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## Evaluating Sensory Quality, Willingness to Try, Risk and Product Appropriateness of Seafood Byproducts

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# **EVALUATING SENSORY QUALITY, WILLINGNESS TO TRY, RISK AND PRODUCT APPROPRIATENESS OF SEAFOOD BYPRODUCTS**

A Thesis

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Master of Science

in

The School of Nutrition and Food Sciences

by  
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## **TABLE OF CONTENTS**

ACKNOWLEDGMENTS .....	ii
ABSTRACT .....	vi
CHAPTER 1. INTRODUCTION .....	1
CHAPTER 2. LITERATURE REVIEW.....	3
2.1. Seafood production (Global and the United State).....	3
2.2. Fish and catfish production (United States) .....	3
2.3. Food loss and food waste definition .....	4
2.4. Seafood and fish byproducts .....	5
2.5. Fish byproducts.....	6
2.6. Fish bones mineral composition and extraction methods .....	6
2.7. Effect of fish bone powder on sensory and physicochemical properties .....	8
2.8. Texture of fried foods .....	9
2.9. Uncommon food source perception .....	10
2.10. Risk linked to uncommon food sources consumption .....	12
2.11. Effect of health and safety statements on PI and WTT.....	12
2.12. Effect of emotions in food consumption. ....	13
CHAPTER 3. WILLINGNESS TO TRY (WTT), PRODUCT APPROPRIATENESS AND PERCEIVED RISKS ASSOCIATED WITH FOODS CONTAINING SEAFOOD BYPRODUCTS AS AFFECTED BY GENDER AND RACE .....	14
3.1. Introduction .....	14
3.2. Materials and Methods.....	17
3.3. Results and Discussions .....	19
3.4. Conclusion.....	38
CHAPTER 4. INCORPORATING CLEAN-LABEL CATFISH BONE POWDER IN A BREADING MIX FOR PREPARATION OF FRIED CATFISH, AND DETERMINATION OF CONSUMER ACCEPTANCE AND EMOTION, AND PURCHASE INTENT .....	40
4.1. Introduction .....	40
4.2. Materials and Methods.....	42
4.3. Results and discussion .....	48
4.4. Conclusion.....	61
CHAPTER 5. SUMMARY AND CONCLUSION .....	63
APPENDIX A. IRB APPROVAL FOR CHAPTER 3 .....	64
APPENDIX B. QUESTIONARY FOR CONSUMER STUDY FOR CHAPTER 3 .....	65

APPENDIX C. R CODES FOR CHAPTER 3 .....	75
APPENDIX D. IRB APPROVAL FOR CHAPTER 4 .....	76
APPENDIX E. QUESTIONARY FOR CONSUMER STUDY FOR CHAPTER 4 .....	77
APPENDIX F. SAS CODES FOR CHAPTER 4 .....	103
REFERENCES .....	104
VITA .....	120

## **ABSTRACT**

Valorization of food wastes/byproducts has become a major subject of research to increase sustainability of the global food supply chain. Seafood industries generate a substantial quantity of byproducts. An online survey was used to evaluate Willingness-to-try (WTT), the effect of a Consumer Safety Statement (CSS) on WTT, perceived risks and product appropriateness associated with seafood byproducts in food as influenced by gender and race. Based on the finding from this survey, a clean label catfish bone powder (CBP) was developed and used for breaded catfish sticks which were evaluated for sensory liking, emotional profile, and purchase intent. Previous consumers of seafood/fish byproducts (N=904) participated in the online survey during April-June 2020. Overall, males were more open to foods containing seafood byproducts than females, Caucasian was less WTT seafood byproducts by 87% and 138% compared to Asian and Hispanic consumers respectively, and WTT rates significantly increased for all racial groups after CSS was given (77.27%, 73.73%, and 58.45%, respectively). The three most appropriate products for seafood-byproduct incorporation were fish products, seasoning mixes, and soup/gravy. Taste, texture, and safety were the most cited risks. WTT and perceived risks associated with consumption of seafood byproducts were significantly affected by gender and race. The second part of the thesis showed that CBP can be incorporated up to 20% (20CBP) in the breading mix without affecting the sensory qualities of fried catfish. Surface crispiness liking was significantly different between the treatments. The majority of consumers (79-80%) rated surface color of 10CBP and 20CBP as just-about-right. Emotional profiles for all products were similar with the top five emotions elicited being Good (52%), Pleasant (41.5%), Satisfied (40%), Happy (38%), and Interested (35%). The negative emotions (Unsafe, Worried, and Guilty) were selected by <4% of the consumers. PI of 10CBP and 20CBP ranged from 69-73%, which was increased to 82-85%

after the product benefit (i.e., increased calcium content) was given to consumers. This study demonstrated that WTT, product appropriateness, and perceived risks associated with consumption of seafood byproducts were affected by race, and incorporation of CBP up to 20% did not affect the consumer acceptance of catfish sticks.



## **CHAPTER 1. INTRODUCTION**

Seafood is an important food source worldwide. Its production and consumption are the base of the economy of the Southern states. In the United States more than 78% of the consumers who responded to a survey reported that they consumed seafood at least twice per week. Their consumption is directly related to perceiving seafood, especially fish, as a nutritional protein source high in essential oils (Hicks et al., 2008). More than half of the fish produced in the United States comes from the Southern states such as Louisiana, Texas, Mississippi, and Alabama. Aquaculture is needed to meet the seafood consumption demand (USDA, 2020). The seafood industry produces a large amount of waste that can be used to develop new products and incorporate them into the production chain.

In order to develop new products, scientists need to know the consumers' preferences. Consumers can provide highly valuable information that can be used for product development. This information can be obtained from trained and untrained panelists. The appropriate techniques to evaluate products with untrained panelists include consumer acceptance and preference, penalty analysis, flash profiling, check-all-that-apply, and free choice profiling (Meilgaard et al., 2015). Knowing the consumer liking profile is essential to develop and reach the right market. Sensory evaluation is well used in different fields that need understanding and measuring human perception across products. Food sensory test is applied to measure, and predict market needs, and help consumers to make purchase decision for a product (Jaeger, 2006).

Knowing consumer perception is very important. However, introducing a new product based on unknown food sources is challenging. Seafood byproducts have been used to develop new products such as snacks (fish and bones). On the other hand, seafood byproducts are important for providing high nutritional compounds such as protein, minerals, and essential amino acids that

are essential for human body functions (Food and Agriculture Organization of the United Nations, 2016). Other benefits are related to enhancing matrix structures for products such as sausage and surimi (Hemung et al., 2018; Yin et al., 2017). Consumers have been willing to try uncommon food sources (Ardoín & Prinyawiwatukul, 2020; Bearth et al., 2021; Castro Delgado et al., 2020). However, finding the correct type of products to incorporate seafood byproducts is essential to save time and economic resources prior to launching a product. For example, Mitterer et al. (2014) found that modifications in the food matrix, such as presenting a fish-based burger instead of fried fish which made consumers perceived it as less healthy (Mitterer-Daltoé et al., 2014). Appropriateness and previous consumption experiences with the food can determine future expectation.

Therefore, this thesis comprehends two independent studies that intended first to measure WTT, risk, and product appropriateness of seafood byproduct and, second, evaluate consumer perception, liking, emotions, and PI of catfish sticks that were incorporated with CBP up to 20% in the breeding mix.

## **CHAPTER 2. LITERATURE REVIEW**

### **2.1. Seafood production (Global and the United State)**

The global seafood production is concentrated in Southeast Asian countries, where products are mainly exported to the United States and Europe (Shamshak et al., 2019). Seafood consists of a large group of different species such as fish, mussels, clams, shrimp, oysters, etc. Aquaculture production is essential because it has helped maintain sustainable fish production (FAO, 2018). Seafood is well consumed, and high production is needed to satisfy consumer demand. High demand of seafood is associated with health benefits. Globally, seafood consumption has increased from 10 kg to 20 kg per capita, and the production has increased by 3.3% per year from 2009 to 2014. This represent about 20% of the consumers' protein intake (Guillen et al., 2019). Nowadays, the United States is not a major seafood producer. Currently, the United States after China is one of the countries with higher seafood importations, which is about 90% of the total consumption, and the leading exporters are Vietnam and Norway (NOAA, 2018).

### **2.2. Fish and catfish production (United States)**

In 2018, global fish production peaked at 179 million tons which accounted for 401 billion U.S. dollars. Just 156 million tons were consumed, and the remainder was used for animal feed. In order to maintain an adequate seafood consumption, new production methods such as aquaculture have taken place. Aquaculture productions represent about 47 percent of the total fish production. About 50% of the global fish production comes from China, Indonesia, Peru, India, the Russian Federation, the United States of America, and Vietnam (FAO, 2018; FAO, 2020). The United States is one of the largest catfish producers; in 2016, the United States produced 320 million pounds of catfish with a value of \$363 million (NOAA, 2018). The high demand for catfish increases every year. In 2018, in the United States the total sales were 360 million dollars, and 379

million dollars in 2019. The primary production is concentrated in the southeastern states, including Mississippi, Louisiana, Arkansas, and Alabama (USDA, 2020). The catfish industry represents an essential economic and social industry in the south of the United States, especially in Louisiana, in which more than 2,328 employments come from the fish industry (Processing and wholesale) (NOAA, 2018). Catfish belong to the Siluriformes order, and in the United States, the species that are more consumed and produced are blue catfish (*Ictalurus furcatus*) and channel catfish (*Ictalurus punctatus*). This represents about 50% of the freshwater aquaculture production in which Louisiana leads the wild-caught market, followed by Maryland and Virginia (NOAA, 2017; NOAA, 2016). The main products from catfish are regular fillets, shank fillets, fillet strips, and nuggets (Bosko et al., 2018). This production generates byproducts that are commonly discarded or used as low-value products.

### **2.3. Food loss and food waste definition**

Some authors define food loss and food waste as the edible parts of plants and animals that were produced for human consumption but ended up in the trash. Nevertheless, FAO defined the term food loss as everything that is trashed and not recovered before the retail level, and food waste takes places at distributor, retail, and consumer level (FAO, 2021). However, both food waste and food loss are terms used to define the products that humans do not consume due to their physical appearance, spoilage, and bad postharvest techniques. Usually, these products are discarded as trash or placed in public garbage dumps that will decompose and not be transformed into new ingredients or products for animal and human consumption (Parfitt et al., 2010; Gustavsson et al., 2011). Spang et al. (2019) included the non-intended human consumption material inside the concept of food loss and waste, and suggested a step in the food supply chain called "food rescue," to include loss, waste and inedible parts again into the consumption chain.

According to the European Union regulation, animal byproduct is defined as "the entire bodies or part of animals, products of animal origin or other products obtained from animals that are not intended for human consumption" but these products can be wasted if they are not well used. There are three categories that animal byproducts can fit into. Category 1 is defined as the most risk material. This can be pet animals, zoo animals, essential parts of exotic animals, animals that can carry diseases, and catering waste from aboard (Outside of the E.U.). Category 2 is also a risk, and the examples are fallen stock, manure, and digestive content, but it does not include parts of animals from categories 1 and 3. Category 3 is a low-risk material that had been tried or tested for human consumption, for instance, bones, hair, and feathers. This category fits the waste from the kitchen that can be used for composting or anaerobic digestion (Welsh Assembly Government, 2011). The United States Department of Agriculture refers byproduct to as the edible, inedible offal, blood, hides, and rendered products; this concept includes all the part of the live animal that are not part of the dressed carcass and, in the case of seafood byproduct, head, bones, frames, tails, skin, and viscera (FAO, 2016; USDA, 2011).

#### **2.4. Seafood and fish byproducts**

A large amount of nutrients such as protein and minerals are discarded from raw materials. About 39% of the seafood produced in the United States is discarded; this discard comes from the bycatch, distribution, and retail operations, in addition to the consumer level. Regarding nutrients, the total loss accounts for about 208 billion grams of protein and 1.8 trillion mg of essential oils such as eicosatetraenoic (EPA) and docosahexaenoic (DHA) acids (Love et al., 2015). There are already in the market some valuable products like chitosan and chitin, which are extracted from exoskeletons of mollusks, and crustaceans. Chitosan is well-known for its antimicrobial properties that have been applied in the pharmaceutical, food, and cosmetic industries (Santos et al., 2020).

Other bioactive compounds such as collagen and gelatin have also been recovered and used in different industries as high-value ingredients due to their suitable and high nutritional profile of essential and nonessential amino acids (Pal & Suresh, 2016). However, there is still a big amount of seafood byproducts that have not been exploited.

