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Aquaculture and sensometric characteristics of minimally processed snapping shrimps (*Alpheus* sp.) processed cold cuts (Luncheon meat)

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Abstract

Sensory research in aquaculture has been developed in different ways depending on the commercial interests of the species implicated. The application of aquaculture research has shown tremendous impact for the continued growth of the industry needs and to complement the findings and possibilities offered by sensometric. The main purpose of the study is to produce snapping shrimp processed into cold cuts *(luncheon meat)* and utilized to evaluate the sensory acceptability of snapping shrimp processed cold cuts in terms of appearance, aroma, mouthfeel, texture, taste, and overall acceptability. A mixed-methods research design was used in the study. A quasi-experimental design was used to test the preliminary characteristics and 9-point hedonic scale for consumer preferences. Results have shown that the proposed selling price of T_0 is P 16.8 compared to T_4, which is P 19.78. The shelf-life and other physical characteristics, including aroma and appearance for both at room temperature and in the refrigerator, showed no changes from day 1 to day 7. The luncheon meat also possessed remarkable physical characteristics while being stored at a high freezing point. There is a significant difference in terms of appearance, aroma, mouthfeel, texture, taste, and overall acceptability in five (5) treatments. This further implied that all treatments have different levels of acceptability in terms of the four (4) sensory attributes. From the 5 treatments used, T_2 (25% pork and 75% snapping shrimp) was the most accepted and considered preferable by the respondents compared to other treatments. The processed cold cuts (luncheon meat) have a potential for adoption either from the identified community or from aquaculture entrepreneurs.

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Introduction

In the past decades, aquaculture has been one of the most promising production industries. It is the controlled process of cultivating aquatic organisms that is being used, particularly for human consumption. It's a similar concept to agriculture, but with fish instead of plants or livestock. Aquaculture is also referred to as fish farming. The seafood that you find at your local grocery store is likely labeled as farmed fish. Aquaculture can happen all over the world, either in coastal ocean waters, freshwater ponds and rivers, or even on land in tanks. Several studies, like the study of Yongqiang Zhao *et al.* (2020), have suggested that changes in the production process, especially those related to nutritional and feeding interventions may have an impact on the final quality of farmed animal food products, including those from aquaculture.

One of the examples of an integrated approach to closing the gap between consumers' responses and aquaculture products is the sensorial quality aspects that could be altered by the inclusion of new alternative protein and lipid sources in aquafeed. Applied research efforts in aquaculture should recognize the significance of consumers' behavior and preferences with the aim of making this industry economically sustainable. Until now, sensory research in aquaculture has been developed in different ways depending on the commercial interests of the species implicated. The sensory analyses generally used in aquaculture were identified in four main application research areas: nutrition and feeding, production aspects, quality products, and marketing topics (Calanche *et al.*, 2019). The existence of snapping shrimp (*Alpheus sp.)* is very timely, as it's one of the most promising marine products that have greater potential for aquaculture production. Knowing its biology and habitat classification, with the addition of several trials of experiment conducted, this species has a high opportunity for mass production. Snapping shrimp is one of the fishery resources that are abundant in the town of Calape, Bohol. They live particularly in coastal areas with a wide intertidal zone, mangroves, and rich mud banks. This species is locally known as *"takla"* because of its very unique sounds and is considered a seafood delicacy in the municipality. Shrimp that is among the worlds fastest and that produces the loudest sounds underwater. They use the sound to communicate with one another and to defend their territory (Baobao *et al.*, 2015).

The abundance of snapping shrimp in the locality was one of the factors that the researchers considered in developing processed cold cuts, which are generally termed luncheon *meat*. Luncheon meat is a type of cooked meat that is often sold in tins. It is a mixture of meat and other ingredients. It is convenient and shelf-stable. One of the biggest benefits of luncheon meat is that it is convenient and easy to prepare when running short on time or with limited ingredients available. It is also shelf-stable, which makes it simpler to stock up on compared to perishable protein foods like chicken or beef. In addition to these, luncheon meat has healthy benefits; it provides small amounts of vitamin C, magnesium, folate, and calcium. Luncheon meat is high in calories, fat, and sodium but also contains some protein, zinc, potassium, iron, and copper (Harcourt, 2010).

