Sausage of pompano fish Peprilus medius on the Ecuadorian coast

Salchicha de pescado pámpano Peprilus medius en la costa ecuatoriana

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Centrosur
Instituto Superior Edwards Deming, Ecuador
ISSN-e: 2706-6800
Periodicidad: Trimestral
vol. 1, núm. 13, 2022
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Recepción: 12 Junio 2021
Aprobación: 05 Octubre 2021

URL: http://portal.amelica.org/ameli/journal/646/6463152005/

Resumen: La pesquería pelágica de Ecuador se compone principalmente de sardinas, anchoas y caballas. Observándose que la mayor parte de las anchoas y sardinas enlatadas se preparan para el mercado de exportación y el resto es para la elaboración de harina de pescado que es usado para la alimentación de aves de corral. La flota de pesca pelágica se compone de 152 embarcaciones que operan hasta 70 millas náuticas (nm) de la costa. Ecuador produce grandes cantidades de harina de pescado, la mayoría de los cuales se utiliza como alimento en criaderos de camarones.

Palabras clave: pesquería, costa, peces.

Abstract: Ecuador's pelagic fishery consists mainly of sardines, anchovies, and mackerel. Most of the canned anchovies and sardines are prepared for the export market, and the rest is used to produce fishmeal for poultry feed. The pelagic fishing fleet consists of 152 vessels operating up to 70 nautical miles (nm) offshore. Ecuador produces large quantities of fishmeal, most of which is used as feed in shrimp farms.

Keywords: fishery, coastline, fish, fish.

Introduction

Fish is an important food source for humans that currently has an annual increase in consumption that on average exceeds that of meat consumption of all other animal food proteins. (FAO, 2020). World fish production has grown to 179 million tons (valued at USD 401 billion), of which aquaculture contributed 46% in terms of quantity (82 million tons) and 62% in terms of value (USD 250 billion).(FAO, 2020)

Fish as a seafood product play a crucial role in global food and nutrition security (FNS), as they represent an important and nutrient-rich food of animal origin, especially in many low- and middle-income countries (LMICs) (Béné et al., 2016) Fish are a good source of key nutrients, such as highly bioavailable animal protein (Larsen et al., 2011)fish, marine long-chain omega-3 polyunsaturated fatty acids (LCPUFA n-3), including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), and numerous micronutrients, including vitamin A, vitamin B12, vitamin D, zinc, selenium, and iodine. Fatty fish are generally considered the best source of fatty acids (especially EPA and

DHA) and fat-soluble vitamins, while lean fish are generally considered the best source of iodine. (EFSA, 2014).

It is necessary to take advantage of this raw material of high consumption in the investment of new and innovative products that satisfy a high nutritional value, the pressure of globalization, technological changes, the socio-economic evolution of the countries.

The small pelagic fishery is the second most important industrial fishery in Ecuador. The productive chain generated by this activity includes processing activities such as frozen fish, canned fish, fishmeal, and oil. These linkages have attracted foreign investment in processing plants that, together with the fishery, provide close to 25,000 jobs in the country.

However, in recent years the small pelagic fish fishery has been affected by a considerable increase in overexploitation rates. The diversity of actors involved in this fishery constitutes one of the most important challenges at the time of establishing an efficient and effective management mechanism. Ecuador, our country, is not exempt from these changes, even more so when its products are sought after worldwide for their exotic characteristics.

To take advantage of the benefits of the richness of the fishery, the production of fish sausage was proposed to satisfy the needs and nutritional requirements of the consumer.

Sausage is a product in which meat is mixed with additives, stuffed into suitable casings and processed with heat (Raju et al., 2003). In the processing process the different components such as fiber, myofibrils and filaments are broken down and the size of fatty tissues are reduced. Components such as myofibrillar proteins, in the presence of salt, become soluble and migrate to the surface of the fat globule, concentrating and forming a protein matrix at the fat/water interface. (Intarasirisawat et al., 2014).

According to (TELLEZ, "Fish Sausages" 1975), in Japan, fish hams and fish sausages are popular products. The sausages typically contain chopped fish meat, with 10% pork fat, 10% starch and 2.5% salt, seasonings and preservatives. Chemical preservatives such as m- furyl furmide and nitrofurazone have been used to allow the products to be stored at room temperature for a month or more. The products are cooked and can be sliced.