## **2.5. Fish byproducts**

Globally, fish discard is around 23 million tons, which is about 35% of the total fisheries' supply production (FAO, 2020). The common byproducts account for about 55%-65% of the total harvest weight of the fish (Silva et al., 2014). The major fish byproducts include heads, tails, viscera, and backbones (Wangkheirakpam et al., 2019). Fish waste contains about 15-30% protein and up to 25% fat. The recovery of these byproducts can generate high-value products, medicine, food, and animal feed ingredients. Fish oil is one of the most expensive and nutritious components extracted from fish byproducts. It is used as margarine, omega-3 fatty acids, and biodiesel (Ghaly et al., 2013). However, there is still a considerable amount of raw material that is not utilized discarded or used to produce low-value products. Those byproducts can be used to extract bioactive materials, proteins, minerals, enzymes, biopolymers, and fatty acids that can be incorporated into the production chain to reach the consumer level (Aspevik et al., 2017). For example, fish bones are full of minerals that can be extracted and used to develop new food products. Developing opportunities for seafood byproducts will help to reduce the negative environmental impact of waste produced and at the same time increase profits for the seafood industry (Erasmus et al., 2021).

## **2.6. Fish bones mineral composition and extraction methods**

The quality and the quantity of the minerals vary depending on the type of fish and extraction method. The most used method to extract the mineral from fish bones are water and

chemical boiling. Amitha et al. (2019) used both the water and chemical methods to evaluate the nutritional compounds of fish bones. The water method consists of soaking the fish frames in water and boiling them for 30 minutes, drying for 3 hours, and grinding. The alkaline method follows the same procedure, but NaOH solution was used instead of water.

The quality of the fish bone powder differs depending on the method used, fish species, feed, age, and the size of the fish (Luu & Nguyen, 2009). Amitha et al. (2019) found that the water boiling method was able to recover a white and fine bone powder with lower % moisture, higher % protein, higher % fat, and lower % ash content than was the alkaline method. The author attributed these changes to the fact that the alkaline method removed more organic material from the fish frames than hot water. Therefore, the fat and protein content were lower in the powder made by the alkaline method. The fat content was decreased with the alkaline method because the mixture of heat and NaOH removed more fat than water (Nemati et al., 2016). Similar results were found for yellowfin Tuna Bone Powder (TBP), in which the alkaline boiling method yielded a powder with a 3.86% fat (Nemati et al., 2017).

Some of the most principal minerals that are present in fish bone powder is phosphorus and calcium. The water boiling method was able to recover up to 37.6% calcium and 18.6% phosphorous (Ozawa & Suzuki, 2002), while the alkaline method recovered 38.16% of calcium and 23.31% of phosphorus (Nemati et al., 2017). However, the calcium and phosphorus content varies depending on the method and type of fish. Benjakul & Karnjanapratum (2018) reported that TBP contain 27.1% Ca and 12.8% P and Hemung et al. (2018) found that silver carp bone contain 32.07% Ca and 20.96% P. Nemati et al. (2016) stated that calcium coming from fish should be close to a calcium-phosphorus ratio of 2:1 because it is similar to the human mineral bone content.

The water boiling method and alkaline method can recover fish bone powder with a similar calcium and phosphorus ratio.

The next step consists of taking the dried material and grinding it. The grinding step determines the size of the particle; it can be a simple step by using a pulverizer or by using a new grinding technology. The complex grinding process is divided into the wet and dry media milling process, and it consists of boiling the bones, which are subsequently mixed with deionized water to create a paste, and it goes through a high-energy wet bead mill, and finally dried and coarsely ground to recover smaller particles. This process helps to reduce the particle size to nano and ultrafine particles (Yin et al., 2015, 2016, 2017). Lower calcium (10.82%) and phosphorus (9.4%) values were observed by using these methods because, during the suspension milling process, calcium can be released. However, the main objective of using this method is to develop a nano fish bone powder with 115.5nm particle size (Yin et al., 2015).

Fish bones account for almost 30% of the total catfish weight and contain about 60 to 70% minerals such as calcium, phosphorous, magnesium, manganese, zinc, and nickel (Kim & Mendis, 2006). Those minerals are important for essential functions of the human body (Pravina et al., 2013). Currently, the average calcium intake is 60% below the recommended value. The health professional has recommended fortification to reach the adequate consumption level (Cormick & Belizán, 2019). Calcium from fish bones can be used to fortify food to increase calcium content.

## **2.7. Effect of fish bone powder on sensory and physicochemical properties**

Calcium obtained from fish bones has been incorporated in bakery, meat, and surimi products to evaluate liking and physicochemical properties. Calcium fortification is needed to reach adequate calcium intake levels. However, lactose intolerance conditions in some populations do not let the consumer to obtain calcium from dairy products. Nemati et al. (2016) evaluated the



addition of TBP on bakery products (cookies and bread) and found that sensory liking scores (odor (fish), taste, texture, color, general appearance, and overall liking) were not significantly different in cookies and bread incorporated with TBP and commercial calcium (tricalcium phosphate). Njoroge & Lokuruka (2020) found that cookies with TBP (2%) were more liked by consumers. However, cookies with TBP got the lowest fracturability values, which means that cookies with 2% of TBP have harder texture than the control. However, other studies showed that consumers tended to accept up to 30% TBP added to whole wheat crackers (Benjakul & Karnjanapratum, 2018). Fish bone powder has been incorporated in sausage and surimi to improve textural properties, and water holding capacity, and to address calcium fortification. Sausage with fish bone powder showed to increase hardness, gumminess, and calcium content. In addition, sensory texture liking score was higher for samples with fish bone powder added compared to the control. Due to the addition of a white powder (fish bone powder), lighter colors were obtained from the color analysis, and color liking scores were negatively affected (Hemung et al., 2018; Hemung & Sriuttha, 2014; Yin et al., 2017).

## **2.8. Texture of fried foods**

Texture properties are important in fresh and processed food. For fried food, texture is one of the principal determinants for consumer acceptance (Asokapandian et al., 2019). Nowadays, there are different frying processes such as pan, shallow, air, and deep-frying, but all follow the same concept, which is to cook the product by heat transferred from the surface to the product. Deep frying is one of the oldest frying methods and provides an appealing color, texture, aroma, and flavor to the product. The texture of fried food depends on exposure time, temperature, frying method, and material of the frying container, and it is the result of protein, fat, and carbohydrates reactions inside a product while it is exposed to temperature and oil (Bordin et al., 2013). When

food products are exposed to an excess of time and temperature they will decrease the product's moisture (Ahmed et al., 2009). Fried food is an appealing fast food, and currently, the trend is to provide fried food with an edible coating that is low-carbohydrate, low-fat, reduced-salt, and popcorn-size; the last one is typically used for seafood and chicken products (Kulp et al., 2011). The objective of batter and breaded coating is to develop a product with an appealing crunchy texture and at the same time, providing variety and novel products (Voong et al., 2018).

## **2.9. Uncommon food source perception**

Consumer perception is learning throughout the senses and the mind because it is a mixture of previous experiences, motivational and contextual factors. Measuring perception is a complex and dynamic process, so it is difficult to predict as it is easy to change directions (Troy & Kerry, 2010). Currently, the trend is to consume healthy, sustainable, and environmentally friendly products. However, consumers differ in their WTT and willingness to pay. This variation is usually associated with the lack of previous exposure to the food source and a high-risk perception toward consumption (Ardoin & Prinyawiwatkul, 2020; Bearth et al., 2021). Psychological factors seem to be the main reason to reject food containing uncommon food sources (Castro & Chambers, 2019a). At the same time, Henthon, McCarthy, & O'Callaghan (2016) stated that a prerequisite to accepting a product comes from the idea that the product is safe, and inappropriateness of the product concept can lead to avoiding and not repeating a purchase.

A byproduct is considered an uncommon food source, and its introduction as a food source has been questioned by consumers. Seafood byproducts such as fish bones have been incorporated in sausages and bakery products at a laboratory level to measure sensory liking, and it has been well accepted (Hemung & Sriuttha, 2014; Nemati et al., 2016). On the other hand, recent studies on insects, fruits, and animal (beef) byproducts provide insights about consumers WTT (Ardoin &

Prinyawiwatkul, 2020; Aschemann-Witzel & Peschel, 2019; Bearth et al., 2021; Castro & Chambers, 2019b). Ardoin & Prinyawiwatkul (2020) studied consumer perception of insect protein powder and found that the consumer was WTT, but unfamiliarity was one of the most cited barriers to decline insect-based products. One of the barriers to overcome in order to introduce to the market uncommon food sources is the risk perceived for consuming unknown food ingredients (Baker et al., 2016). A product properly developed will help the consumers to perceive byproducts positively and see them as a nutritional food source. Bearth et al. (2021) strongly recommended developing novel products with animal byproducts with a better presentation to help consumers avoid the idea that byproducts are dirty, bloody, and unsafe. Plant byproducts have been used to develop chocolate drinks, and consumers' perceptions were changed by sustainability information about the grass and potato byproduct usage (Aschemann-Witzel & Peschel, 2019). This information is meant for the marketing and food science industry to develop and promote novel products.

Another critical factor in determining consumer perception and acceptance of a product is the difference in culture. A product is accepted or rejected depending on the location where it is going to be sold. Lombardi et al. (2019) stated that Eastern culture is more WTT insects than Western. However, Castro & Chambers (2019a) found that the United States was not in the top countries willing to try new products with insects. Mexican consumers present the higher scores of WTT insects which was attributed to the familiarity and exposure to insects as food (Hurd et al., 2019). Consumer perception must be studied directly for each product, country, and race to determine differences and develop the appropriate product for that specific market (Castro & Chambers, 2019a).

## **2.10. Risk linked to uncommon food sources consumption**

The rejection process is determined by the risk perception attributed to consumption of a product. Risk perception is classified into four dimensions: functional risk (sensory properties and price), physical risk (safety and nutrition), social risk (social acceptability), and psychological risk (negative emotions and unfamiliarity) (Baker et al., 2016). Recent research has addressed this critical problem that novel products face before launching into the market. Insect protein has been well explored; Ardoin & Prinyawiwatkul (2020) cited unfamiliarity, negative emotions, and sensory properties such as texture and taste as the most cited risks to consume insect protein. Unfamiliarity and negative emotions are linked to food neophobia, and those problems can be solved by education and exposure to the product, while appropriateness can reduce the fear to try new products due to sensory properties (texture and taste). According to Bearth et al. (2021), animal byproducts rejection is linked to negative emotional appropriateness and previous experience (taste). Insect and animal byproducts share similar risk perception. Avoiding these barriers will help to increase acceptance and consumption of new nutritional products containing CBP (Poortvliet et al., 2019).

## **2.11. Effect of health and safety statements on PI and WTT.**

Safe, health and sustainability statements have been used to persuade consumers to consume and buy a specific product (Žeželj et al., 2012). Carabante et al. (2018) used a health statement to enhance acceptability and PI of grass-fed beef; (Pujols et al. (2019) used a nutritional statement ("*low sodium health benefit*") to measure emotions and PI. Ardoin & Prinyawiwatkul (2020) pointed out that Entomophagy benefit information positively increased WTT; Danish consumers accepted more a chocolate drink containing byproducts when a nutritional and educational statement was given to consumers than when an image of the uncommon food source

is shown alone (Aschemann-Witzel & Peschel, 2019). Additional information helps consumers to think about the benefits of the products and to accept, buy and be more WTT the product. However, for animal byproducts, sustainability information was not considered an important factor to promote consumption and WTT (Bearth et al., 2021). The same happened for an A-biofortified orange-fleshed sweet potato in which detailed nutritional information decreased acceptance of texture and taste (Lagerkvist et al., 2016a). The author stated that nutritional information should be selected carefully in order not to affect consumer acceptance.

## **2.12. Effect of emotions in food consumption.**

Food consumption can be affected and related to cognitive and emotional dimensions (Bechara, 2004). King & Meiselman, (2010) defined emotion as an intense mental and physiological reaction. Scientists defined emotions as good and bad feelings, and those are unique to each person. Feelings are the result of a stimulus, and the stimulus can be direct and indirect (Mulligan & Scherer, 2012). Negative emotions are related to consuming unusual food sources such as parasites and insects (Randler et al., 2017). In comparison, positive emotions are linked to consume tasty snacks and increase cravings (Moore & Konrath, 2015). Consumers look for food that helps them to increase positive emotions. It has been proved that sugar enhances dopamine production in consumers' brains; chocolate consumption has been demonstrated to positively change the mood and increase positive emotions such as happiness in consumers (Meier et al., 2017). Knowing the emotion profile can be helpful to understand and predict consumer preferences (Gutjar et al., 2015).

