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Feasibility study for the elaboration of shrimp meat nuggets (litopenaeus vannamei) enriched with quinoa (chenopodium quinoa) as a nutritional alternative for the population of guayaquilaña

Estudio de factibilidad para la elaboración de nuggets de carne de camarón (litopenaeus vannamei) enriquecidos con quinua (chenopodium quinua) como una alternativa nutritiva para la población

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Abstract
In the following investigation work a study is carried out for the elaboration of shrimp nuggets (Litopenaeus vannamei) enriched with quinoa (Chenopodium Quinoa) from shrimp meat as a real gastronomic alternative for Guayaquil city and in turn expand the food offer in the country, Shrimp is a symbolic product for the country, from which delicious Ecuadorian dishes are obtained are typical in the cities and towns of the country. The data and history of shrimp activity are investigated and observed, beginning with the generalities of shrimp, its production at the national level, the life cycle of shrimp and everything that involves shrimp and quinoa production. INIAP Thunkahuán. At the same time, the research method to be used in the present work is analyzed, seeking to find the ideal method to find the way to elaborate the nugget and, at the same time, to observe which is the nugget that the Guayaquil population would like to acquire and consume.The main idea to elaborate the nugget is to give to Guayaquil citizens a nutritious alternative based on this seafood in order to give the Guayaquil population a healthy option. With which in turn it is also sought to strengthen the economy and consumption of these indigenous products, experiments are carried out to observe the preference of the product with which the liking of the judges was observed, demonstrating that there is a technical and economic possibility for the elaboration of the shrimp nugget enriched with quinoa.

key words
Shrimp, quinoa, nugget, export, economy

Resumen
En el presente trabajo de investigación se realiza un estudio para la elaboración de Nuggets de camarón (Litopenaeus vannamei) enriquecido con quinua (Chenopodium Quinua) a partir de la carne del camarón como alternativa real gastronómica para la ciudad de Guayaquil y a su vez ampliar la oferta alimenticia en el país, El camarón es un producto simbólico para el país, de la cual se obtienen deliciosos platos ecuatorianos que son típicos en ciudades y pueblos del país. Se investiga y se observa los datos e historia sobre la actividad camaronera en el país, comenzando con las generalidades del camarón, su producción a nivel nacional, el ciclo de vida del camarón y todo lo que envuelve a la producción del camarón y de la quinua INIAP Thunkahuán. A su vez se analiza el método de la investigación a utilizar en el presente trabajo, se busca encontrar el método idóneo para hallar la manera de elaborar el Nuggets y a su vez observar cual es el Nuggets que la población guayaquileña le gustaría adquirir y consumir. La idea principal de la elaboración del Nuggets es otorgar a la ciudadanía guayaquileña una alternativa nutritiva a base de este marisco con el fin de dar una opción saludable a la población guayaquileña. Con lo cual a su vez también se busca reforzar la economía y consumo de estos productos autóctonos, se realizan experimentaciones para observar preferencia del producto con lo cual se observó el agrado por parte de los jueces lo demuestra que existe una posibilidad técnica y económica para la elaboración del Nuggets de camarón enriquecido con quinua.

Palabras clave
Camarón, quinoa, Nuggets, exportar, economía.

1. Introduction

This research refers to shrimp nuggets enriched with quinoa, which can be defined as a meat mass to which ingredients and additives are added to enhance the organoleptic properties of the product. It is a product that undergoes a coating process to provide a crispy and golden texture.

The main characteristics of the nuggets to be made are shrimp and quinoa. Ecuadorian shrimp contributes significantly to the country's economy, providing employment to around 180,000 families. On the other hand, quinoa is a superfood that offers minerals, vitamins, fiber, etc., at a higher level than other commonly consumed cereals. In 2013, the FAO designated this year as the International Year of Quinoa, which peaked in 2015 in Ecuador, thus increasing its production in the country. However, there is a contradiction in quinoa production, which has decreased significantly in Ecuadorian agriculture in recent years.

To analyze the issue, it is necessary to mention its causes. One of them is the lack of knowledge regarding the production of shrimp on the part of companies and retail producers. For quinoa, it is the lack of societal awareness of the nutritional benefits it provides to the body.