Fish sausages have been studied from various fishes, including Talang Queenfish (Scomberoides commersonnianuus) (Yousefi & Moosavi-Nasab, 2014)), tilapia (Oreochromis niloticus) (Hemung & Sriuttha, 2014) and Argentinean anchoveta (Engraulis anchoita) (Piotrowicz & Mellado, 2015). However, dark-fleshed fish sausages have limited uses due to their dark color, susceptibility to oxidation and bad taste that affects their flavor, odor, color, texture and nutritional value. It can rapidly develop hydrolytic rancidity or oxidative rancidity flavors under refrigerated storage conditions, and different types of casings are used for stuffing, including artificial casings, which are becoming increasingly important, especially in the production of the types of fish products used in the production of fish products. (Jimenez & Carballo, 1989) especially in the production of cut sausages, but also in the production of meat products using casings. The indisputable advantages of this type of casing are the absolutely equal calibre, the uniformity of the section and less trimmings.

The *Stromateidae* family groups the fishes commonly known as pompanoes or pompanoes. *Peprilusmedius*, has a relatively tall body (its height is 1.6 - 2.1 in standard length), the snout is shorter than the diameter of the eye, the dorsal fin and particularly the anal fin are long and falcate, it has no pelvic fins, the caudal fin is very forked, and its color is silvery white.

The pampanito, *Peprilus medius* (Peter, 1869), of the family *Stromateidae*, is a euryphagous organism, of the demersal subsystem (coastal benthopelagic), and its distribution includes the Eastern Tropical Pacific, from the Southern Gulf of California (Mexico) to Pisco (Peru), and including the Galapagos Islands. (Fischer et al., 1995) (Del et al., 2011; Noma, 1998) Commercially, its sizes vary from 12 to 33 cm in total length. It is important as a forage for many commercial fish species. (Fischer et al., 1995).

The pompano in the province of Santa Elena is fished at all times of the year with the exception of the closed seasons for pelagic fish that are regulated by the National Government and it is done for two times of the year during the whole month of March and September, which makes foresee that it is a raw material that can be used with an added value in the production of a product such as fish sausage that preserves the essential nutrients for the benefit of the consumer. The use of marine raw material from pelagic fishing comes from the canton of La Libertad in the Province of Santa Elena, and is mostly used in the production of fishmeal, or what remains of the daily catch is sold in popular markets at low prices. In these localities of the province there is little or no vision for the use of small fish for fish sausage production.

There is also a low cost of raw material, finding values of pompano fish between 1.50 - 2.0 dollars per kilo that is sold freely in the market of Canton La Libertad, which provides a product within the reach of the consumer.

Materials and methods

Experimental research consists of the manipulation of an untested experimental variable, under rigorously controlled conditions, in order to describe how or why a particular situation or event occurs. It is an experiment precisely because the researcher provokes a situation in order to introduce certain study variables manipulated by him, to control the increase or decrease of that variable, and its effect on the observed behaviors.

One of the scientific methods used in the research is the Hypothetical - inductive method, by formulating a hypothesis process in which the utilization of fish muscle raw material processed using two processing methodologies (deodorization and non-deodorization) is formulated. The mentioned hypothesis leads to the analysis in a deductive or inductive way and to verify it at the end of the research.

This study employed a randomized complete block design (RCBD) with a 3*2 factorial arrangement, with 3 replications. The scheme of the sources of variation is as follows:

For the comparison of treatments and factor levels, the Tukey test was used at 5% probability.

The treatments under study is a combination of three factors, we have:

Factor A, fish concentrations 60% (C1), 70% (C2) and 80% (C3).

Factor B, deodorized (L1) and non-deodorized (L2) wash type.

TABLA 1

Fish sausage formulations according to concentrations (C) of deodorized (L1) and non-deodorized (L2) raw material.

Table 1. Fish sausage formulations according to concentrations (C) of deodorized (L1) and non-deodorized (L2) raw material.

