0.639	12.791 ± 0.217

[a-b] Equal letters in the same column indicate that there was no significant difference (p> 0.05)

Microbiological analysis

Microbiological analysis, besides having a preventive character, provides an inspection that allows to assess the microbial load, since all the foods have microorganisms like normal flora or like acquired flora, and the microbial contamination is the most important potential source of danger in the Food [26]. Most microorganisms come from raw meat, condiments and spices may contain bacteria, mainly spores, which do not die in the process of scalding unlike other vegetative forms, causing an acceleration in the deterioration of the sausage.

Table 2 presents the results of the microbiological tests carried out on the different treatments, which were made to the product one week after elaboration, kept at a temperature of 0 ± 2 ºC. It is notorious that in general all treatments had concentrations of microorganisms lower than those allowed in Colombian Technical

Standard NTC 1325, considering therefore that the sausages were suitable for human consumption.

Table 2 Microbiological analysis of the sausages

Microorganism	Permissible value NTC 1325	Assay 1	Assay 2	Assay 3	Assay 4
Count of mesophilic aerobes (CFU/g)	100000	1700	2000	1500	3000
Total coliforms	500	26	< 10	< 10	20
(CFU/g) Fecal coliforms (CFU/g)	< 10	< 10	< 10	< 10	< 10
Mold and yeast counts (CFU/g)	N/A	110	130	180	310

Texture profile analysis

In Table 3, the effect of the Zaragoza bean modified starch on the texture profile analysis of the sausages can be observed, in which it was observed that there were no differences ($P > 0.05$) for the elasticity and adhesiveness between the four treatments, It should be noted that hardness and fracturability were lower in treatment number 4 ($P < 0.05$), whereas for these two parameters there were no significant differences between the remaining samples.

The texture profile analysis allows to give a general idea of the structure of the foods, it is observed that the treatment 3 obtained a greater firmness, although the treatments 1 and 2 had similar values, whereas the treatment 4 obtained the least firmness, Which is related to its higher moisture content and at the same time to its higher concentration of modified starch. The decrease in the hardness or firmness of a food can be a desirable characteristic, since this parameter is related to the juiciness of the product, therefore the use of extenders is related to this parameter and to the yield of the product [27]. On the other hand, the greater firmness of the treatment 3 can be attributed to the ideal or more adequate percentage of modified starch of Zaragoza bean, since according to Cierach et al. (2009) [28], the use of a suitable concentration of hydrocolloids in low-fat meat emulsions usually forms homogeneous structures whose shape and size are similar to fat drops of fatty products, similarly Ayadi et al. (2009) [29] reported that the use of hydrocolloids results in an increase in water retention capacity and texture, as well as products with greater firmness, cohesiveness, less elastic and without significant changes in taste.

Table 3 Sausage Texture Profile Analysis

Treatment	Hardness Newtons	Fracturability Newtons	Elasticity Dimensionless	Adhesiveness Joules
1	27,155 ± 2,163[a]	27,340 ± 2,193[a]	0,500 ± 0,002[a]	-0,285 ± 0,030[a]
2	24,378 ± 1,757[a]	24,682 ± 1,846[a]	0,497 ± 0,003[a]	-0,269 ± 0,096[a]
3	29,312 ± 3,618[a]	29,585 ± 3,665[a]	0,505 ± 0,010[a]	-0,275 ± 0,050[a]
4	17,386 ± 3,547[b]	17,651 ± 3,499[b]	0,524 ± 0,032[a]	-0,300 ± 0,060[a]

[a-b] Equal letters in the same column indicate that there was no significant difference (p>0.05)

Here we also show the results regarding the elasticity of the sausages, where it is noted that there was no significant difference between the treatments (P> 0.05), however, it should be noted that the results obtained for this parameter increased in small proportion as The percentage of starch in the treatments was increased, due to the use of carbohydrates as hydrocolloids to replace fat, provide viscosity in gel formation, providing a greater elasticity, also mimic the effect of fat, stabilizing the water added in The gel matrix, resulting in a greater capacity of water retention, lubricity and low moisture release similar to high fat products [24].

The results of the effect of the Zaragoza bean modified starch on the adhesiveness of the sausages indicate that there was no significant difference between the four treatments (P <0.05), although, similarly to the elasticity, the adhesiveness increased slightly as the percentage of Starch in treatments. It is important to note that the results obtained were negative, indicating that the texture of the sausage was sticky or sticky, ie, when the product is consumed, it will tend to adhere to the palate, although slightly according to the data obtained, This behavior could be due to the inclusion of carbohydrates contributed by the presence of starch and modified starch in the treatments [30].

Sensory evaluation

By using non-conventional additives such as modified starch bean Zaragoza, it is necessary to consider what points3, in which the current food system of the population, highlights the need to provide increasingly new and varied food products that generate some benefit to the consumer. In this context, the quality assessment of foodstuffs, should consider a sensory evaluation, which allows to control the quality from the organoleptic point of view and predict the acceptability to take the product at the consumer level [31], as well That the population currently has a tendency to consume lean, dietetic, low-calorie products and, consequently, reduce consumption of products with visible fat3. Sensory analysis was performed

to evaluate qualitative characteristics of sausages as they were color, smell, taste and texture by a survey of 50 non-specialists between 15 - 50 years old consumers of this type of product, practicing statistical analysis to find differences, Table 4 shows the general summary of the scores obtained with respect to the attributes evaluated for the four treatments, among which there were no significant differences (P> 0.05).

Table 4 Sensory evaluation of sausages

Treatment	Color	Odor	Flavor	Texture
1	3.56 ± 0.502^{a}	3.78 ± 0.679^{a}	4.52 ± 0.505^{a}	3.82 ± 0.701^{a}
2	3.52 ± 0.467^{a}	3.80 ± 0.307^{a}	4.54 ± 0.850^{a}	3.94 ± 0.537^{a}
3	3.54 ± 0.393^{a}	3.80 ± 0.485^{a}	4.60 ± 0.606^{a}	4.1 ± 0.390^{a}
4	3.58 ± 0.206^{a}	3.94 ± 0.549^{a}	4.50 ± 0.745^{a}	3.76 ± 0.608^{a}

$^{a-b}$ Equal letters between columns indicate that there was no significant difference ($p>0.05$)

Conclusion

From the results obtained, the following conclusions can be drawn: (1) The products were considered to have met the requirements of NTC 1325 for processed, cooked and sausage meat products. (2) According to the data obtained through the sensorial analysis, it was found that the sausage had a good acceptance by the panelists regarding the characteristics evaluated, although no significant differences were found between the treatments, it was observed that the treatment 3 had slightly better grades for texture and flavor. (3) After the study, it was considered that the best formulation against the standard was treatment three, which corresponds to the use of 2% of Zaragoza bean modified starch, because it presented the best characteristics in terms of profile analysis Of texture and the greater acceptance in the sensorial analysis, therefore, this modified starch can be postulated as a good additive in the meat industry. (4) The objectives set out were met by finding an ideal formulation with modified bean Zaragoza starch to obtain a meat emulsion with the characteristics appropriate for the production of a sausage, representing notable improvements in the product, according to the analyzes performed. Being an alternative formula for the production of sausages.

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Received: September 7, 2017; Published: December 15, 2017