1.1. General Characteristics of Shrimp

Penaeid shrimp are crustaceans classified in the decapod order (ten legs). They are animals that live on the surface

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of the water bottom, swimming and filtering in the early stages of their lives, swimming through their swimming appendages [1].

1.2. Creation of the Shrimp Industry in Ecuador

Su origen fue a finales de los 60, empezó cuando Its origin dates back to the late 1960s when entrepreneurs dedicated to agriculture, with large lands bordering the coast, noticed that shrimp grew in their rain-fed ponds or wells, which had some connection with estuaries, naturally trapping the shrimp after the high tides.

Some time later, they began to build larger ponds, which allowed the high tides to fill with water, loaded with post-larvae or juvenile shrimp. Due to the low concentration of planting, the natural productivity of the ponds provided enough food [2].

By the second half of the 1980s, Ecuador became a pioneer in the exportation of shrimp farming worldwide. The most cultivated species were Litopenaeus vannamei and Litopenaeus stylirostris [2].

1.3. Shrimp Varieties in Ecuador

The use of shrimp in the country officially began in the 1960s. Shrimp fishing emerged as a means of survival and later became an important source of employment and foreign exchange for the country's economy. Today, there are about 40 vessels dedicated to catching red shrimp, brown shrimp, and hake.

Currently, six shrimp species are in high demand in Ecuador:

Table 1.
Most Consumed Shrimp Species in Ecuador

Species	Characteristics	Habitat
Litopenaeus vannamei	Known as white shrimp, maximum size of 23 cm, white in color.	Warm climate not exceeding 20° C. South America and Central America.
Protrachypene precipua	Known as pomada shrimp, size from 5.1 to 10.2 cm.	Tropical and subtropical areas. Deltas, estuaries, lagoons, etc.
Litopenaeus stylirostris	Known as blue shrimp, maximum size of 21.4 cm for males, 26.3 cm for females.	Found in the sea, approximately 75 meters below sea level, in the Eastern Pacific Ocean.
Litopenaeus occidentalis	Known as prawn, primarily caught in Colombia, Venezuela, and Peru.	Coastal areas. Deltas, estuaries, sandy or muddy bottoms. Western Atlantic Ocean.
Farfantepenaeus californiensis	Known as brown shrimp, oceanic species, maximum size of 35 mm in total length.	Found approximately between 4 to 160 m deep. On the continental shelf and in estuarine waters, such as creeks, coastal lagoons, etc.
Farfantepenaeus brevirostris	Known as red shrimp, maximum size of 20.8 cm	Inhabits sandy bottoms between 20 to 180 meters deep.

1.4. Taxonomy

Table 2.
Taxonomy

Pacific White Shrimp
SCIENTIFIC NAME: Litopenaeus vannamei
COMMON NAMES: White shrimp Pacotilla shrimp White-footed shrimp Latin American prawn
SYSTEMATICS: Kingdom: Animalia Phylum: Arthropoda Sub-Phylum: Crustacea Class: Malacostraca Subclass: Eumalacostraca Order: Decapoda Family: Penaeidae Genus: Litopenaeus Species: vannamei

1.5. Characteristics of Litopenaeus vannamei Shrimp

The characteristic profiles include the face with dorsal and ventral teeth, counted in front of the epigastric tooth. The adrostral grooves and carinae are short, ending slightly behind the level of the epigastric tooth. The gastro-frontal carina is omitted. The free distal portion of the adjacent petasma lobe is long and elliptical, surpassing the medial lobe directly. The telson of the female shrimp specimen is “open.” It is light to yellowish in color, with the underside of the shell slightly darker. Its maximum length can reach 23 cm in total extension.

1.6. Nutritional Composition of Litopenaeus vannamei

Table 3.
Nutritional Composition of Litopenaeus vannamei

Amino Acid	Recommended FAO G OF AMINO ACID /100G PROTEIN	Variable Protein
Isoleucine	4.0	4.2
Leucine	7.0	6.2
Lysine	5.5	6.7
Methionine	2.2	1.0
Phenylalaniney	3.5	7.1
Threonine	4.0	3.9
Valine	5.0	3.8

It states that “Seafood is established as different ingredient components, particularly regarding nutrients,

and thus, it is necessary to define its significant nutritional properties" [3]. It also mentions that among seafood, the most important and relevant correspond to mollusks and crustaceans, in that context being shrimp, mussels, clams, cockles, squid, and similar species. [3]

According to [3] "They contain a high nutritional proportion, concentrating a large amount of healthy nutrients in their composition, and although they are ingredients with minimal fat, they have minerals and vitamins, highlighting vitamin E with its antioxidant function and B complex vitamins, primarily folic acid, which is relevant in the diet of pregnant women and to prevent nutritional anemia" [3].