## **CHAPTER 3. WILLINGNESS TO TRY (WTT), PRODUCT APPROPRIATENESS AND PERCEIVED RISKS ASSOCIATED WITH FOODS CONTAINING SEAFOOD BYPRODUCTS AS AFFECTED BY GENDER AND RACE**

### **3.1. Introduction**

Food loss and waste (FLW) are among the most significant issues to solve to achieve sustainable food systems (Brizi & Biraglia, 2021; Muth et al., 2019). Because it is a global problem, the United Nations sets up to cut food waste to half by 2030 on its sustainable development goals agenda (Graziano da Silva, 2019). According to the Food and Agriculture Organization of the United Nations, almost one-third of the food produced for human consumption is wasted every year (Gustavsson, Jenny, Cederberg Christel, 2011). The waste in the United States accounts for 39% of the global food waste produced. In 2016, the United States created 289 metric tons of FLW, and it is projected to increase from 342 in 2030 to 396 in 2050, respectively (Huang et al., 2020). FLW keeps growing along with population and consumption, especially seafood products (Erasmus et al., 2021). The production of seafood loss and waste occurs at different levels of the food supply chain, as in harvesting, processing, distribution, and consumption (Love et al., 2015). FAO reported that during the processing, almost 55% of some seafood products, such as fish, is discarded since byproducts (inedible parts) are not consumed (FAO, 2019), while the USDA reports seafood losses of 39% at the retail and consumer level (Buzby et al., 2014). Overall, Love et al. (2015) reported that 47% of the total of the United States seafood supply is lost across the processing chain. This loss has high economic, environmental, and social negative consequences on individual countries (Seberini, 2020).

A solution to this significant global problem is to create close and circular economic systems in which the FLW can be incorporated and transformed into food, pharmaceutical, and

agriculture novel value-added products (Caruso G., 2015; Ghaly et al., 2013; Sasidharan & Venugopal, 2020; Senevirathne & Kim, 2012). The recovery of seafood byproducts represents a smart strategy to reduce waste, and it can increase profits for the seafood industry and address food insecurity (Erasmus et al., 2021). However, incorporating products with seafood byproducts requires data to understand consumer perception toward using byproducts for human consumption. Previous studies denoted cultural and social norms, negative emotions, lack of sensory appeal, and neophobia as some barriers faced by the adoption of new products containing unfamiliar ingredients such as insects and animal byproducts (Bearth et al., 2021; Looy et al., 2014; Sogari et al., 2019). However, those hurdles can be addressed by increasing processing levels, improving sensory properties, and providing educational and nutritional information (Ardoin & Prinyawiwatkul, 2020; Henchion, McCarthy, & O'Callaghan, 2016; Sogari, 2015). The literature available in the recovery of seafood byproduct is limited to early steps of products development, including characterization of nutritional composition of seafood byproducts, laboratory scale testing and potential future use (Bergman, 2015). Understanding consumer perception and acceptability of seafood byproducts as a food source need to be researched.

Prior studies stated that appropriateness and the final product presentation could encourage consumption of new products (Bearth et al., 2021; Tan et al., 2016). Ardoin & Prinyawiwatkul, 2020 used the product appropriateness concept to determine the best product to incorporate an ingredient such as cricket powder without affecting consumer perception. This concept can be expanded and used to explore other types of unfamiliar food products (Ardoin & Prinyawiwatkul, 2020). Additionally, it is well established that the consumption of novel products containing unknown and unfamiliar ingredients generates negative emotions such as fear and resulting in a decrease of acceptance, PI, and Willingness-to-try novel food (Baker & Shin, 2016; Bearth et al.,

2021; Jang & Kim, 2015). However, prior studies showed that providing educational, nutritional, and sustainability information increased WTT of novel products containing unfamiliar/uncertain ingredients (Lombardi et al., 2019; Pambo et al., 2018; Schouteten et al., 2016). The present study evaluated cross-cultural differences among Asian, Hispanic, and Caucasian consumers, which have been well explored on insects, parasites, but not in seafood byproducts. Byproduct recovery have been recently studied by several authors. Aschemann-Witzel & Peschel (2019) evaluated consumer liking and effect of sustainability statement on the perception of a potato protein from byproducts and the use of grass based cocoa drink. Bearth et al. (2021) studied WTT and consumer perception of animal byproducts. Tan et al. (2016) conducted a sensory evaluation and WTT burger patties containing lamb brain, frog meat and mealworms. However, those studies were done with a small sample size; appropriateness was evaluated in one product, and risk of consuming was not evaluated. These limitations leave a large room to study actual appropriateness, risk, and WTT seafood byproducts. There is no additional evidence of published literature about consumer perception, perceived risk, WTT, and appropriateness of seafood byproducts in the last ten years. The search was via Google Scholar, and consumer perceptions, WTT, or risk of seafood co-products, byproducts, and subproducts were used as keywords. However, we could find similar studies on insects that evaluated similar market and consumer insights (Ardoin & Prinyawiwatkul, 2020; Baker et al., 2016; Jang & Kim, 2015).

The present study aimed to evaluate the effects of race and gender on identifying product appropriateness among 12 food categories for incorporation of seafood byproducts, the perceived risk of seafood byproducts consumption, and the effect of consumption safety statement on WTT products containing seafood byproducts.



## **3.2. Materials and Methods**

### **Respondents and data collection**

Louisiana State University (LSU; Baton Rouge, LA, USA.) Agricultural Center Institutional Review Board approved the use of human subjects as part of this research (IRB# HE18-22). The online survey was developed and administered using Qualtrics software (Qualtrics Provo, UT, USA). Participations in this study were entirely voluntary, and did not get any monetary compensation for filling out the survey, and a consent form was signed before starting the survey. Weblinks and Codes were generated to distribute and collect data from online platforms such as Facebook, email, and Instagram and a consumer database, “Tiger Taster,” compiled by the LSU AgCenter Sensory Lab.

### **Questionnaire - Study design**

After the consumers agreed and signed the consent form, they were screened by two factors; age (>18) and seafood consumption (Do you consume seafood or fish products?). Negative answers will terminated the survey and redirected the participant to the end of the survey. Data from consumers that did not meet the requirements were not included in this investigation. The demographic information collected in the survey was gender, race, and socioeconomic such as education and employment status.

Emotional baseline was evaluated on a 9-point scale (Disagree extremely, disagree very much, disagree moderately, disagree slightly, neither disagree or agree, agree slightly, agree moderately, agree very much, and agree extremely) with an additional option of not applicable. The 21 emotions evaluated were energetic, happy, pleased, aggressive, friendly, satisfied, free, adventurous, peaceful, loving, eager, healthy, nostalgic, active, enthusiastic, glad, unsafe, calm, bored, good, and worried. The emotions terms were selected from the Essence Profile® (King et

al., 2010) and from previous studies (Sukkawai et al., Wardy et al., 2016; Poonnakasem et al., 2016).

The following questions related to WTT seafood byproducts were recorded on a 'Yes/ Maybe not/ No' scale. General WTT questions were asked first, and then a safety statement was given to consumers “*Would you be willing to try new products containing a small portion of seafood byproducts such as bone and skin, knowing it is safe for consumption? (CSS)*”. Finally, an extra consumer statement about health and safety was given to consumers “*would you be willing to try new products incorporated with safe seafood byproducts that are claimed to provide health benefits (CSH)*” and consumers who selected "Yes" or "maybe" for this question were redirected to evaluate product appropriateness. The products were grouped into twelve different categories: dairy products; bakery products; meat and meat products including poultry and game; fat and oil and fat products; drink and beverage; snack and energy/protein bars; candy and confectionery; cereals and cereal products; seasoning mix, sauces and dressings; soup and gravy products (canned and frozen); fish and fish products including mollusks and crustaceans; pasta and noodles (USDA, 2015). On the other hand, consumers who were not WTT seafood byproducts evaluated the perceived risk-related seafood byproduct consumption from the following list: taste, appearance, odor/aroma, texture/mouthfeel, safety, nutrition, negative emotions (boredom, disgust, fear, guilty, worry, etc.), social acceptability, cultural or religious beliefs, unfamiliar with byproducts and price (Baker et al., 2016). Product appropriateness and perceived risk were evaluated in a check-all-that-apply (CATA) format.

### **Statistical Analysis**

Data were analyzed using RStudio and Microsoft Excel software (2013). Demographic data were reported in frequency and or percentage. Multivariate analysis of variance (MANOVA),

descriptive discriminant analysis (DDA) (Huberty & Olejnik, 2006), and Analysis of variance (ANOVA) with its respective Tukey post hoc test were used to determinate differences in emotions among the race and age groups. The effect of CSS and CSH on WWT was analyzed by McNemar's test and Stuart Maxwell's test, and Cochran-Q test. The cumulative logistic regression model was used to evaluate the relationship between race and gender with WWT (Ardoin & Prinyawiwatkul, 2020), and logistic regression analysis (LRA) was used to modulate risk with gender and race (Agresti, 2007).

### **3.3. Results and Discussions**

A total of 1010 consumers participated and filled out the survey that took about 5 minutes to complete. The data were collected during the lockdown of the COVID-19 pandemic from April to June of 2020. One hundred fifty data points of consumers who dropped the survey before they finished and did not belong to Caucasian, Hispanic, or Asian races were removed from the data pool. The final total people used for data Analysis was 860 people.

The sample was represented by Caucasian (40.58%), Hispanic (38.95%), and Asian (20.47%) race. The participants' age range was between 19 to 65 years old. Of the total of participants, 61.98% were female, and 38.02 were male. The education level was divided into three categories Graduate degree (MS, Ph.D., ED) (58.84%), College or equivalent (35.00%), and High School diploma or below (6.16%). Additionally, 76.04% of the participants knew what a seafood byproduct is, and for the rest (23.95%), we provided a concept statement "Related to seafood and aquacultural products, a byproduct is something (for example, bone, skin, gut) which is produced during the manufacturing or processing of another product (for example, catfish fillet)." Respectively, 46.16%, 39.42, and 14.42 responded not sure, yes, and have not consumed any product incorporated with seafood byproducts.

## **Emotions baseline**

This research was conducted during the COVID-19 pandemic that emerged in December 2019 in Wuhan, China. The emotion terms come from the EsSense Profile® list (King et al., 2010); and were evaluated on a 9 point scale without the influences of food and seafood byproducts. It is well known that the lockdown has carried significant economic, mental, and affective issues (Zhu et al., 2021). Stress can reduce positive emotions and increase negative and physiological conflicts in individuals (Minglu et al., 2020). This study evaluated 21 baseline emotion of 860 people from different races in which the top 6 emotions in this data set were worried, loving, nostalgic, friendly, healthy, and unsafe (5.30 slightly agree - 6.21 moderate agree), and the emotions with the lowest scores were aggressive, free, adventurous, pleased, satisfied and glad (3.61;4.72). Studies confirmed that negative emotions such as anxiety, depression, insomnia, loneliness, fear, and stress are the most common emotions evoked during the COVID-19 pandemic (Duan & Zhu, 2020; Pfefferbaum & North, 2020; Tracy, Merchant, & Lurie, 2020). Even with all the adversities, this study showed that positive emotions were present during the lockdown. Sun et al., (2020), evaluated emotions in a medical environment, and found that positive emotions occurred simultaneously with negative emotions, similar to our results.

On the other hand, Wang et al. (2021) compared the emotional stage of an epidemic and nonepidemic focus group in China and found that the epidemic group got higher scores on negative emotions. However, the authors suggested controlling demographic variables to reduce the variability of the emotions selected and increase the number of positive emotions evaluated. These studies affirm that the environment and external motivation can maintain a positive mindset. This variation can be seen in table 1, which shows the differences in gender and race across emotional terms.

Caucasian and Hispanic populations tended to have similar emotional baseline. However, the Asian population reported the lowest scores for positive emotions such as friendly, glad, healthy, good, happy, and loving (3.67;5.57), and higher scores for negative emotions such as unsafe, worried, and bored (6.66-6.25). These results may be explained by the fact that the COVID-19 pandemic emerged in Asian countries (China). The lockdown measured by these countries to prevent spreading the virus was more intense and robust than Western Countries (Dong et al., 2020; Imran et al., 2020). Johnson, Saletti-Cuesta, & Tumas (2020) run a study in Argentina (Hispanic America) at the same time that this study was performed. It found similar positive and negative emotions such as solidarity, healthy, awareness, uncertainty, worry, and boredom. This study attributed those positive emotions evoked during this pandemic could be linked to the lack of freedom, environment, family, and the time spent with the family circle that people experienced. Furthermore, emotions that required outdoor activities such as adventurous and free did not show any significant difference across the three races as expected due to the confinement during the lockdown.