RAW MATERIALS	L1 (g)		L2 (g)		L1 (g)		L2 (g)		L1 (g)		L2 (g)	
	C1%	g	C1%	g	C2%	g	C2%	g	C3%	g	C3%	g
Deodorized fish												
Undeodorized fish												
Ice water									5		5	
Salt												
Cornstarch	5		5		5		5		5		5	
Polyphosphate	0,3	1,2	0,3	1,2	0,3	1,2	0,3	1,2	0,3	1,5	0,3	1,5
Ascorbic Acid	0,05	0,2	0,05	0,2	0,05	0,2	0,05	0,2	0,05	0,25	0,05	0,25
Pepper	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,2	1	0,2	1
Vegetable oil	5		5		5		5		5		5	
Garlic powder	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,2	1	0,2	1
Spices	0,4	1,6	0,4	1,6	0,4	1,6	0,4	1,6	0,4		0,4	
Paprika	1,85	7,4	1,85	7,4	1,85	7,4	1,85	7,4	1,85	9,25	1,85	9,25
		560		560		520		520				

Prepared by Author

The frankfurters from the 6 treatments according to the experimental design, from which the treatment with the best acceptance in the sensory test carried out by the 40 untrained panelists was selected. (ROLANDO 2000)

The panelists will be made up of employees and students of the Peninsula Santa Elena State University. According to the results obtained in the application of the sensory analysis, the best treatment was selected. The treatment with the best acceptability was analyzed as follows:

- Physical-chemical: pH, moisture, protein, fat, ash.
- Microbiological: Mesophilic Aerobes, Total Coliforms, Fecal Coliforms, E.Coli, Salmonella sp, Stapilococcus, Aureus, Vibrio Parahemolyticus, Vibrio Cholerae, the results obtained at the microbiological level determined the stability card, affecting the shelf life.

Sensory quality

Sensory evaluation is defined as a scientific instrument used to measure, analyze and interpret reactions to food characteristics perceived through the senses of sight, smell, taste, touch and hearing. In sensory analysis, taste, odor, color and texture are evaluated using the sense organs.

A hedonic sensory evaluation was carried out where each panelist was provided with a sample of product to rate the level of liking of each treatment considering deodorized fish mass and non-deodorized mass. The results of the panel evaluation were analyzed by applying analysis of variance (ANOVA). The attributes analyzed in the sensory quality are: flavor, odor, color, texture.

A five-point hedonic table was used, with the following descriptors: Bad = 1, Fair = 2, Acceptable = 3, Good = 4, Excellent = 5. The samples were heated to a temperature of 70ºC and then cut into 1.5 cm pieces. The evaluation was carried out in a ventilated area, with good lighting, free of extraneous odors, (Marine Science Laboratory and Chemical Sciences Laboratory of the Peninsula St. Helena State University) by a panel of 40 untrained evaluators, who were provided with the evaluation form.

Physical-chemical characteristics and nutritional value of the final product

The chemical analyses were carried out in the laboratories of Chemical Sciences of the Peninsula de Santa Elena State University and in the laboratory of a private chemical analysis company (Guayaquil), being necessary due to the lack of specific equipment in the Peninsula de Santa Elena University laboratory. It is important to highlight that the tests will be carried out following the NTE INEN Standards and Official Methods of Chemical Analysis (AOAC): Moisture, pH, total ash (gravimetric calcination method), total fat (Soxleth liquid-liquid extraction method), proteins.

Microbiological analysis of the final product

The analyses will be based on Official Methods of Chemical Analysis (AOAC): Mesophilic Aerobes, total coliforms, fecal coliforms, *E. Coli, Salmonella* spp, *Staphilococcus Aureus. Vibrio parahaemolyticus. Vibrio cholerae,* Fungi.

Flow diagram in the production of the Pampano fish sausage.