1.7. Shrimp Life Cycle

According to [4] "The shrimp undergoes four phases during its life course: the embryonic phase, which is when the female and male shrimp come together and the eggs are released; the larval period, during which the shrimp stays in laboratories; the juvenile period, which lasts about 20 days in the nursery; and the adult stage, where it rests in larger ponds." The reproducing shrimp are found far from the Ecuadorian coast. The process is straightforward: the male places the sperm inside the female, and she expels the eggs. The female is characterized by the color of her shell and her green ovaries, which are visible due to her transparent exoskeleton [5].

Females are sexually immature when they leave the estuaries; they do not mature until they reach the mating fields, which are located far from the coast at depths of 12 to 18 meters. Males naturally mature before females. For mating to occur, the female must have molted and be in a characteristic state, with a soft carapace or exoskeleton, while the male must have a hard exoskeleton. The number of eggs per spawning fluctuates between 200,000 and 300,000 eggs [4].

Cultured shrimp are initially placed in tanks for what is known as the fattening or growth phase, where they are placed with a density of about ten shrimp per square meter. They are then moved to ponds or pools, where they remain until they reach a commercial weight of approximately 18 g, a weight they reach in an estimated time of four months, depending on factors such as climate and feed [6].

The normal life span of shrimp is approximately 12 months, but some can live up to two years. There is evidence that females spawn more than once [4].

"Shrimp are invertebrate animals that belong to the crustacean group. They grow through successive molts throughout their life cycle and undergo metamorphosis during their first life stage called larval".

1.8. Shrimp / Shrimp Farming

Ecuador has always faced economic problems at the governmental level, one of these problems, and perhaps the most significant, is the decline in oil revenues. In light of this issue, Ecuadorians must exploit their nature and products because they are highly sought after for their quality at an international level. The shrimp industry has gradually grown, as indicated by history, thanks to the environmental conditions that our country offers.[7].

The shrimp industry began in Ecuador in the late 1960s when a group of capitalists started to exploit the salt flats or salitrales. Since this became a profitable business, they began to take over agricultural lands and mangroves. According to data from the former INEFAN, in January 2000, there were 207,000 hectares of shrimp farms [8].

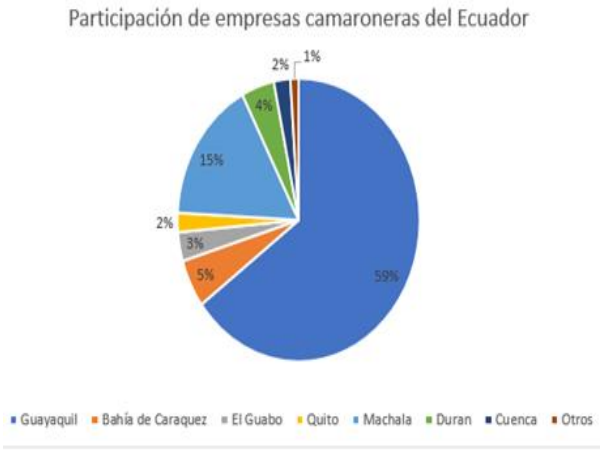

Fig 1. Participation of shrimp companies in Ecuador.

According to [7] "There are two categories: producer and/or exporter. According to the data provided by the National Chamber of Aquaculture, which registers 187 companies in these categories, they currently report around 210,000 hectares dedicated to shrimp farming, most of which is located in the Guayas province." [7]. This indicates that the greatest concentration of shrimp farming is more focused on the foreign market, with a low percentage directed toward local production.

Graph 2. Distribution of the shrimp sector in Ecuador.