Eating cold cuts like luncheon meat is convenient; no cutting or cooking is required. Simply buy the meat, slap it on the sand or in a wrap, and head out the door. They are also high in protein and beneficial vitamins and minerals such as iron, zinc, and vitamin *B12*. On the flip side, they are high in saturated fat, both of which you'll want to be especially wary of if you have heart disease or high blood pressure (Younkin, 2017). Luncheon meat is a canned lunch meat product. It has a salty and slightly spicy ham flavor with a moist and spongy texture similar to sausage patties. You can eat uncooked luncheon meat because it is already steamed; it can be eaten straight from the can and requires minimal preparation prior to eating. It is also highly versatile and can be added to a wide variety of recipes. One of the first things you need to know about canned meats or luncheon meat is that they are almost always already cooked (Miranda, 2020). Generations of Filipinos love eating processed cold cuts of luncheon meat regularly,

typically sliced or diced, then stir-fried and served on a bed of steamed rice, sometimes with a fried egg. It is now devoured in 44 countries worldwide, but it first came to life in 1937 in the small town of Austin, Minnesota. Fried, baked, boiled, or braised, the pork-based luncheon meat was first a hit in the US during the great depression and then in Asia after World War II. It is noticeable that people are very busy and are always in a hurry nowadays. The number of groceries and manufacturers of canned goods like luncheon meat is increasing because people have less time to cook and prepare their own food. Canned goods are the best choice for an emergency food supply. Canned goods luncheon meat can provide protein of high nutritional value for what is considered a highly nutritious food.

Some of the sensometric components include appearance, which is the most important attribute of any food's appearance, and color, especially when it is directly associated with other food-quality attributes. The color quality of the illumination, in terms of intensity, color temperature, and fidelity, and the nature of the structure of the product all affect the appearance. Another preference is in aroma, where it is very sensitive to the processing and storage conditions. Flavor loss as well as off-flavor development is a problem of the food industry and could be limited by the encapsulation of the volatile ingredients prior to their use (Madene *et al.*, 2006). The texture is defined as those properties of a food that are sensed by touch in the mouth and with the hands. We use many words to describe food texture. Foods can be soft or hard, mushy or crunchy, or smooth or lumpy. It is most important to the enjoyment and acceptability of foods, as well as the taste of some of the finest things in life. The most amazing finding is that taste sensitivity varies from person to person. It comes from a chain reaction that starts with sensitive proteins on the tongue, races through taste buds, enters the nerves, and ends with the brain. Almost everyone lives in a unique taste world, which directly relates to the interaction food has with the consumer at a given moment in time. The factors that affect food acceptability are different for the foods they love and hate. Overall acceptability includes customer characteristics, sensory characteristics of food, and the feel-good factor (Maina, 2018).

Processing snapping shrimp meat is a significant sector of the global economy, contributing to food security and nutrition as well as livelihoods. Processed food enables the supply of safe, affordable, and nutritious foods. The processed food sector accounts for a significant share of income generation and employment, is essential to maintaining a steady global supply of safe, affordable, and nutritious foods, and is thus key to supporting food security and nutrition. Processed food reduces the number of harmful bacteria in food that can cause diseases. It boosts the shelf life of food products and provides employment to a large population. Processed foods have been preserved by steaming, salting, or adding chemical preservatives. It refers to any food that is changed from its natural state. This may include adding preservatives, flavors, nutrients, and other food additives. It has a place in healthy diets. The key to healthy eating is to educate yourself on what to look for and talk with your health care professional or nutrition expert to discuss a food plan that works best for you (Harguth, 2022).

In this study, it only focused on the application of this species to aquaculture and the sensometric characteristics of a new product of processed cold cuts of luncheon meat; however, it showed some significant application not only to the contribution of the body of knowledge but also to the applicability for research utilization and commercialization of the product. The results of the patent search showed tremendous impact on the potential of commercialization for the following reasons: first, PH22019000243Y1 discloses the process of producing fresh water shrimp meat dumplings; second, RU2337589C1 specifies the method of manufacturing special-purpose canned food soup with shrimps and third, the RU 02332083 method of production of preserved food shrimps with vegetables and potherbs is invented. The prior art mentioned

above discloses the methods and composition of producing freshwater shrimp and dumplings. Although they are using the same commodity, which is shrimp, there are features and meat quality compositions that are different from freshwater and snapping shrimp. The product is dumplings, but the present invention relates to snapping shrimp luncheon meat in a tin aluminum can. Another prior art is the production of canned shrimp soup. In this invention, there is no disclosure as to what type of shrimp is used or the amount of soup that is added. The present invention is different because the processed snapping shrimp has no liquid in the canned product. The last prior art discloses the ingredients used in the preparation of the preserved food shrimps with vegetables and potherbs. The present invention is different from the last prior art since no liquid is involved in the canned processed food. No mention was also made of the kind of shrimp used.