Females felt significant more nostalgic, enthusiastic, unsafe, and worried than males, while males tended to feel significant more adventurous, calm, friendly, glad, peaceful, and satisfied than females. This is supported by Czeisler et al. (2020), who studied the effect of gender on emotions during COVID-19. This study found that the female group tended to experience more anxiety, leading to developing negative emotions than men. On the other hand, de Sousa et al. (2020) evaluated Brazilian men's feelings and reported their mix between positive and negative emotions during COVID-19 was linked to the provider role because they had to be strong to motivate and support emotionally to their families. Furthermore, Choi & Chentsova-Dutton (2017) and Imran

et al. (2020), affirmed that emotions and reactions can differ by race and gender even under normal and controlled circumstances.

Table 1. Mean and standard deviation of baseline emotions by gender and race

	Female	Male	Caucasian	Hispanic	Asian	Overall
Active	5.20±2.39 <sup>NS</sup>	5.42±2.39	5.51±2.47 <sup>a</sup>	5.47±2.37 <sup>a</sup>	4.49±2.11 <sup>b</sup>	5.29±2.39
Adventurous	3.98±2.28 <sup>b</sup>	4.46±2.37 <sup>a</sup>	4.28±2.40 <sup>NS</sup>	4.08±2.36	4.07±2.11	4.16±2.33
Aggressive	3.49±2.17 <sup>NS</sup>	3.79±2.15	3.38±2.09 <sup>b</sup>	3.37±2.13 <sup>b</sup>	4.52±2.15 <sup>a</sup>	3.61±2.17
Bored <sup>NS</sup>	5.81±2.42 <sup>a</sup>	5.71±2.48 <sup>b</sup>	5.46±2.54 <sup>b</sup>	5.62±2.47 <sup>b</sup>	6.66±1.97 <sup>a</sup>	5.77±2.44
Calm	5.10±2.13 <sup>b</sup>	5.60±2.08 <sup>a</sup>	5.52±2.06 <sup>a</sup>	5.30±2.15 <sup>a</sup>	4.82±2.11 <sup>b</sup>	5.29±2.12
Eager	5.02±2.14 <sup>b</sup>	5.38±2.15 <sup>a</sup>	5.40±2.14 <sup>a</sup>	5.14±2.21 <sup>b</sup>	4.46±1.96 <sup>b</sup>	5.15±2.15
Energetic	4.76±2.19 <sup>b</sup>	5.21±2.16 <sup>a</sup>	5.04±2.17 <sup>a</sup>	5.15±2.24 <sup>a</sup>	4.27±2.01 <sup>b</sup>	4.93±2.19
Enthusiastic	4.66±2.05 <sup>b</sup>	5.11±2.14 <sup>a</sup>	4.79±2.02 <sup>ab</sup>	5.06±2.19 <sup>a</sup>	4.44±2.00 <sup>b</sup>	4.83±2.09
Free	3.66±2.23 <sup>b</sup>	4.15±2.47 <sup>a</sup>	3.91±2.32 <sup>NS</sup>	3.76±2.36	3.87±2.34	3.85±2.33
Friendly	5.82±2.1 <sup>b</sup>	6.16±2.0 <sup>a</sup>	6.36±1.89 <sup>a</sup>	6.05±2.03 <sup>a</sup>	4.90±2.15 <sup>b</sup>	5.95±2.07
Glad	4.57±2.24 <sup>b</sup>	5.00±2.23 <sup>a</sup>	4.81±2.11 <sup>a</sup>	5.20±2.30 <sup>a</sup>	3.67±2.06 <sup>b</sup>	4.74±2.25
Good	5.53±2.00 <sup>b</sup>	5.80±2.09 <sup>a</sup>	5.97±1.82 <sup>a</sup>	5.84±2.04 <sup>a</sup>	4.53±2.09 <sup>b</sup>	5.63±2.04
Healthy	5.69±2.19 <sup>b</sup>	6.19±2.10 <sup>a</sup>	6.25±2.05 <sup>a</sup>	6.15±2.08 <sup>a</sup>	4.64±2.13 <sup>b</sup>	5.88±2.17
Happy	5.21±2.06 <sup>NS</sup>	5.43±2.16	5.62±1.96 <sup>a</sup>	5.44±2.11 <sup>a</sup>	4.36±2.06 <sup>b</sup>	5.29±2.10
Loving	6.12±2.09 <sup>NS</sup>	6.18±2.06	6.61±1.81 <sup>a</sup>	6.22±2.06 <sup>a</sup>	5.05±2.22 <sup>b</sup>	6.14±2.08
Nostalgic	6.15±2.13 <sup>a</sup>	5.81±2.25 <sup>b</sup>	5.96±2.09 <sup>b</sup>	6.32±2.24 <sup>a</sup>	5.57±2.16 <sup>b</sup>	6.02±2.18
Peaceful	4.99±2.14 <sup>b</sup>	5.50±2.24 <sup>a</sup>	5.29±2.0 <sup>a</sup>	5.29±2.3 <sup>a</sup>	4.77±2.3 <sup>b</sup>	5.19±2.19
Pleased	4.43±2.09 <sup>b</sup>	4.88±2.26 <sup>a</sup>	4.66±2.05 <sup>a</sup>	4.80±2.27 <sup>a</sup>	4.10±2.13 <sup>b</sup>	4.60±2.17
Satisfied	4.59±2.11 <sup>b</sup>	4.94±2.22 <sup>a</sup>	4.97±2.05 <sup>a</sup>	4.89±2.17 <sup>a</sup>	3.88±2.10 <sup>b</sup>	4.72±2.15
Unsafe	5.43±2.31 <sup>a</sup>	5.07±2.36 <sup>b</sup>	4.69±2.38 <sup>c</sup>	5.45±2.28 <sup>b</sup>	6.25±1.93 <sup>a</sup>	5.30±2.33
Worried	6.49±1.96 <sup>a</sup>	5.74±2.31 <sup>b</sup>	6.00±2.14 <sup>b</sup>	6.21±2.25 <sup>b</sup>	6.64±1.80 <sup>a</sup>	6.21±2.13

<sup>NS</sup> No significant difference, p-value >0.05

<sup>abc</sup> Difference in race (Caucasian, Hispanic, Asian), p-value <0.05

<sup>AB</sup> Difference in gender (Female, Male), p-value <0.05

In order to find out if there was an overall difference across the race and gender when all the emotion terms were considered at the same time, MANOVA and DDA were conducted. Results were significant ( $P < 0.001$ ) for MANOVA, so the DDA test was performed as a post hoc to determine and identify which emotions were more discriminating across race and gender. The pooled within-canonical structure (Can 1) shown in table 2 explained 79% of the variance with

bored, aggressive, unsafe, and worry were the emotions that contributed less to the variance and discrimination on race. However, the positive emotions such as loving, happy, healthy, good, and friendly were significant discriminating emotions among Hispanic, Asian, and Caucasian. On the other hand, as gender contains two variables, there was just one canonical (Can1\*) dimension that explained the whole variation. The emotions that account for higher discrimination were the positive emotions such as calm, pleased, and healthy, and the lesser discrimination were bored, nostalgic, unsafe, and worried, all of which were negative emotions.

Table 2.- The pooled within canonical structure describing differences among 21 emotions

	Can1 <sup>†</sup>	Can2 <sup>†</sup>	Can1*
Active	0.28	-0.07	0.12
Adventurous	0.06	-0.23	0.32
Aggressive	-0.4	-0.17	0.17
Bored	-0.37	-0.14	-0.12
Calm	0.2	-0.09	0.46
Eager	0.13	-0.05	0.31
Energetic	0.23	0.11	0.34
Enthusiastic	0.11	0.27	0.36
Free	0.03	-0.18	0.33
Friendly	0.5	-0.11	0.3
Glad	0.34	0.42	0.42
Good	0.51	0.11	0.29
Healthy	0.49	0.05	0.38
Happy	0.43	0.12	0.26
Loving	0.59	-0.06	0.08
Nostalgic	0.08	0.27	-0.21
Peaceful	0.12	-0.01	0.4
Pleased	0.18	0.23	0.43
Satisfied	0.31	0.14	0.4
Unsafe	-0.49	0.34	-0.27
Worried	-0.2	0.03	-0.7
Cumulative Variance explained	79%	21%	100%

Can1\*=Gender canonical dimensions

Can1<sup>†</sup> and Can2<sup>†</sup> = Race canonical dimensions

MANOVA (Shapiro Wilk=F-value) p-value< 0.001

## **Race and gender effects on WTT seafood byproducts**

Before introducing seafood byproducts concepts, consumers were asked about typical willingness to try (TWTT) new products, and it was seen that 82% of the consumers responded positively to this question. Afterward, 339 consumers affirmed (39%) that they have consumed some products containing seafood byproducts, but 397 responded "not sure" (46%). More than half of Asian consumers (76.70%) have eaten seafood byproducts (data not shown). However, less than half of Hispanic and Caucasian consumers reported that they have had this experience. Four hundred fifty participants (48%) were WTT new products with seafood byproducts, and 39% of the consumer were not wholly convinced of this idea. Likewise, Caucasian population was less (23.54%) WTT seafood byproducts than Asian consumers, and negative responses of Caucasian consumers (18.05%) were the highest in this category. However, TWTT's new products are significantly higher (>35%) than the WTT of seafood byproducts. Ardoin & Prinyawiwatkul (2020) reported that openness to try new products (TWTT) is expected to be higher than WTT of uncommon products because the former does not contain any neophobia information. However, their study was focused on U.S. consumers and did not evaluate the variability that different cultures can influence WTT unusual food sources. Our results showed that the Caucasian population exhibited less WTT seafood byproducts compared to Asians and Hispanics. Similar results were found by Woolf et al. (2019), who subministered a survey to 397 consumers from different ethnicity and found that Asians report higher scores (3.74) than Hispanics (3.71) and Caucasians (3.77) for WTT products containing insects on a scale of 1 to 10 points. Those results showed that there were differences in WTT between races.

Castro & Chambers (2019) evaluate the perception of insect consumption in different countries and found that consumers from the United States were less WTT insects than countries



like Peru, Mexico, China, and Thailand. Additionally, they found that even Mexico, Peru, and the United State belong to the western culture, their WTT and perception toward the consumption of insect protein were different. The same behavior was found in Asian countries in which China and Thailand differed from Japan and India. Additionally, Gmuer et al. (2016) found that Switzerland consumers were more WTT insect products with a higher degree of processing than less processed products. On the other hand, this survey was done during the COVID-19 lockdown, and data can be affected by the perception and emotions of that period of time. Khalil et al. (2021) administered an online survey in Catalonia during COVID-19 and found that the WTT of dairy products with insect protein decrease by 5% during the lockdown. Further research needs to be done to investigate more deeply the relationship between WTT seafood byproducts and COVID-19. The variation of WTT of seafood byproducts was explained by differences in race, and previous consumption experience.

### **Effect of race and gender on WTT safe and healthy seafood byproduct**

Cumulative logistic regression was used to predict WTT (Yes=1, Maybe 2, No=3) of seafood byproducts by Gender (Female=1, Male=0) and race. The model satisfied the assumption of proportional odds assumption ( $p\text{-value} > 0.05$ ); therefore, the model could be used to evaluate the relationship between race and gender with WTT (table 3).

Table 3. Parameter estimates and odds ratio values for WTT seafood byproducts

Parameter	Estimate	P-value	Odds Ratio
Intercept1	0.2593	<0.001	N/A
Intercept2	2.7954	<0.001	N/A
Gender M vs F	0.3068	0.052	1.36
Race <sup>1</sup>	0.8661	<0.001	2.38
Race <sup>2</sup>	0.6256	<0.001	1.87

P-value <0.001 significant

Race 1= Asian versus Caucasian

Race 2= Hispanic versus Caucasian

N/A= Not applicable

The estimated odds ratio of WTT of Yes compared to Maybe and No for Gender were tentatively significant (p-value 0.052). This means that the odds of trial for men were 36% higher compared to females. These results aligned with the raw data showing that 64.91% of females and 73.47% of males were WTT seafood byproducts. However, the model could underestimate this result since the sample size of male consumers was 38% compared to 62% of females. These findings were similar to previous studies that found that males presented higher positive scores than females on WTT uncommon food sources such as insects (Ardoin & Prinyawiwatkul, 2020; Ruby et al., 2015; Sogari et al., 2017). Significant estimates (p-value<0.001) were found in Caucasian versus Hispanic and Caucasian versus Asian. The odds ratio of yes compared to maybe and no shows that Caucasians were less WTT seafood byproducts by 87% and 138% compared to Asian and Hispanic, respectively (table 3). In other words, Asians and Hispanics were more WTT seafood byproducts by 2.38 and 1.87 times than Caucasian consumers. These findings were similar to previous research on Eastern and Western consumers; Castro & Chambers, (2019a) found that consumers from Asian countries and Hispanic countries were more WTT products containing unusual novel food sources. Our results can be explained by the historical consumption and commercialization of seafood byproducts in Asian and Hispanic countries (Newton et al., 2014). Even though Caucasian present lower odds ratio compared to Hispanics and Asians, raw data indicated that more than half (58.45%) of the Caucasian consumers were WTT seafood byproducts. Our results are supported by previous studies that showed that Caucasian consumers have positive intentions on WTT uncommon food sources (Castro & Chambers, 2019b; Ruby et al., 2015). However, these studies did not evaluate different cultural perceptions.