1.9 Cultivation

FAO states: In Ecuador, three crop system methods are known: extensive, semi-intensive, and intensive. Shrimp production in Ecuador is largely semi-intensive. The benefits vary considerably between shrimp farms and from year to year; this is affected by the method applied to production. Cultivation begins in a laboratory that tends to use tanks ranging from 8 to 15 tons in width, where 80 to 150 nauplii can be seeded, with survival rates of half or up to 70%. [9].

Table 4.
Cultivation systems

System	Main Characteristics
Extensive	Low densities: 10,000 – 15,000 / Ha
	No formulated diets
	Average production: 600 lbs/Ha/year
Semi – intensive	Medium densities: 15,000 – 12,000 / Ha
	Formulated diets
	Average production: 1,000 – 5,000 lbs/Ha/year
Intensive	High densities: over 120,000 / Ha
	Formulated diets
	Average production: over 5,000 lbs/Ha/year

1.10 Main Diseases

1.10.1 White Spot Syndrome

It is a disease caused by the white spot syndrome virus, which affects shrimp, leading to decreased food consumption, lethargy, slow reflexes, erratic swimming, disrupted impulses, and empty intestinal tract, often resulting in a 100% mortality rate within 3 to 10 days. Clinical symptoms are identified in loose cuticles with white spots ranging from 0.5 to 2.0 mm in diameter, becoming more evident within the shell. The coloration of the shrimp ranges from pink to reddish due to the expansion of cuticular chromatophores [10].

1.10.2 Taura Syndrome

It appeared in 1991 and is also known as the Taura syndrome virus. It is one of the most devastating diseases affecting the shrimp production industry worldwide, commonly referred to as "red tail disease." This disease occurs during the single molt in juvenile shrimp, which takes place between day 5 and day 20 post-seeding. Symptoms include weakness and soft shell, with mortality rates ranging from 5% to 95%. Surviving shrimp may exhibit black lesions and carry them for as long as they live. [11].

1.10.3 Vibriosis

"Vibriosis is a bacterial disease caused by extracellular pathogenic strains from various species belonging to the Vibrio genus. In penaeid shrimp, pathogenicity has only been demonstrated for a few species of vibrios, although many bacteria have been observed in sick shrimp." [12].

It belongs to the Vibrio spp. type of bacteria, particularly V. parahaemolyticus and V. harveyi, which causes various symptoms, such as reddish coloration, loss of appendages, and bioluminescence, mainly during the larval period.

1.11 Consumption Benefits

Shrimp are a favored product. Recent studies indicate that the cholesterol level in shrimp is significantly lower than previously believed. 100 g of shrimp contains about 100 mg of cholesterol, which is approximately 33.3% of the cholesterol present in a chicken egg [13]
he nutritional value of shrimp depends on many factors; the shrimp produced in America will not be the same, specifically in terms of nutritional value, as that produced in Europe. Many factors intervene, such as geography, climate, and species. Shrimp are very nutritious as they contain proteins and a low caloric index; in a 100 g serving of shrimp, there are 20 g of proteins and between 90 to 100 calories. [13].

1.12 Concept of Nugget

A nugget is "a small piece of chicken or protein that has been coated with batter and subsequently fried," created by Robert C. Baker, a professor of poultry science and food science at Cornell University. Baker and Joseph Hotchkiss worked to develop modified atmosphere packaging and vacuum packaging to improve the chicken transportation process. [14].

1.13 Concept of Quinoa

Quinoa (Chenopodium quinoa) is a pseudo-cereal rich in proteins that grows under the extreme agroecological conditions of a high-altitude desert, with an annual precipitation of barely 250 mm, about 210 frost days per year, and sandy soils poor in nutrients and organic matter. Despite these adverse conditions, it is precisely here that quinoa grows. It is called a pseudo-cereal

because its properties are very similar to those of cereals, with the difference being that cereals belong to the grass family with very defined characteristics.