Generally, this study aims to determine the potential of snapping shrimp for aquaculture and the sensometric value of processed cold cuts *(luncheon meat)* of snapping shrimps. Specifically, this study focuses on the following indices: 1) qualitative description of the snapping shrimp in making processed cold cuts *(luncheon meat);* 2) preliminary assessment; 3) sensometric components of the snapping shrimp processed cold cuts *(luncheon meat)* in terms of appearance, aroma, taste, texture, and overall acceptability in the five treatments identified: T_0- (100% pork luncheon meat), T_1 (50% pork + 50% snapping shrimp), T_2 (25% pork + 75% snapping shrimp), T_3 (75% pork + 25% snapping shrimp), T_4 (100% snapping shrimp); and 3) significant differences in the acceptability.

Materials and methods

Research design

This study uses a mixed-methods research design. The qualitative research design includes interviews with the product as to preparations, cost, and materials used. Quantitative research design uses quasi-experimental and descriptive survey methods. The quasi-experimental was made by preparing a series of trials in the preparation of the ingredients as to their quality in terms of taste, form, and size. Sensometric components were assessed by the experts, particularly those with knowledge of food processing and food handling, during the validation of research instruments. The treatments for the quasi-experiment include T_0 (100% pork luncheon meat), T_1 (50% pork + 50% snapping shrimp), T_2 (25% pork + 75% snapping shrimp), T_3 (75% pork + 25% snapping shrimp), and T_4 (100% snapping shrimp) (Fig. 1). Postharvest characteristics with the data on aroma, appearance, texture, and shelf life in different storage conditions were also assessed using descriptive survey method.

Fig. 1. The Frontal description (a) and (b) fresh meat appearance of snapping shrimps (*Alpheus* sp.)

Participants and environment

This study was conducted in Calape, Bohol, Philippines. The Municipality of Calape was known to have a vast intertidal zone with a reasonable brackish water area needed for the culture of snapping shrimp. The idea of its production rate in the town as to abundance is the reason that this fishery species could possibly be a source for some by-products as an input or a raw material to derive another new product, which was the luncheon meat. In this study, the identification of the research participants undergoes the process of sampling. During the preliminary assessment, critiquing and validating the research indicators were also considered. The results from the preliminary assessment were the basis for identifying the post-harvest characteristics as to aroma, appearance, physical texture, and shelf life in

the two-storage condition. This was done with constant checking of the advisers' perceptions of the acceptability of the product using the final treatments.

The researchers used random sampling in selecting the respondents to assess the product. The selected respondents were food experts (chefs and cooks in restaurants) who had a lot of experience in the food industry. The qualified individuals who taste the product have the ability to criticize its taste and provide accurate information regarding the study. In that way, it was easy for them to determine the acceptability of the food in terms of appearance, aroma, mouthfeel, texture, taste, and overall acceptability. Identifying the number of respondents was done after the pre-oral and before the conduct of the study, with the consultation of a statistician and research adviser. Random sampling was done through the lottery technique in order to infer from the given population. The Sloven formula was used for the sample size determination, and the rule of thumb was considered to be not below or at least 30% of the given population as the sample. Below is the table of the respondents. The self-made questionnaire was divided into two parts: Part A was the demographic profile; in this part, the name was optional, but age was required, as were gender, religious affiliations, income, and source of income. Part B included a series of statements that pertain to aroma, flavor, taste, mouthfeel, texture, and overall acceptability. The food expert evaluated and validated the set of statements at the same time. The results underwent content and face validity testing through the Content Validity Index (Lawshe, 1975). The rating sheet was used to determine the rater's sensory perception of the appearance, aroma, flavor, mouthfeel, texture, and overall acceptability of the product. The respondents rated the product using the nine-point hedonic scale specifically for the sensory attributes of the product, with the highest description being "extremely acceptable" and the lowest description being "extremely unacceptable."