On the other hand, Hispanic countries such as Mexico (71%), Peru (58%), and Brazil (45%) have shown the highest WTT insect proteins (Castro & Chambers, 2019a). Consumption of insect

and animal byproducts by Hispanic consumers is well known. For instance, Mexico celebrates the *Jumil festival*, in which people catch stinkbugs and eat them raw. Animal byproducts such as beef and pork olfs, fish, chicken, pork skin, and gut are consumed regularly (Guiné, Correia, Coelho, & Costa, 2021; Lynch, Mullen, O'Neill, Drummond, & Álvarez, 2018). Bearth et al. (2021) and Woolf et al. (2019) suggested that effective marketing techniques and developing appealing products can help to increase the WTT of animal byproducts and insect products. Their research agreed that uncommon food sources such as insects or animal byproducts have a large room to be explored and transformed into nutritional and safe products to approach a market niche in different countries and cultures. Different factors can affect WTT, but a technique that has shown a positive impact helping to change consumers' minds is health and sustainability statements. This technique was explored in this research and will be discussed in the next section.

#### **Effect of consumer safety (CSS) and consumer safety and health statement (CSH) on WTT**

Healthy, safety, and sustainability statements have been already used to evaluate PI, liking scores, Willingness to buy, and WTT novel products (Ardoín & Prinyawiwatukul, 2020; Carabante et al., 2018; Kornher et al., 2019; Torrico et al., 2015). However, some studies proved that sustainability statements do not positively impact WTT animal byproducts (Bearth et al., 2021). In this study, CSS was used to persuade consumers about the benefits of seafood byproducts. Data were analyzed by Cochran-Q, and Stuart-Maxwell tests, which evaluated the marginal homogeneity on the 860 consumers' responses of WTT before and after CSS and CSH were delivered to consumers. Positive, negative, and maybe responses were significantly ( $p\text{-value} < 0.05$ ) changed after CSS and CSH were delivered to consumers. The same behavior was seen when the data were sort by race (Caucasian, Hispanic, Asian) and gender (Female-Male). Negative responses and maybe were collapsed to create a 2\*2 table to evaluate differences between before

versus after CSS and CSH by McNemar test, which was performed for total WTT, and by race, and gender. For all the categories, positive responses (>17%) significantly increased, and negative responses (>20%) regarding WTT of seafood byproducts decreased after the CSS. These results were similar to those of Torrico et al. (2015), who evaluated the effect of a health benefit statement on PI of forage-finished rib-eye steaks and found that Hispanics and Asians obtained higher scores than Caucasians on PI, but the three categories increased after the healthy statement. In our study, the most significant change was seen in gender, in which positive male responses shift more than 30%, which was higher than female (20%). Cochran-Q test was significant (p-value < 0.05) for all the categories, and McNemar showed a significant shift between WTT without benefit statement and CSS and between WTT without benefit statement and CSH (table 4). However, WTT did not significantly increase or decrease between CSS and CSHS except for Hispanics and males. These results were different from Coderoni & Perito (2020) who reported that positive PI on Italian males were more likely when males thought about sustainability than on safety products. However, Castro Delgado et al. (2020) found that Caucasian males were more willing to eat chocolate chips with cricket protein than females and found that Spain and Mexican males were less willing to eat chocolate chips with cricket protein. Castro Delgado et al. (2020) stated that different cultures can give different outputs from gender about likings and Willingness to eat cricket products.

Table 4. Effect of CSS and CSH on WTT seafood byproducts

Variable	Yes Before	Yes CSS	Yes CSH	No Before	No CSS	No CSH	Stuart- Maxwell p-value	McNemar p-value
Total								
WTT	48.26	65.12	68.26	51.74	34.88	31.74	0.001	0.001
Caucasian	38.40	57.31	58.45	61.60	42.69	41.55	0.001	0.001
Hispanic	51.34	67.76	73.73	48.66	32.24	26.27	0.001	0.001*
Asian	61.93	75.57	77.27	38.07	24.43	23.30	0.001	0.001

(table cont'd.)

Variable	Yes Before	Yes CSS	Yes CSH	No Before	No CSS	No CSH	Stuart- Maxwell p-value	McNemar p-value
Female	40.71	60.98	64.92	59.29	39.21	35.08	0.001	0.001
Male	39.45	71.87	73.70	60.55	28.13	26.30	0.001	0.001*

Base on N=860 responses

\*p-value > 0.001 for differences between CSS and CSHS.

CSS= Consumer Safety Statement, CSH= Consumer Safety and Health Statement, WTT= Willing to try

Overall, healthy and safety statements lead to a positive perception of insect product consumption (Schouteten et al., 2016). However, no studies have evaluated both statements in a different section in a survey. Therefore, our results (table 4) point out that using two benefit statements did not significantly increase the consumer's perception toward seafood byproduct consumption. The benefit statements "*....with pieces of seafood byproducts knowing it is safe for consumption and ... incorporated with safe seafood byproducts that are claimed to provide health benefits?*" were focused to reduce the negative emotions (disgusting), food neophobia, safety, nutrition, and sensory properties risk induced by byproducts and insects to become appealing for consumption (Baker et al., 2016; Coderoni & Perito, 2020; Poortvliet et al., 2019). Eve though the benefit statements cover most of the risk perceived; a total of 273 (31.74%) consumers hesitated (Maybe = 25.02%) and refused (No = 3.72%) to eat seafood byproducts. Some of the limitations of this study can be related to COVID-19 and self-survey reports, which other studies had similar faced. For example, Bearth et al. (2021) suggested that COVID-19 could have had a negative impact on the WTT of animal byproducts and that in-person studies should be done to corroborate WTT and perception of animal byproducts.

### **Risk perception of seafood byproduct consumption**

Consumers (N=273) who were not WTT new product and hesitated (maybe) were redirected to evaluate the risk perceived in a CATA format. The top five risks perceived for

consuming seafood byproducts were taste, texture, safety, odor, and appearance. The top five risks perceived by at least 50% of the consumers were used to analyze the effect of gender and race by a Logistic Regression analysis (table 5). Consumer choices are determined by risk; Baker & Shin (2016) found four perceived risk categories for edible insect consumption that affected consumer choice. However, for seafood byproducts, social acceptability, negative emotions, and cultural beliefs were selected as a risk for less than 30% of the participants, but functional (appearance, odor/aroma, taste, texture) and physical (safety and nutrition) risk were the most selected factors as to why consumers were not WTT seafood byproducts even after knowing that it is safe and healthy (table 6). Our results were similar to Bearth et al. (2021), who found that animal byproducts have been linked to unfamiliarity, negative emotions (disgusting), unhealthy and low appeal. However, negative emotion results were different from all previous studies for an uncommon food source in which food neophobia, unsafety, and unfamiliarity tended to evoke negative emotions (Ardoin & Prinyawiwatkul, 2020; Bearth et al., 2021; Kornher et al., 2019; Poortvliet et al., 2019; Woolf et al., 2019). Prediction of risk perceived is shown in table 5, excluding for the data for appearance, odor, and taste in which gender and race were not significant as a predictor.

Table 5. Prediction of risk associated with seafood byproduct consumption by LRA

	Safety		Texture		Nutrition	
	P-value	Odds ratio	P-value	Odds ratio	P-value	Odds ratio
Gender M-F	0.7824	0.92	<0.001	0.45	0.0553	1.73
Race <sup>1*</sup>	0.2507	0.39	<0.001	0.76	0.4704	0.75
Race <sup>1**</sup>	<0.001	0.31	<0.001	1.94	<0.001	0.37
Race <sup>2</sup>	0.4214	1.26	<0.001	0.39	<0.001	2.05

Parameter estimates were obtained from the Analysis of maximum likelihood

Race<sup>1</sup> Asian is the baseline (Hispanic vs. Asian\*; Caucasian vs. Asian\*\*)

Race<sup>2</sup> Caucasian is the baseline (Hispanic vs. Caucasian)

Sensory properties (taste, texture, odor, and appearance) were the most selected risks perceived for seafood byproduct consumption; this is a common barrier to engage people to

consume novel products (Aschemann-Witzel & Peschel, 2019). However, less than 9.78% of the consumers who have had the experiences of consuming seafood byproducts (...*head, bones, gut, or skin*) selected these terms as risk. Consumers are judging by expectation and not prior consumption, and it has been a limitation of an online survey against an actual trial within which the consumers can see and try the product (Ardoin & Prinyawiwatkul, 2020; Gmuer et al., 2016). Taste (82.72%) was the most selected risk, but race and gender cannot predict the behavior of this risk. Generally, related to animal byproducts, Bearth et al. (2021) suggested that developing novel products with high-quality sensory properties will lead to engaging consumers. No significant odds for any race and gender can be explained by the fact that taste is a general sensory aspect that consumers need to satisfy in order to accept or decline a product.

A total of 71.43% of the consumers who were not WTT seafood byproducts were contained about the texture. On the other hand, gender and race were predictors for texture risk in which the highest odds ratio was found between Caucasians and Asians. Hispanic perceived the texture as a risk by 24% and 61% less than Asian and Caucasian, respectively. These results are aligned with the percentage scores in which 81.38% of the Caucasian consumers picked this term. Texture has been claimed as the main problem with the incorporation of new protein or healthy food sources. Ardoin & Prinyawiwatkul (2020) evaluated risk perceived in 30 products and found that texture mouthfeel was the most selected for more than half (19 products). In addition, Castro Delgado et al. (2020) confirmed that texture, taste, and appearance were crucial for consumer acceptance. While Sogari et al. (2018) reported the texture as a risk that can cause the disgusting experience to retain pieces of the insect on the teeth. Castro & Chambers (2019a) removed the "*the texture would be bad*" statement because it was not a significant predictor of WTT. The texture is an important attribute that can be modified in order to reach consumer acceptance.

Odor and appearance were placed in the third and fourth place as the most selected risks for seafood byproducts, and gender and race were not a predictor for these attributes. Appearance and odor evoked repugnant feelings on insect consumption on Brazilian consumers (Schardong et al., 2019); however, negative emotions were not in the most listed risk. Negative emotions are linked to unfamiliarity with the food source. However, some cultures are already consuming some of the animal byproducts (Bearth et al., 2021; Woolf et al., 2019). On the other hand, previous research strongly recommended incorporating byproducts and insects in the invisible form that do not affect the product's appearance and avoid negative emotions (Castro & Chambers, 2019a; Woolf et al., 2019). Therefore, an actual trial should be performed to measure sensory properties to boost seafood byproducts as potentially nutritious and safe novel products (Bearth et al., 2021).

The resistance to consume insect-based products is related to sensory, negative emotions, and safety deficiencies (Castro & Chambers, 2019b, 2019a). Previous studies have pointed out safety concerns as a human nature behavior to avoid insect-based products (Jang & Kim, 2015). Risk perception comes from the idea that the food source is dirty and is processed under low sanitary and quality control procedures, which could become dangerous for consumers (Looy et al., 2014). Our results show that even safety was the third most selected by the total consumers (N=587), Asian consumers perceived safety in the second place as a risk for seafood byproduct consumption (77.50%). Additionally, it was the highest score (77.50%) in this category compared to Hispanic (56.82%) and Caucasian (51.72%) (table 6). Significant Odds ratio showed that Caucasian was 69% less concerned about safety risk than Asian (table 5).