2. Materials and Methods

The materials and weights used in the following experiments vary depending on the experiment number being conducted; the experiments differ in their ingredients. The reason for selecting a low quantity of ingredients is due to the nutritional content we aim to provide in the nuggets, as using a larger quantity of ingredients such as additives and preservatives would classify them as ultra-processed foods, which in turn would result in a higher caloric content and increased economic value in production, thereby impacting the product's selling price. The materials to be used are as follows:

2.1.1 Shrimp

The shrimp selected for making the shrimp nuggets is Litopenaeus vannamei, which is among the most produced shrimp at the national level. The shrimp must undergo a proper cold chain process to ensure that the delivered product is safe for the consumer. For this research, we will choose shrimp obtained from the La Pony shrimp farm located in the Muisne canton in the province of Esmeraldas.

2.1.2 Quinua

Quinoa is a superfood known as a pseudocereal, which contains many proteins, fiber, micronutrients, and more. The quinoa selected for making the shrimp nuggets is the INIAP Tunkahuan quinoa, which is the most widely produced variety in Ecuador. This quinoa is chosen for its high nutritional value as well as its flavor.

2.1.3 Ice

Ice is essential in the process of making nuggets because, when processing the ingredients, the protein temperature rises due to the speed of the blades while spinning. Ice helps maintain a low temperature for the shrimp, preventing any harm to the final product.

2.1.4 Soy

Soy is obtained by fermenting soybeans with fungi; this condiment helps reduce the shrimp's flavor, making it less intense during tasting. Soy is a salty condiment with a slight sweetness.

2.1.5 Transglutaminase

Transglutaminase is a protein that allows the binding of the aforementioned ingredients. It acts as a binder in the dough and facilitates the handling of the Nuggets.

2.1.6 Corn Starch

Commonly known as cornstarch, this cereal is used as a thickening agent.

2.1.7 Spices

The use of spices or condiments in the preparation of the nuggets generates aroma and flavo.

2.1.8 Eggs

The use of beaten eggs in the preparation of the nuggets allows for better adherence of the processed quinoa.

3. Results

3.1 Receipt of Raw Materials

This is the first and most important stage in the preparation of the nuggets. It is crucial to observe certain characteristics such as color, odor, texture, prior temperatures, packaging, and labeling. Fresh shrimp that meets the necessary organoleptic characteristics according to INEN 0456 standards, such as color, odor, texture, etc., is selected.

3.2 Mise en Place

The ingredients and utensils necessary for the preparation of the recipe are prepared, and the ingredients are weighed for later use.

3.3 Processing

The shrimp is placed in the cutter or food processor and processed for approximately 14 to 16 seconds along with the ice. Soy and spices are then added, and processing continues for about 2 minutes.

3.4 Molding

The homogeneous mixture is placed in silicone molds, then covered with plastic wrap, and subsequently frozen at a temperature of –10 °C for 8 hours or until completely frozen.

3.5 Coating

The eggs are beaten until a homogeneous mixture is achieved, and the nuggets are dipped in the egg one by one. Each nugget that has been coated in egg is then covered in quinoa powder and subsequently frozen.

3.6 Quinoa Powder

The quinoa powder is obtained from processing previously toasted quinoa. First, the quinoa is placed in a pan over medium heat for 5 minutes, then it is placed in a blender and blended for 3 minutes. It is then passed through a #7 sieve (2.80mm), and the residues are blended again for 2 minutes before passing through a #9 sieve (2.36mm). Finally, the residues are blended once more for 1 minute and passed through a #10 sieve (2.00mm), thus obtaining processed quinoa.

3.7 Experiments

The experiments conducted were as follows E1=FA; E2=FB; E3=FC.
Experiment 1 = Formulation of Nugget A
Experiment 2 = Formulation of Nugget B
Experiment 3 = Formulation of Nugget C

Where:
E = Experiments
F = Formulations

3.8 Particularities of the Experiments

Table 5.
Experiment NC #504

MASS	
Product	**Percentage (g/100g)**
Shrimp	83
Ice	27
Salt	1
Black pepper	0.1
Garlic powder	0.2
Saffron powder	0.2
TOTAL	100
COATING	
Product	**Percentage (g/100g)**
Mass	80
Quínoa	18
Egg	2
TOTAL	100

Experiment NC #504 was conducted based on the preparation of 100% mass exclusively with shrimp. This differs from the other two experiments because other ingredients are added during preparation. The shrimp was processed with the ice for approximately one minute and 45 seconds, after which seasonings such as pepper, salt, saffron, and garlic powder were incorporated. It was frozen at -18°C for an estimated time of 8 hours, then coated with processed quinoa, followed by egg, then again with quinoa, and it was frozen for another 8 hours.