Research procedure

The main ingredients of the luncheon meat were salt, ground pepper, white sugar, cornstarch, patis, cold water, and oil. All these ingredients were used in five (5) treatments. The tools and equipment used for the preparation of the product were the following: a mixing bowl, knife, chopping board, plates, measuring cups, spoon, molder, strainer, steamer, and frying pan. The snapping shrimp and processed cold cuts *(luncheon meat)* were presented to the food experts. The researchers provided water for each respondent after tasting each of the different treatments and an interval time of five (5) minutes to distinguish the different treatments of the product. With the distribution of the sample products, the rating sheets were given to the respondents to identify the sensory qualities of the snapping shrimp meat in making processed cold cuts *(luncheon meat)* in terms of appearance, aroma, taste, texture, and overall acceptability. To ensure that the respondents would answer the rating sheets sincerely, clear instructions and enough time were given. The questionnaire was retrieved immediately and used in interpreting the study.

Statistical treatment

To test if there was a significant difference among the treatments, a one-way ANOVA was used, and the results were analyzed using SPSS, or Statistical Packages for the Social Sciences. This tool was first launched in 1968 as a software package (Creswell, J.W., 2014). This package was mainly for statistical analysis of data, which includes surveys and many others. It also provided data analysis for descriptive statistics, which includes the mean, which was very helpful in the study. SPSS version 23 was used to analyze the post-harvest characteristics (aroma, appearance, texture, and shelf life) and the perceptions of the possible adopters in terms of appearance, aroma, taste, texture, and overall acceptability.

Results and discussion

Qualitative description

Nowadays, foods are often processed and have a lot of preservatives added. Thus, consumers should be wise in choosing foods that are beneficial to health while also being affordable. In T_0 (100% pork), the color was light brown because of the presence of 100% pork; it was 3 inches in diameter; it has a 0.5-inch

thickness; it weighs 30 grams; and the number of servings per recipe was 15 pieces. The production cost per recipe was P21.31; it has a cost of P14.00 per serving, and the proposed selling price per serving was P16.08 with a 20% markup on the production cost per recipe. In T_1 (50% pork + 50% snapping shrimp), the color was slightly brown because of the presence of 50% pork and 50% snapping shrimp; it was 3 inches in diameter, 0.5-inch thickness, and 30 grams in weight; the number of servings per recipe was 15 pieces; the production cost per recipe was P230.31; it had a cost of P16.35 per serving; and the proposed selling price per serving was P18.32 with a 20% markup of the production cost/recipe. In treatment 2 (25% pork and 75% snapping shrimp), the color was brown because of the presence of 25% pork and 75% snapping shrimp. It was 3 inches in diameter, 0.5 inch thick, and 30 grams in weight, and the number of servings per recipe was 15 pieces. The production cost per recipe was P240.06; it has a cost of P16.04 per serving; and the proposed selling price per serving was P 19.25 with a 20% markup of the production cost per recipe. Therefore, the snapping shrimp processed cold cuts luncheon meat in terms of color and size was slightly the same compared to the product on the market. It showed that this product has potential; even though it was expensive, it has an impact on the entrepreneurs to sell a new product.

Preliminary assessment (Quasi-experiment)

The mean acceptability rating score for appearance ranged from 6.58 in trial 1 T_1 (50% pork + 50% snapping shrimp), which was described as moderately acceptable, to 7.80 in trial 2 (25% pork + 75% snapping shrimp), which was described as moderately acceptable, which was presented in table one (1) based on the rating of the nine (9)-point hedonic scale in the preliminary quality assessment of snapping shrimp processed cold cuts *(luncheon meat)* as assessed by the food experts. In terms of aroma, in trial 1, T_0 (100% pork) got the highest acceptability rating score of 6.16, described as slightly acceptable, and T_1 (50% pork + 50% snapping shrimp) was the least acceptable. In trial 2, T_3 (75% pork + 25% snapping shrimp) got the highest acceptability rating score of 7.86, described as moderately acceptable, and T_0 (100% pork) was the least acceptable. In terms of mouthfeel and texture, in trial 1, T_0 (100% pork) got the highest acceptability rating score of 7.00, described as moderately acceptable, and T_1 (50% pork + 50% snapping shrimp) was the least acceptable. In trial 2, T_4 (100% snapping shrimp) got the highest acceptability rating score of 7.92, described as moderately acceptable, and T_0 (100% pork) was the least acceptable.