Deodorized raw material

Result

Table 2. *Descriptive Statistical Test: L1C1. L1C2. L1C3. L2C1. L2C2. L2C3.*

Table 2

Descriptive Statistical Test L1C1 L1C2 L1C3 L2C1 L2C2 L2C3

Variable	Result Mean	Error	Deviat.	Variance	Variance	Minimum	Q1
	Variable Standard Standard						
L1C1	4,250	0,112	0,707	0,500	16,64	3,000	4,000
L1C2	2.8250	0,0792	0,5006	0,2506	17,72	2,000	3,000
L1C3		0,0792	0,5006	0,2506	20,64	2,000	3,000
2,4250		0.0831	0,5256	0,27,63	19,65	2,000	2,000
L2C1	2,6750	0,0905	0,5723	0,3276	27,58	1,000	2,000
		0,0944	0,5970	0,3564	41,17	1,000	1,000
L2C2	2,0750						
L2C3	1,4500						

The treatments carried out on the raw material (deodorized and non-deodorized) at different concentrations evaluated by the hedonic test showed that the L1C1 treatment corresponding to the deodorized raw material with 60% fish mass concentration has a mean of 0.112, being the best treatment compared to the others.

The Hedonic test carried out with a rating scale of 5 to 1 from Excellent to Poor respectively for the different treatments showed a mean of 4.25 with a standard deviation of 0.7071 for the deodorized raw material treatment and raw material concentration of 60% (L1C1).

With respect to the treatment of raw material without deodorizing at different concentrations of fish mass, the results showed that the treatment of raw material without deodorizing at 60% concentration (L2C1) obtained a mean of 2.6750 with a standard deviation of 0.5256 being superior to the treatment of L1C3 described above.

Table 3. *Flavor evaluation of deodorized fish sausages with pooled data.*

TABLA 3

Flavor evaluation of deodorized fish sausages with pooled data.

Level N Mean Standard Deviation
L1C1 40 4.2500 0.7071
L1C2 40 2.8250 0.5006
L1C3 40 2.4250 0.5006

Source: Author

L1C1 40 4.2500 0.7071
L1C2 40 2.8250 0.5006
L1C3 40 2.4250 0.5006

TABLA 4

Odor evaluation of deodorized fish sausages with pooled data.

Level N Mean Standard Deviation Odor
L1C1 40 4.2250 0.7334
L1C2 40 2,7000 0,6485
L1C3 40 2,2250 0,7334

Source: Author

2,40 3,00 3,60 4,20

Clustered standard deviation = 0.5777

The information reveals that the 40 evaluators placed the L1C1 treatment with a taste that reveals a mean of 4.25 and standard deviation of 0.7071 being superior to the C2 and C3 concentrations, in terms of standard deviations.

As for the non-deodorized material, the results reveal that the non-deodorized raw material, when evaluated with the 40 panelists in the different concentrations of fish mass, obtained an average of less than one tenth, so it is estimated that in terms of flavor it does not exceed the value obtained in the deodorized mass.

L1C1 40 4.2250 0.7334
L1C2 40 2,7000 0,6485
L1C3 40 2,2250 0,7334

2,10 2,80 3,50 4,20

Clustered standard deviation = 0.7062

95% Tukey simultaneous confidence intervals

The information reveals that the 40 evaluators placed the L1C1 treatment with an odor revealing a mean of 4.2250 and Standard deviation of 0.7734 equal in the L1C3 formulation with a significant difference in terms of its mean, however, the information obtained from the odor in the L1C2 treatment is lower in the evaluated criteria.

The results concerning the non-deodorized fish sausages revealed atypical data far from the average, however, the L2C1 and L2C3 treatments, despite having concentrated data, are lower than the average, therefore, it can be analyzed that the results do not exceed the results of the L1C1 treatment (deodorized raw material with 60% concentration).

Table 5. *Color evaluation of deodorized fish sausages with pooled data.*

Table 5

Color evaluation of deodorized fish sausages with pooled data

Level N Mean Standard Deviation Color
L1C1 40 4,6250 0,6279
L1C2 40 3.8750 0.9111
L1C3 40 3,7750 0,8912

Source: Author

L1C1 40 4,6250 0,6279

L1C2 40 3.8750 0.9111

L1C3 40 3,7750 0,8912

3,85 4,20 4,55 4,90

Clustered standard deviation = 0.8203

95% Tukey simultaneous confidence intervals

The information reveals that the 40 evaluators placed the L1C1 treatment with a mean of 4.6250 and standard deviation of 0.62794; in comparison with the L1C2 and L1C3 treatments, which do not present significant differences. The tests have been carried out at 95% of simultaneous confidence in Tukey's test.