Table 6.
Experiment NC#805

MASA	
PRODUCT	**PERCENTAGE (G/100G)**
Shrimp	75
Ice	20
Soy	5
Salt	1
Black pepper	0.3
Garlic powder	0.25
Saffron powder	0.2
TOTAL	100
COATING	
PRODUCT	**PERCENTAGE (G/100G)**
Mass	80
Quinua	18
Egg	2
TOTAL	100

Experiment NC #805 contains soy, which diminishes the flavor of the shrimp. To prepare the nugget, the shrimp was processed for 1 minute and 45 seconds along with the ice, and the soy was added after obtaining the shrimp paste. The seasonings were also added, and it was placed in silicone molds for approximately 8 hours at -18°C. Then, it was removed from the molds, coated with processed quinoa, eggs, and again with quinoa, and it was frozen for another 8 hours.

Tabla 7.
Experiment NC #452

MASS	
Shrimp	65
Ice	26.5
Soy	2.5
Cornstarch	2.5
Salt	1
Black pepper	0.07
Garlic powder	0.2
Saffron powder	0.2
Transglutaminase	3.5
TOTAL	100
COATING	
Mass	80
Quínoa	18
Egg	2
TOTAL	100

The NC #452 experimentation includes cornstarch and transglutaminase in its preparation, an additive that helps bind the dough. This resulted in a more homogeneous dough that was easy to handle. First, the shrimp was processed together with ice for approximately one minute and 45 seconds. Then, the seasonings were added, followed by the cornstarch and transglutaminase. The mixture was then placed in silicone containers and frozen at -18°C for approximately 8 hours. After being removed from the freezer, it was coated in processed quinoa, dipped in beaten egg, and then coated again in processed quinoa before being returned to the freezer for 8 hours.

3.9 Economic Analysis

This study includes two economic analyses since the producer of the nuggets is primarily a shrimp farmer who does not want to sell his shrimp at a low cost, also known as tail shrimp. For this reason, an economic study was conducted for the production of a 10-hectare pond in the Manabí area, specifically in Cojimies. Although the price of shrimp per hectare varies according to many factors such as climate, diseases, and production, this research focuses on one of the lowest productions of the year 2019, which was 10,000 pounds.

Table 8.
Production Expenses for Shrimp

Description	Cost
Larvae	$ 1´800,00
Feed	$ 3´640,00
Kal	$ 525,00
Diesel	$ 400,00
Labor for 3 months	$ 1´200,00
Fishing personnel	$ 420,00
Medication	$ 500,00
Bacteria	$ 185,00
Initial investment	$ 8´670,00

For this production of 10,000 pounds, 88% will be sold at whole shrimp prices, while 12% will be directed to tail shrimp. An investment of $8,670.00 is required, which currently, due to the drop in shrimp prices caused by COVID-19, results in a balance of $12,320.00 for the 88%. However, the 12% for tail shrimp is still needed. If we leave that tail shrimp at the packaging facility at a price of $1.90, we must deduct 33% for the weight of the head, resulting in a balance of $1,527.60. This gives a total of $13,847.60, but if we account for the initial investment, we have a final balance of $5,177.60.

3.10 Economic Analysis of Quinoa-Enriched Shrimp Nuggets

This study provides insights into the financial status of producing quinoa-enriched shrimp nuggets. The following analysis seeks to utilize that 12% (12,200 lbs taken from the previous example) for the production of shrimp nuggets.

Table 9.
Expenses for Producing Shrimp Nuggets

Description	Cost
Equipment	$ 1903,00
Utensils	$ 150,00
Salaries	$ 1500,00
Packaging	$ 450,00
Nugget production (500 portions)	$ 641,02
Initial investment	$ 4´644,02

If 1 pound of shrimp yields 1.5 portions of nuggets, with 8 units in each portion, then from 2,200 lbs of shrimp, we can obtain 3,300 portions of quinoa-enriched shrimp nuggets. At a price of $3.25 per unit, this results in a value of $10,728.00. Subtracting the previously mentioned expenses of $4,644.02 gives a final balance of $6,083.98.