The results are similar to Castro & Chambers (2019b) who found that consumers in Japan and India, linked consumption of insect-based products as a potential safety risk related to allergic reactions. Ardoin & Prinyawiwatkul (2020) results pointed that the U.S. Consumers were less



concerned about the safety and suggested that education can help to avoid safety risk perception on insect-based products. On the other hand, the emotional stage of Asians during the COVID-19 pandemic could have influenced the safety risk perceived due to the fact that Asians (6.25) were feeling more unsafe than Caucasians (4.69) and Hispanics (5.45) (table 1). Even though negative emotions were not in the top 6 risks perceived for seafood byproduct consumption, Asian (35%) consumers perceived it two times more than Caucasian (16.55%) and Hispanic (13.64%) consumers (table 6). The baseline emotional stage was highly correlated with the safety risk. Asian consumers (table 1) reported a higher score for negative emotions such as bored, worried, and unsafe (6.64 - 6.66) during the lockdown because of COVID-19.

Nutrition was selected by at least half of the consumers as a risk of eating seafood byproducts (table 6). Bearth et al. (2021) found that consumers tended to reject animal byproducts due to the unhealthy information associated with coronary diseases. However, Bearth et al. (2021) studied offal which is well known as a high cholesterol source. Commonly, U.S. consumers have not related nutrition as a risk for insect-based product consumptions (Ardoin & Prinyawiwatkul, 2020); Insects are related to food by providing high valuable nutritional benefits (Woolf et al., 2019).

These results are correlated with the logistic model prediction that found race as a significant predictor for nutrition risk, showing being Hispanics (2.05) and Asians (2.702) more WTT seafood byproducts than Caucasian consumers (table 5). Safety and nutritional barriers against seafood byproduct consumption can be addressed by providing specific educational material about benefit compounds; however, sensory properties such as appearance, texture, taste, and odor can be improved by selecting the appropriate ingredient for the appropriate product to develop appealing new products.

Table 6.- Risk perceived (%) from seafood byproduct consumption (N=273)

	Asian	Hispanic	Caucasian	Overall
Taste	85.00	88.64	78.62	82.78
Texture	67.50	56.82	81.38	71.43
Safety	77.50	56.82	51.72	57.14
Odor/Aroma	52.50	55.68	57.93	56.41
Appearance	67.50	54.55	52.41	55.31
Nutrition	65.00	61.36	39.31	50.18
Price	57.50	48.86	18.62	34.07
Unfamiliar with byproducts	25.00	25.00	35.17	30.40
Negative emotions	35.00	13.64	16.55	18.32
Social acceptability	20.00	10.23	5.52	9.16
Cultural or religious beliefs	15.00	1.14	2.76	4.03

### **Product appropriateness**

To introduce novel foods, it is necessary to expose consumers to products by trial probability and recognize consumer expectations (Tan et al., 2016). This research aimed to provide meaningful quantitative data to help scientists to develop the most appropriate products to reach the right market niche. Product appropriateness to incorporate seafood byproducts in foods has not been previously studied. However, for insects there was a list of products to perform future sensory studies to determine acceptance (Ardoin & Prinyawiwatkul, 2020). Novel products face limitations of not being consumed, and appropriateness can help to reduce that rejection by increasing acceptance. Tan et al., (2016) used three different novel food sources (lamb brain, frog meat, and mealworm) to evaluate product appropriateness on burgers and found that product appropriateness is correlated to sensory liking.

Moreover, Gmuer et al. (2016) pointed out that the degree of processing of crickets in snacks was the determining factor of product acceptance. Incorporating invisible insects has helped increase acceptance and liking scores (Tan et al., 2015). Therefore, industry is using high technology to develop high nutritional powders and protein isolates to use as an ingredient to

develop novel products without affecting sensory properties (Poortvliet et al., 2019). Consumers (N=587) who responded affirmatively to the WTT question evaluated product appropriateness. The results (table 7) show that fish and fish products including mollusks and crustaceans, seasoning mix, sauces and dressings, soup and gravy products (canned and frozen), meat and meat products including poultry, snack and energy/protein bars, and game products were more appropriate to incorporate safe seafood byproducts for this population.

A total of 486 from 587 consumers selected fish products as the most appropriate product to incorporate seafood byproducts. Fish odor is difficult to mask. Peinado et al. (2016) found that samples containing fish oil showed a significant difference in odor and taste compared to the samples with EPA and DHA. They recommended using a carrier product to evaluate future sensory properties. Linking Peinado et al. findings and our findings, it can be seen that fish products could be a good carrier to incorporate seafood byproducts. Multiple products such as salmon skin crackling, fried backbones are already in the market under fancy and gourmet labels. Seafood byproduct incorporation into fish products has rarely been studied. However, fish oil has been added to chicken nuggets without affecting sensory likings (Jiménez-Martín et al., 2016). Meat and poultry products belong to the protein category (USDA, 2015), and it was selected by 61.33% of the consumers. Our results differ from Ardoin & Prinyawiwatukul (2020) in which meat, poultry, and seafood products were less appropriate for insect protein incorporation for U.S. consumers. While in this study, 90.20% and 71.08% of Caucasian consumers agreed that fish, meat, and poultry products were more appropriate. It is expected that the results about appropriateness differed between countries. Studies showed that Dutch consumers were WTT burgers patties with insect powder (Tan et al., 2017), but another study showed that Dutch consumers tend to decrease WTT (Kornher et al., 2019). These data are useful since they help us understand that uncommon

food sources cannot be treated similarly. Future studies should be focused on evaluating sensory properties and consumer perception on real trials with products containing seafood byproducts (Next chapter).

Seasoning mix, sauces, and dressings category was the following category behind fish products (table 7). Fermented fish sauces are well known in Asian countries as well as in Mexico, where whole insects are used as ingredients to prepare traditional food such as tamales, spice mixes, salsas, and mole (Hurd et al., 2019; Mouritsen et al., 2017). However, there are few or no current published data that show the use of seafood byproducts in food. Familiarity plays an essential role in determining appropriateness; Caucasian consumers have been less open to trying novel products, but in this study, their selection presented the highest scores for 5 of the top appropriate categories (table 7). These results can imply that U.S. consumers are more WTT products fortified with invisible insect parts (Woolf et al., 2019). Soup and gravy products follow the same pattern. However, this food category was presented as canned and frozen, and it can be related to safe foods.

After meat products, one of the most explored categories to evaluate acceptance, WTT, and sensory properties was snacks and protein bars (Castro & Chambers, 2019a; Gmuer et al., 2016; Woolf et al., 2019). A total of 345 consumers selected snacks and protein bars as viable carriers to incorporate seafood byproducts. These results are aligned with Ardoin & Prinyawiwatkul (2020) that found protein bars and snack crackers as the most appropriate product to incorporate insect protein powder. Differences in race can be explained by familiarity with this kind of product; fish skin snacks just started to be marketed in the United States, but in Asian countries they have been used to eating fried backbones and fish skin snacks (Love et al., 2015). The use of seafood byproducts in snacks has been previously studied; Nawaz et al. (2019) incorporated fishbone to

increase nutritional value and texture of fried snacks. However, consumer studies were not performed on the final product. Korean consumers did not penalize sensory liking in snacks with fish frames, and they even gave higher scores for the product with 30% fish frames (Kang et al., 2006). Future studies should focus on developing new products with different seafood byproducts parts and evaluating WTT, Willingness to pay, acceptance, and emotions on real products.

Pasta was selected by 53.83% of the consumers as appropriate for incorporating in foods. However, the incorporation of seafood byproducts (fish frames) on pasta affected texture and color. Sirichokworakit (2014) suggested decreasing the particle size of the tilapia fish bones to increase liking and the substitution percentage on the final product. On the other hand, consumers from the United States (Ardoin & Prinyawiwatkul, 2020) and Italian consumers (Lombardi et al., 2019) agreed that pasta is an excellent product to incorporate insect protein powder. In this study, bakery and cereal products were selected by 34.24% -25.89 of consumers. However, studies confirmed that consumers accepted bakery and cereal products for incorporation of insect and seafood byproducts (Castro Delgado et al., 2020; Nemati et al., 2016). This is contradictory as consumers try the products because they tend to like insects (crickets, grasshoppers, and bugs) in salty recipes than sweets (Tan et al., 2015). However, the high appropriateness in some studies can be because consumers are also more WTT when incorporation is unnoticeable (Sogari et al., 2018). This research shows that consumers tend to relate the appropriateness of seafood byproducts with salty food than with sweet products such as bakery and confectionery. These results should be corroborated with real trials in each category and different flavors, shapes, and recipients across the cultures.

Table 7.- Appropriateness of seafood byproduct consumption (N=587)

	Asian	Hispanic	Caucasian	Female	Male	Overall
Fish and fish products including mollusks, and crustaceans	76.47	80.16	90.20	78.90	88.38	82.79
Seasoning mix, sauces and dressings	66.18	66.40	78.43	69.36	72.20	70.53
Soup and gravy products (canned and frozen)	59.56	57.09	69.61	60.40	64.32	62.01
Meat and meat products including poultry and game	63.24	52.23	71.08	57.80	66.39	61.33
Snack and energy/protein bars	72.79	47.37	63.24	60.69	56.02	58.77
Pasta and noodles	51.47	50.61	59.31	51.45	57.26	53.83
Fat and Oil, and fat products	25.74	44.13	65.20	44.22	51.45	47.19
Bakery products	22.06	28.74	49.02	34.10	34.44	34.24
Cereals and cereal products	13.97	20.24	40.69	26.30	25.31	25.89
Dairy products	8.09	15.79	29.90	17.34	21.16	18.91
Confectionery	5.88	12.15	27.94	15.90	16.60	16.18
Beverages	9.56	8.10	22.55	14.16	12.45	13.46

### 3.4. Conclusion

Healthy and safety statements inserted a positive impact on WTT seafood byproducts. However, using both at the same time did not increase more WTT. One statement was enough to help consumers to shift to positive WTT of seafood byproducts. Emotions can determine consumption, and this study demonstrated that it can infer consumers' risk perception. Asian consumers faced the most negative emotions shown in the baseline emotion obtained from the survey during COVID-19, and it can be seen that Asians reported the highest percentage for safety as perceived risk of seafood byproduct consumption. Sensory properties are the first attributes that help to engage the consumer to eat products, and in this study, the results pointed out that those were the most perceived risks of seafood byproduct consumption. In order to develop novel products containing seafood byproducts and be able to compete in the market, future work should be done to improve the taste, texture, odor, and appearance of these new products. Fish products,

including seafood such as mollusk and crustaceans were found the most appropriate food matrix to incorporate seafood byproducts. This research was done during the COVID -19 pandemic. Therefore, more research needs to be done to determine if the pandemic influenced WTT, appropriateness, risk, and emotions. Additionally, the sample size for each race should be increased to make a fair comparison. An actual product trial should also be performed to determine liking and WTP.

## **CHAPTER 4. INCORPORATING CLEAN-LABEL CATFISH BONE POWDER IN A BREADING MIX FOR PREPARATION OF FRIED CATFISH, AND DETERMINATION OF CONSUMER ACCEPTANCE AND EMOTION, AND PURCHASE INTENT**

### **4.1. Introduction**

The United States is one of the largest Catfish producers, especially the aquaculture segment. The farm-gate catfish production had a sale of 103 million kg with \$379 million in 2019. Catfish production is concentrated in the south of the United States. About 96 percent of the United States' total sales of farm raised catfish comes from Mississippi, Alabama, Arkansas, and Texas (USDA, 2020). Catfish industries' processing includes regular fillets, shank fillets, fillet strips, and nuggets (Bosko et al., 2018). Therefore, the rest of the catfish is not used and is characterized as waste or byproduct, which accounts for about 55%-65% of the total harvest weight of the fish (Yin et al., 2010; Silva et al., 2014). The major fish byproducts include heads, tails, viscera, and backbones (Wangkheirakpam et al., 2019). Discarding these byproducts has caused problems in terms of economic loss, environmental pollution and sustainability (Bechtel, 2003). One of the most common uses for this byproduct is the transformation to protein meals and oil for animal feed ingredients, which has a low economic value. Other uses with higher economic value include hydrolyzed protein and edible fish oil, which involve a complex, high-cost production (Ytrestøyl et al., 2015). To increase the economic value, it is imperative to know the benefits and composition of the raw material.