Sensometric of snapping shrimps processed cold cuts

Appearance

In benchmark statement 1, which stated that the luncheon meat has enough size, while in the second statement, the color of the luncheon meat is appealing at first glance, the majority of the respondents agreed that T_2 (25% pork + 75% snapping shrimp) got the highest acceptability. Indicator 3 was in good shape, and the majority of the respondents agreed that T_4 (100% snapping shrimp) had the highest acceptability. The mean acceptability rating score for appearance was 7.77, which is described as very acceptable. The results showed that T_2 got the highest acceptability rating and T_0 was the least acceptable. This implied that, among all treatments, T_2 (25% pork + 75% snapping shrimp) was the most acceptable and preferable by the food experts in terms of appearance. The desirable appearance of snapping shrimp processed into cold cuts *(luncheon meat)* was criticized for adding more to the enhancement of the different treatments. The food industry has historically favored synthetic color additives over natural colorants in terms of storage conditions (Tijsken *et al.*, 2001).

Aroma

In indicators 1 (which stated that the pork luncheon meat has an evident smell), 3 (which stated that the luncheon meat has a fresh smell), and 4 (which stated that the smell of the species used complements each other), the majority of the respondents agreed that T_2 (25% pork and 75% snapping shrimp) got the highest acceptability. In indicator 2, which stated that the snapping shrimp luncheon meat is evident in its smell, the majority of the respondents agreed that T_4

(100% snapping shrimp) had the highest acceptability. In addition, the mean acceptability rating score ranges from 7.45, which is described as very acceptable, to 7.79, which is described as very acceptable. The table showed that T_2 got the highest acceptability rating score of 7.79, whereas T_0 got the lowest. This implied that among all the treatments, T_2 (25% pork and 75% snapping shrimp) was the choice and considered preferable by the food experts in terms of aroma. Aroma is very sensitive to processing and storage conditions. Among the five senses, aroma is one of the key drivers of our flavor experience (Madene *et al.*, 2006). Flavor loss as well as off-flavor development is a problem for the food industry and could be limited by the encapsulation of the volatile ingredients prior to their use.

Mouthfeel and texture

In indicators 1 (which stated that the luncheon meat is crispy), 2 (which stated that the meat used can be felt in the mouth), and 4 (which stated that the taste of the species can be recognized), the majority of the respondents agreed that T_2 (25% pork and 75% snapping shrimp) got the highest acceptability. Indicator 3, which stated that the luncheon meat has a fair texture, the majority of the respondents agreed that T_1 (50% pork + 50% snapping shrimp) got the highest acceptability. In addition, the mean acceptability rating score ranges from 7.46, which was described as very acceptable, to 7.80, which was described as very acceptable. The table showed that T_2 got the highest acceptability rating score of 7.80, whereas T_0 got the lowest. The results imply that among the treatments, T_2 (25% pork and 75% snapping shrimp) was the choice and considered preferable by the food experts in terms of mouthfeel and texture. It was subjectively assessed as described collectively to sensometric using a validated instrument (Kohyama, 2020).

Taste

The acceptability in terms of taste is shown in different indicators. It is first stated that the luncheon meat has an appealing taste, and the majority of the respondents agreed that T_2 (25% pork + 75% snapping shrimp) got the highest acceptability. Indicator 2 stated that the luncheon meat has a savory taste, and indicator 3 stated that the taste of the species can be identified. The majority of the respondents agreed that T_4 (100% snapping shrimp) had the highest acceptability. In indicator 4, which stated that the taste of the luncheon meat, which is made from snapping shrimp and pork, complements each other, the majority of the respondents agreed that T_0 (100% pork) had the highest acceptability. In addition, the mean acceptability rating score ranged from 7.60, which was described as very acceptable, to 7.77, which was described as very acceptable. The table showed that treatment 2 got the highest acceptability rating score of 7.77, whereas T_1 got the lowest. This implied that among all the treatments, T_2 (25% pork and 75% snapping shrimp) was the choice and considered preferable by the food experts in terms of taste. Taste is the number one purchase driver for food and drink products; a superior taste is key to creating a strong product experience (Acta Psychol, 1993) that will encourage consumers to buy your product again and again.