3.11 Investment in Equipment and Utensils

Table 10.
Investment in Equipment and Utensils

Description	Quantity	Cost/unit	Toatal cost
Stainless steel work table	1		$ 120,00
Food processor	1		$ 100,00
Digital scale	1		$ 35,00
Industrial stove	1		$ 200,00
Surgical steel pots	5	$ 56,00	$ 280,00
Freezer	1		$ 260
Refrigerator	1		$ 650
Blender	1		$ 60,00
Fryer	1		$ 200,00
Steel knife	2	$ 22,00	$ 44,00
Cutting boards	3	$ 13,00	$ 39,00
Surgical steel ladles	3	$ 5,00	$ 15,00
Bowls	5	$ 5,00	$ 5,00
Silicone molds	10	$ 4,00	$ 40,00
Thermometer	1		$ 5,00
Total investment in equipment and utensils			$ 2´053,00

4. Conclusions

- Shrimp is a product of vital importance to Ecuador's economy, ranking among the country's main sources of income. Quinoa is a product with multiple benefits for human consumption, and this research demonstrates the technical and economic feasibility of producing shrimp nuggets enriched with quinoa.

- A standard recipe for shrimp nuggets enriched with quinoa was successfully developed through experimentation and sensory analysis, which, with the help of judges, yielded the recipe with the highest palatability for consumers.

- The sensory analysis of acceptance testing using a hedonic scale indicated that all three experiments were well-received by the judges, with less than 10% of judges expressing disapproval of the product. In this way, 90% approved the product and indicated that they would be pleased to consume it in their diets.

References.

[1] Farfante Pérez; Kensley B., Penaeoid and sergestoid shrimps and prawns of the world., Paris, France: Memories du Museum National d´Historie Naturelle, 1997.

[2] C. R. Rajoy, Artist, *Cultivo de Crustáceos.* [Art]. Universidad Europea Miguel de Cervantes, 2015.

[3] Accerto, «Alimentación, conceptos fundamentales.,» Grupo Planeta, España, 2014.

[4] V. Morales, «Levantamiento larvario de camarones peneidos,» Dirección nacional de acuicultura, Panama, 1990.

[5] V. Santos y N. Pilco, Artists, *Propuesta para la elaboración de chorizo a base de camarón y su comercialización en la ciudad de Guayaquil.* [Art]. Universidad de Guayaquil, 2018.

[6] M. G. Torres, «Análisis de la producción y desarrollo sostenible del cultivo de camarón en la provincia de Santa Elena, cantón Santa Elena, parroquia Chanduy,» ULVR 2016, Guayaquil, 2016.

[7] L. B. Argandoña, «Sector Camaronero: Evolución y proyección a corto plazo.,» FCSHOPINA, 87, Guayaquil, 2016.

[8] J. P. Fierro Aguilar, F. J. Duque-Aldaz y H. A. Pérez Benítez, «Análisis de la percepción de los consumidores y empleados de una empresa de productos cárnicos de la ciudad de Guayaquil – Ecuador para la aplicación de un sistema de gestión de inocuidad alimentaria,» *Observatorio de la Economía Latinoamericana,* 2017.

[9] FAO, «Organización de las Naciones Unidas para la Alimentación y la Agricultura,» 1 Febrero 2005. [En línea]. Available: http://www.fao.org/fishery/countrysector/naso_ecuador/es.

[10] J. C. -. Anjel, «Enfermedades de las manchas blancas,» The Center for Food Security & Public Health, Iowa, 2013.

[11] G. H. M. Bazurto, Interviewee, *Ingeniero en acuicultura.* [Entrevista]. 22 07 2019.

[12] J. Cuéllar-Anjel, «Vibriosis,» Agosto 2013. [En línea]. Available: http://www.cfsph.iastate.edu/Factsheets/es/vibriosis-in-shrimp-es.pdf.

[13] D. Krummenauer, «Cultivo de camarón bajo invernadero en un sistema con bioflocs,» *AQUA Cultura,* pp. 44-48, 2015.

[14] B. Friedlander, «Cornell University,» 16 Marzo 2006. [En línea]. Available: http://news.cornell.edu/stories/2006/03/food-and-poultry-scientist-robert-c-baker-dies-age-84.