Fish byproduct contains about 58% proteins, 19% between fat and minerals, and 22% of monosaturated, palmitic, and oleic acids (Wangkheirakpam et al., 2019). Several studies had proven that fish byproducts contain nutritional compounds that can be transformed into animal feed ingredients, fish meal, oil, glue, calcium, and collagen (Ahuja et al., 2020; Ching-Velasquez et al., 2020; Hemung, 2013). Silva et al. (2014) found that tilapia carcasses contain bioactive



molecules, and one of them is a protease enzyme that can be used in the biotechnological process. Other uses have been explored in which other authors have found that fish waste can be transformed into pharmaceutical and high value-added products for human consumption (Peinado et al., 2016; Alfio et al., 2021; Araujo et al., 2021). Today, there are a good number of fish byproducts being used as food ingredients for human consumption for their high nutritional value, and one of these is fish bones (Sentina, 2013). Fish bone accounts for almost 30% of the total catfish weight and contains about 60 to 70% minerals such as calcium, phosphorous, hydroxyapatite, and in fewer quantities, magnesium, manganese, zinc and nickel (Kim & Mendis, 2006). Bechtel et al. (2019) found that catfish bone powder contained between 21 to 25% calcium, depending on the extraction process. There are several ways to extract calcium from fish byproducts. The methods most used include chemical processes such as alkaline treatment, catalyst treatment, and high milling technology (Hemung et al., 2018; Kusumaningrum et al., 2016; Luu & Nguyen, 2009; Yin et al., 2016). Those methods are expensive, non-environmentally friendly, and require advance technology. However, other studies have found that simple extraction methods such as boiling with water can reach similar mineral extraction results as the chemical methods (Bechtel et al., 2018; Xiong et al., 2018). Those methods had proved to be cheap, efficient, and food-grade.

There is a growing body of literature that recognizes that the incorporation of fish bone powder into food matrix can be used to fortify nutrients and improve physicochemical properties (Yin et al., 2017). Previous research comparing commercial calcium such as calcium carbonate, lactate, and citrate with tuna bone powder calcium has found that the calcium content tended to be similar and that the acceptability of the bakery product was not interfered by the addition of fish bone powder (Nemati et al., 2016). Another matrix has been explored, such as bakery, meat, and

pasta products, and all were well accepted by consumers (Yin, Park, & Xiong, 2017, Benjakul & Karnjanapratum, 2018). Hemung, Yongsawatdigul, Chin, Limphirat, & Siritapetawee (2018) found that sausage products that contain fish bone powder received higher overall acceptance in texture than the product without fishbone.

Texture in fried products is an undoubtedly important attribute to determine the quality, and freshness, and contributes to the pleasure of eating fried products (Ross & Scanlon, 2004; Asokapandian et al., 2019). Previous studies have determined that the crispiness of fried products is directly related to overall sensory quality and consumer acceptance (Jaworska & Hoffmann, 2008). Extensive research has been conducted on fish bone powder, but it remains a large field to study new sensory attributes and develop more applicable products for the industry. Therefore, the objectives of this study were to develop a simple and inexpensive method to produce catfish bone powder (CBP) which will be subsequently incorporated into a breading mix, evaluate and compare consumer acceptance, emotional profiles, and PI of fried catfish sticks before and after product benefit claim regarding calcium content will be given to consumers and evaluate the fried catfish's physicochemical properties and microbial safety.

## **4.2. Materials and Methods**

### **Preparation of catfish bone powder (CBP).**

Catfish frames were collected from Guidry's Catfish Inc. (Breaux Bridge, LA., U.S.). Catfish frame's length without head was between 50 to 60 centimeters, and each of them weighed from 1.4 to 1.7 pounds. Frames were transported in a waxed cardboard box with ice. Frames were stored frozen at -20°C until the preparation day. The CBP was prepared following the Amitha et al. (2019) method with some modifications which is shown in Fig. 1. Catfish frames were thawed overnight in a refrigerated cooler at 1-2 °C before being boiled for 10 minutes to later remove the

fish meat attached to the frames. Frames were cleaned and rinsed with tap water and then boiled again for another 20 minutes to remove all the remaining meat. The cleaned frames were dried in an oven (OV310G mini rotating rack oven, BAXTER Inc., Deerfield, IL, U.S.A.) at 105 °C for 6 hours and then ground for 30 seconds in a commercial grinder (Mill Grinder/ Pulverizer, CGOLDENWALL Inc., Hangzhou, Zhejiang, China). The CBP went through to a sieved N° 18 (100 µm) to recover only uniform size particles. CBP was kept in a in plastic bags (Ziploc®, S.C. Johnson & Son Inc., Racine, WI, USA) at refrigeration temperatures (1-2°C) for three days before catfish sticks preparation.

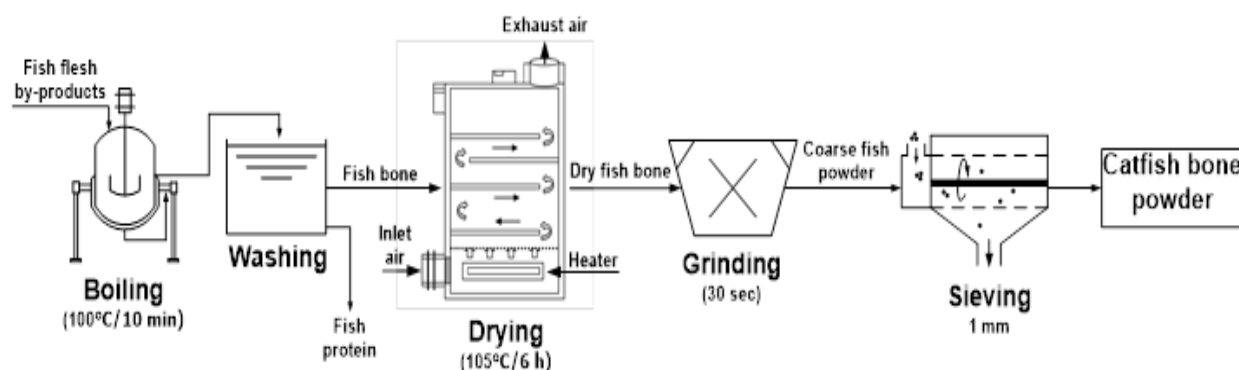


Figure 1. Schematic diagram of catfish bone powder (CBP) production

### Mineral analysis of catfish bone powder

The mineral and metal content of catfish bone powder was analyzed triplicate at the Louisiana Agricultural Chemistry Laboratory, ISO17025 accredited (LSU Campus, Baton Rouge, LA, U.S.). A weight of 0.490 to 0.500g of each sample was placed into 55mL PFA microwave digestion tubes (CEM, NC). A total of 12mL of concentrated acid was added to each tube (10mL of trace metal grade nitric acid, and 2mL of trace metal grade hydrochloric acid). The tubes were capped and digested in a MARSXpress microwave digester (CEM, NC). The MARSXpress was ramped for 20 minutes at 1600W to 200°C and held at this temperature and power for 15 minutes,

followed by a 15-minute cooldown. Samples were transferred into acid-washed class A 100mL volumetric flasks and diluted to volume with deionized water after the microwave digestion and cool down were complete. All samples were analyzed by inductively coupled plasma-optical emission spectroscopy (ICP-OES) using a Perkin Elmer Optima 8300 (Perkin Elmer, Inc., Waltham, WA, U.S.A.). Samples were evaluated for a total of 21 minerals and metals using a modified AOAC Method 985.01 (AOAC, 1995). The analyses included the following: boron (B), calcium (Ca), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), phosphorus (P), potassium (K), sodium (Na), sulfur (S), zinc (Zn), aluminum (Al), barium (Ba), cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), molybdenum (Mo), nickel (Ni), selenium (Se) and arsenic (As). Minerals and metals concentrations were reported in parts per million (ppm) or percent (%) as shown in table 8.

Mercury (Hg) concentrations in catfish bone powder were analyzed in triplicate using a Milestone Direct Mercury Analyzer 80 (DMA80) (Milestone Inc., Sorisole, Italy). The DMA80 methodology used by the Louisiana Agricultural Chemistry Laboratory is the EPA method 7473 (EPA, 1991) and the ASTM D-6722-01 (ASTM D6722-01, 2006). The DMA80 detects total mercury (organic and inorganic) by thermal decomposition, amalgamation, and atomic absorption spectrophotometry. The typical working range for this instrumentation is 0.05 – 300ng with instrument detection limits at 0.01ng. Samples were weighed ( $0.0500 \pm 0.002\text{g}$ ) into metal weight boats and placed in the DMA80. The absorbance peak areas were measured at 253.7nm, and results were reported in parts per billion (ppb).

### **Catfish sticks preparation**

Treatments were prepared using a commercial seasoned crispy fish fry seafood breeding mix (Louisiana Fish Fry Products, LTDS- Wal-Mart, Baton Rouge, LA, U.S.A) and catfish bone

powder at 0 (0CBP), 10 (10CBP), and 20 (20CBP) percent by weight. Fresh catfish fillets weighing 7-9 ounces were obtained from Guidry's Catfish Inc. (Breau Bridge, LA, U.S.). The fillets were cut into a rectangle shape (14cm length by 8cm wide). In this way, the catfish sticks form was more uniform. The catfish pieces were breaded with 0CBP, 10CBP, and or 20CBP and fried in canola oil (Wesson Pure Canola Oil- Wal-Mart, Bentonville, AR, USA) at 190°C for 4 minutes in a deep frier (Hamilton Beach 3-qt. Deep Fryer - Reno, NV, U.S.A.). To maintain the quality properties of the fried catfish, the samples were served warm and fresh (Stastny et al., 2014).

### **Microbiological analysis**

Catfish sticks were analyzed in triplicate. Samples were tested for aerobic bacteria (AC), *Escherichia coli*/ coliforms count (EC), yeast and mold, and *Staphylococcus aureus* (SA). The samples were prepared using 25g of the fried catfish sticks and 25ml of phosphate buffered saline (PBS). Then, it was homogenized for 60 seconds using a stomacher (Easy Mix Biomerieux SA, France). Three dilutions were prepared (100, 10, 1) and plated into Petrifilm (3MTM St Paul, Minnesota, USA). APC and EC petrifilms were incubated for 48±2 hours at 35 ± 2°C. Yeast and mold were incubated for 96±2 hours at 25 ± 1°C. *Staphylococcus aureus* was incubated at 24±2 hours at 35 ± 2°C, then the 3M Petrifilm Staph Express Disk was introduced in the middle between the two layers, and it was incubated for another 24±2 hours at 35 ± 2°C to read the results.

### **Physicochemical analysis (color and texture)**

Texture was analyzed for fourteen replicates and color for ten replicates for each treatment. The samples were fried and cooled before taking the measurements. The color was measured with a colorimeter with 8° illumination angle, and D65 illuminant (BC-10 D65, 10° standard observer, Konica Minolta, Inc., Osaka, Japan) and it was calibrated with the white calibration plate (L\*:100; a\*:0; b\*:5) before measuring the color of the catfish sticks samples. Ten samples for each treatment

were prepared to measure color on the top surface. Color was expressed as L\* (lightness 0-100), a\* (+ for redness, - for greenness), and b\* (+ for yellowness, - for blueness) values. The  $\Delta E$  values were calculated for each sample (0CBP-10CBP, 0CBP-20CBP, and 10CBP- 20CBP). The color of the CBP and the commercial seasoned crispy fish fry seafood breading mix was also measured times. Delta E was calculated with the following equation by using the fried catfish sticks with 0% of CBP as a reference.  $\Delta E$  is the result of the difference in the  $\Delta L^*$ ,  $\Delta a^*$  and  $\Delta b^*$  axis and it was used to interpret the magnitude of the color change in the fried catfish sticks according to the human eye (Chen et al., 2014) (Oliveira & Balaban, 2006).

$$\Delta E = \sqrt{(L1^* - L2^*)^2 + (a1^* - a2^*)^2 + (b1^* - b2^*)^2}$$

Texture profile analysis (TPA) was measured using a Texture Analyzer (TA-XTPlus Texture Analyzer, Texture Technologies, Hamilton, MA, USA). Ten samples from each treatment were cut (3cm length, 2cm width, and 2cm of height) after cool down before performing the TPA. The treatments were exposed to a test speed (1 mm/s), pre-test speed (2mm/s), post-test speed (5mm/s), 30% of deformation using a 30kg load cell and compressed two times with a TA-25 2" diameter cylindrical aluminum probe. The parameters evaluated were hardness (N), adhesiveness (g.sec), cohesiveness (ratio), and chewiness (N) (Bhosale et al., 2011).