Overall acceptability

Table 1 presents acceptability in terms of overall acceptability. In indicators 1 (the overall appearance of the product), 2 (the overall aroma of the product), 3 (the overall mouthfeel and texture of the product), and 4 (the overall taste of the product), the majority of the respondents agreed that T_4 (100% snapping shrimp) got the highest acceptability. In addition, the mean acceptability rating score ranged from 7.5, which was described as very acceptable, to 7.77, which was described as very acceptable. The table showed that T_4 got the highest acceptability rating score of 7.77, whereas T_0 got the lowest. This implied that among five different treatments, treatment 4 (25% pork + 75% snapping shrimp) was the choice and considered preferable by the food experts in terms of overall acceptability. The discipline of hedonic response flourished swiftly in the 20th century, along with the growth of the food processing industries (Kohyama, 2020). It encompasses a set of techniques required for the precise measurement of human reactions to foodstuffs, ultimately persuading consumer perceptions.

Table 1. Overall sensometric characteristics of snapping shrimp *(Alpheus* sp.*)* Meat in making processed cold cuts *(luncheon meat)* as perceived by the food experts (N=34)

Indicator	T_0 (100%pork)		T_1 (50% pork+ 50% snapping shrimp		T_2 (25% pork + 75% snapping shrimp		T_3 (75% pork + 25% snapping shrimp)		T_4 (100 % snapping shrimp)	
	Mean	DR	Mean	DR	Mean	DR	Mean	DR	Mean	DR
Overall acceptability										
Appearance	7.57	Very much acceptable	7.45	Very much acceptable	7.73	Very much acceptable	7.68	Very much acceptable	7.75	Very much acceptable
Aroma	7.72	Very much acceptable	7.79	Very much acceptable	7.88	Very much acceptable	7.85	Very much acceptable	7.95	Very much acceptable
Mouthfeel and texture	7.18	Very much acceptable	7.29	Moderately acceptable	7.45	Very much acceptable	7.43	Very much acceptable	7.55	Very much acceptable
Taste	7.51	Very much acceptable	7.60	Very much acceptable	7.77	Very much acceptable	7.71	Very much acceptable	7.81	Very much acceptable
Total mean	7.5	Very much acceptable	7.53	Very much acceptable	7.71	Very much acceptable	7.67	Very much acceptable	7.77	Very much acceptable

Post-harvest characteristics

The postharvest assessment of the processed luncheon includes the appearance, texture and shelf life both in refrigerated (33–40°F or (0–4°C) and normal environment. Results have shown that in the appearance to include the size, shape, color, gloss, and freedom from defects and decay from Day 1 to day 7 in normal environment is 7-8 of a 9-point hedonic scale, while in refrigerated the processed luncheon meats appeared to have a very good quality until 2 weeks of exposure. It is been said that the quality, the degree of excellence or superiority, is a combination of attributes, properties, or characteristics that give each commodity value, in terms of its intended use. The relative importance given to a specific quality attribute varies in accordance with the commodity concerned and with the individual (producer, consumer, and handler) or market concerned with quality assessment. Other characteristics that were observed are the texture both the refrigerated and normal condition exhibit 9 point as to firmness, crispness, juiciness, mealiness, and toughness. Textural quality of some food product is not only important for their eating and cooking quality but also for their shipping ability especially like for luncheon meat.

Statistical analysis

Both appearance, aroma, mouthfeel, texture, taste, and overall acceptability showed significance in all treatments. It means that respondents significantly rated differently per treatment. The *F-value* obtained for all the treatments in appearance was 5.249, *P*-value =.001, 3.298, *P*-value =.012 aroma, 4.390, *P*-value =.002 mouthfeel and texture, 4.024, *P*-value =.004 taste, and 9.187, *P*-value =.000 for the overall acceptability, which was significant at the 0.05 level of probability. Among the five (5) different treatments, T_2 (25 percent pork and 75% snapping shrimp) was the most accepted and considered preferable by the respondents.

Conclusion

The T_2 which is 25% pork + 75% snapping shrimp was the most preferred sensometric characteristics for the respondents, a good indicator for adoption to local people especially to those who live in the coastal areas. The result can be a useful and a great help for the local people, community, and municipality to start a small business and also snapping shrimps provides greater opportunity for aquaculture production.

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