As for the results obtained in the evaluation of the color of the non-deodorized fish sausages, the data revealed that there was no significant difference between the treatments.

Table 6. *Evaluation of fish sausage texture with pooled data.*

Table 6

Evaluation of fish sausage texture with pooled data

Level N Mean Standard Deviation Color
L1C1 40 4,0750 0,5256
L1C2 40 2.8250 0.5006
L1C3 40 2.2500 0.4385

L1C1 40 4,0750 0,5256
L1C2 40 2.8250 0.5006
L1C3 40 2.2500 0.4385
2,40 3,00 3,60 4,20
Clustered standard deviation = 0.4896
95% Tukey simultaneous confidence intervals

The information reveals that the 40 evaluators placed the L1C1 treatment with a mean of 4.0750 and standard deviation of 0.5256; in comparison with the L1C2 and L1C3 treatments, which do not present significant differences. The tests have been carried out at 95% of simultaneous confidence in Tukey's test.

Regarding the results of the texture of the non-deodorized fish sausage, it can be deduced that the texture of the different concentrations of non-deodorized fish has a relatively low average compared to the deodorized fish.

From the data obtained from the evaluation of the texture of the non-deodorized fish sausage, it can be deduced that the texture of the different concentrations has a relatively low average compared to the deodorized fish.

According to the results obtained during the evaluation of flavor, odor, color and texture attributes, the L1C1 treatment was selected. Subsequently, the preparation of deodorized fish sausages with L1C1 treatment was carried out with 5 repetitions in order to evaluate the chemical characteristics of proteins and lipids, an analysis that was carried out 3 times on different dates.

TABLA 7
Evaluation of chemical parameters

Prarameter	Average		Method
	Before treatment	After treatment	
Protein	17,23	12,05	AOAC 19TH 938.08
Fats	7,2	5,88	AOAC 19TH 940.08

Table 8
Organoleptic analysis

Start date	1	2	3
Features			
Color Odor Taste Texture	light orange characteristic characteristic soft	light orange characteristic characteristic soft	light orange characteristic characteristic soft

Table 8. *Organoleptic analysis*

Table 12
Chemical Analysis

Parameters	1			Units	Methods
pH	6.58	6.54	6.56	g%	NTE INEN0181
Humidity	76.24	76,00	75,9	g%	AOAC 19TH 952.08
Protein	11.66	11.65	11.60	g%	AOAC 19TH 938.08
Grease	5,50	5,5	5,5	g%	AOAC 19TH 940.15
Ashes	2,36	2,35	2,35	g%	AOAC 19TH 94025
Carbohydrates	4,24	4,24	4,24	g%	Calculation
Phosphorus	141,85	141,84	141,84	g%	MMQ-77

Table 13*Microbiological Analysis*

Table 13
Chemical Analysis

Date 1 2 3 Method Features
Aerobic mesophiles < 1 X 10 < 1 X 10 < 1 X 10 < 1 X 10 MME M01 AOAC 19TH 966.23 Total coliforms < 1 X 10 < 1 X 10 < 1 X 10 < 1 X 10 MME M01 AOAC 19TH 991.14 Fecal coliform < 1 X 10 < 1 X 10 < 1 X 10 < 1 X 10 MME M01 AOAC 19TH 991.14 E. Coli < 1 X 10 < 1 X 10 < 1 X 10 < 1 X 10 MME M01 AOAC 19TH 991.14 Salmonella spp N/D N/D N/D N/D AOAC 19TH 031.208 Staphylococcus aureus N/A N/A N/A AOAC 19TH 975.55 Vibrio Parahemolyticus N/D N/D N/D N/D MME M12 BAM CAP-9 Vibrios Cholerae N/D N/D N/D N/D MME M12 BAM CAP-9 Fungi N/A N/A N/A N/A AOAC 19TH 997.02

Conclusions

The fish sausages made from fillets of pompano fish (Peprilus medius) presented optimal physicochemical and microbiological characteristics to be considered as a novel food alternative, providing food of high nutritional value, with a shelf life free of pathogenic microorganisms, and can be frequently consumed by men and women, and the product will also help the development of fishing communities.

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