### **Experimental design and sensory evaluation of fried catfish sticks**

A total of two hundred eleven people (n=211) older than eighteen years and not allergic to fish and fish fry ingredients were recruited to evaluate the three fried catfish treatments (0, 10, and 20% of CBP). This research protocol was performed with the approval of the Louisiana State University Agricultural Center Institutional Review Board (IRB# HE18-22). Panelists were not retributed monetarily for participating in this research. The consumer study was conducted at the

Sensory Analysis Laboratory in the Animal and Food Sciences Laboratory building, at LSU Campus, Baton Rouge, LA U.S. Elaboration and data collection from the survey was managed by computerized Qualtrics software (Qualtrics, Provo, UT, U.S.A.). The experimental design was a randomized complete block design by which each panelist evaluated 3 different treatments (0CBP, 10CBP, 20CBP). To avoid bias, the samples were labeled with three different blinding codes and additionally, the order of the treatments presented in the survey was completely randomized as well.

Consumers evaluated the liking of overall visual quality (OVQ), appearance, aroma, overall texture (OT), crispiness, flavor, and overall liking (OL) of the fried catfish sticks on a 9-point hedonic scale being 1 = dislike extremely, 5= neither like or dislike and 9= like extremely. The color intensity and crispiness were evaluated on a 3-point just about right (JAR) scale (1=not enough, 2= JAR, 3=too much). The emotional profile was determined by check-all-that-apply (CATA) on a list of 25 terms from the EsSense25 profile emotion word list (Nestrud et al., 2016). Emotions were ordered alphabetically and the term secure was changed to unsafe because it has been demonstrated to be more related to food emotion consumption (Wardy et al., 2018). Purchase intent (PI) was evaluated on a binomial scale (yes/no). Purchase Intent was performed before and after a health benefit claim was provided to consumers, advertising that the breeding mix was fortified with edible and safe catfish bone powder to increase calcium, which may provide a health benefit (Pujols et al., 2019). Unsalted crackers and clean water were provided to cleanse the palate between samples.

### **Statistical analysis**

Data were analyzed by SAS (2013) software. The physicochemical properties such as color and texture and sensory acceptability of fried catfish sticks were analyzed by Analysis of Variance

(ANOVA) with its respective Tukey post hoc analysis to identified differences between the three fried catfish sticks treatments. Multivariate analysis of variance (MANOVA) and descriptive discriminant analysis (DDA) were used to identify the attributes that contributed to the overall product differences for the fried catfish samples (Huberty & Olejnik, 2006). The JAR data were analyzed by Penalty mean drop analysis which was conducted to determine if non-JAR responses for brown color and surface crispiness were associated with OL, OT, and surface crispiness liking of the treatments. Logistic Regression Analysis (LRA) was used to predict PI before and after the calcium health claim benefit was given to consumers. Purchase intent was analyzed by McNemar's test for 10CBP and 20CBP and Cochran-Q test was used to find differences among the treatments before the health claim benefit message was given to consumers (Pujols et al., 2019). Emotions were analyzed using Cochran-Q test to find significant differences among the emotions and McNemar's test to find significant differences among the treatments of a specific emotion term that became significant in the Cochran-Q test analysis.

### **4.3. Results and discussion**

#### **Color and mineral content of CBP**

Characteristics of CBP were white color, minimal fish odor, and small particle size (<100 µm), which are preferable characteristics for fortification application in food industries. The catfish bone powder obtained from the boiling clean label process (without chemical substances) has similar color and mineral content to fishbone powder (FBP) made from tilapia frames prepared through alkaline treatments (Amitha et al., 2019; Bubel et al., 2015). The color of CBP visually was a white powder, and the L\*a\*b\* values were 86.08, 1.3, and 14.91, respectively. These results are comparable in L\*a\* and b\* values to the color of seabream fish bone powder obtained from different chemical boiling methods (NaOH, NaOH+citric acid, NaOH+NaClO, NaOH+ ethyl



alcohol, and NaOH+ HCl) (Savlak et al., 2020). However, the other researchers have found lower  $L^*$  values in the FBP prepared by the clean boiling method. Hemung (2013) attributed the change in color of FBP to the presence of high organic compounds. Additionally, he recommended storage of the FBP at a low temperature and under vacuum conditions. The moisture content of CBP was  $3.39 \pm 0.15\%$ , which was close to the results obtained by Amitha et al. (2019) with the boiling method. Amitha et al. (2019) confirmed that the percentage of moisture in FBP was associated with the type of fish, the method of powder extraction and storage condition.

Table 8 shows the results obtained from the mineral composition analysis of CBP. These results indicated that the method was able to recover up to 20.43% of calcium and 8.86% of phosphorus in CBP. Clean boiling methods have found similar results; 21.27% and 9.85% in catfish, 14.23% and 7.66% in Hake fish bone of calcium and phosphorus, respectively (Bechtel et al., 2019; Yin et al., 2016; Flammini et al., 2016). However, studies done with chemical treatment methods recovered higher calcium and phosphorus quantities. Nemati et al. (2016) reported 38.16% calcium and 23.31% phosphorous. Hemung et al. (2018) reported 32% of calcium in silver carp, and Savlak et al. (2020) reported 30.67% and 16.65% calcium and phosphorus for seabream fish, respectively. However, Savlak et al. (2020) confirmed that the content of calcium and phosphorus in fish bone depends on the chemical used during the boiling process, and Nemati et al. (2016) pointed out that the difference of calcium and phosphorous obtained can be related to fish species, the size of the fish (amount of narrow backbones), and the organic material attached to the fish bone.

A Ca:P ratio of 2:1 is the ideal quantity to be absorbed by the human body (Nemati et al., 2016). The Ca:P ratio of our CBP was 2.3:1, which is close to other fish bone powders and recommendations from the literature for mineral absorption. Calcium is an essential mineral for

the body to perform physiological activities such as blood clotting, bone mass formation, transmission of nerve impulses, and muscle contraction (Pravina et al., 2013). Inadequate calcium consumption will increase the chance of developing osteoporosis, hypertension, and colon cancer (Theobald, 2005). The United States recommended dietary allowance (RDA) for calcium is 1000 mg per day for 19 to 50 years old and 1200 mg for 51 or older people (Institute of Medicine, 2011). Globally the calcium intake average is at 400 mg/day with a lower level of 300 mg/day values in undeveloped countries (Cormick & Belizán, 2019). The National Institutes of Health (2020) recommends to consume food sources with high calcium, such as dairy products, dry beans, and green vegetables, and fortify products with calcium to meet the RDA. Calcium from fish bones can be used to fortify various products.

Table 8.- Mineral composition of catfish bone powder (dry basis)

Analyte	Result	Units
Boron	<16.00±0.00	ppm
Calcium	20.43±0.55	percentage
Cooper	<4.00±0.00	ppm
Iron	6.94±0.55	ppm
Magnesium	0.34±0.01	percentage
Manganese	34.63±0.47	ppm
Phosphorus	8.86±0.21	percentage
Potassium	0.18±0.00	percentage
Sodium	0.42±0.01	percentage
Sulphur	0.15±0.00	percentage
Zinc	115.33±2.52	ppm
Aluminum	27.40±4.69	ppm
Barium	10.75±2.73	ppm
Cadmium	<0.20±0.00	ppm
Chromium	4.04±0.12	ppm
Cobalt	<0.20±0.00	ppm
Lead	<1.20±0.00	ppm
Molybdenum	<0.80±0.00	ppm
Nickel	1.13±0.21	ppm

(table cont'd.)

Analyte	Result	Units
Selenium	<16.00±0.00	ppm
Arsenic	<4.00±0.00	ppm
Mercury	11.83±3.81	ppb

Mean ±standard deviation from 3 independent replications.

### **Microbial analysis**

Microbial analysis was done in fried catfish sticks prior to the consumer study. The results for APC, EC, yeast and mold and SA were below the detection level which is 20 CFU/g for APC and 2 CFU/g for the rest of the analysis. Based on these results the fried catfish sticks were safe for human consumption.

### **Effect of catfish bone powder on the physicochemical properties of fried catfish**

Color is a critical quality attribute of fried food, and it is mainly related to a nonenzymatic browning reaction that occurs during the frying process. Light golden-brown color is the desired color for fried foods. This color can be reached by controlling the appropriate temperature and time during deep frying (Sanz et al., 2008). Color values of fried catfish sticks breaded with CBP are listed in table 9. L\* and b\* values were not significantly different for fried catfish with and without CBP. However, 20CBP treatment showed lower ( $p < 0.05$ ) a\* values than 10CBP and 0CBP treatments. These results can be explained by the value of low redness values in the CBP, so a more CBP level will decrease a\* values in fried catfish sticks. The L\*a\*b\* values of the seasoned fish fry seafood breading mix was 84.69±0.43, 10.81±0.41, and 29.45±1.01, respectively. Nawaz et al. (2019) reported that the addition of FBP up to 15% did not affect the color of fried snacks and stated that mixing FBP with a similar matrix food will have less impact on the color change.

Delta E ( $\Delta E$ ) values were calculated to find out if the human eye could notice the color change in the fried catfish stick samples. The comparisons were made between treatment 0CBP

and 10CBP, 10CBP and 20CBP, and 0CBP and 20CBP, and the results were 1.47, 2.05, and 1.42, respectively (data not shown). According to Mokrzycki & Tatol (2011) a standard observer does not see the color difference when the values are between  $0 < \Delta E < 1$ . Just a professional observer can discern differences of color in the range of  $1 < \Delta E < 2$ , and even an inexperienced observer can notice a difference if the result of  $\Delta E$  is up to 3.5. A clear difference in color and two different colors can be observed with higher values of  $\Delta E$ , so based on  $\Delta E$  consumers may not be able to discern color differences, among fried catfish sticks.

Table 9. Physicochemical properties of fried catfish with catfish bone powder

Surface Color	0CBP	10CBP	20CBP
L*	58.82±1.97 <sup>a</sup>	60.20±3.10 <sup>a</sup>	58.87±1.55 <sup>a</sup>
a*	8.62±1.35 <sup>b</sup>	8.62±1.90 <sup>b</sup>	7.21±0.60 <sup>a</sup>
b*	24.11±1.89 <sup>a</sup>	23.61±2.87 <sup>a</sup>	24.30±1.89 <sup>a</sup>
Texture profiles			
Hardness (N)	6.55±1.30 <sup>a</sup>	5.98±1.014 <sup>a</sup>	6.61±1.50 <sup>a</sup>
Adhesiveness (g/seg)	0.117±0.28 <sup>a</sup>	0.167±0.96 <sup>a</sup>	0.038±0.33 <sup>a</sup>
Cohesion (ratio)	0.64±0.037 <sup>a</sup>	0.60±0.054 <sup>b</sup>	0.66±0.032 <sup>a</sup>
Chewiness (N)	3.51±0.75 <sup>ab</sup>	2.86±0.58 <sup>b</sup>	3.56±0.77 <sup>a</sup>

Mean ±standard deviation from 14 replications for texture and 10 replications for color. Mean in the same row followed by different letters are significantly different (p-value < 0.05)

0CBP, 10CBP, 20CBP contained 0, 10, and 20% CBP, respectively.

One of the most critical quality indicators in fried food is texture, especially crispiness. The crispiness of fried food is an important factor responsible for consumer acceptance (Asokapandian et al., 2019). Table 9 provides the texture values for fried catfish in which hardness and adhesiveness were not affected by CBP addition. However, cohesion and chewiness decreased for treatment 10CBP. Nawaz et al. (2019) stated that the FBP contains hygroscopic properties that help to develop dryness and brittleness in snack products, but according to Njoroge & Lokuruka (2020), those properties can develop hardness in cookies because it makes denser product due to the decreased in expansion. The hygroscopic and porosity properties of CBP can explain the reduction of cohesion and chewiness for the 10CBP treatment, and this can help to form well-

structure coating in the catfish sticks. Even though hardness was not significantly different between the treatments it can be seen that 20CBP (6.61N) harder than 10CBP (5.98N). Similar texture (hardness) results have been found in fortifications with FBP in cookies, noodles and sausages in which the authors affirmed that the FBP interfered with the food matrix (Hemung et al., 2018; Abdel-Moemin, 2015; Sirichokworakit, 2014).

### **Liking scores of catfish sticks**

The effect of catfish bone powder on the sensory liking of fried catfish is shown in table 10. All sensory attribute liking scores of fried catfish sticks with CBP were between like slightly and like moderately for the three treatments (6.43-7.20). There were no significant differences in all attributes tested, except for surface crispiness, which was slightly higher scores for the 20CBP treatment (6.88; table 10), but it was not different from the control. These results can be explained by the TPA values in table 9, in which the hardness score for 20CBP was higher but not significant than 0CBP and 10CBP. Additionally, cohesion and chewiness were also different for 10CBP treatment; this can be interpreted that consumers tended to like the texture of the fried catfish when it is hard and compact. Benjakul & Karnjanapratum (2018) suggested that tuna bone powder can be added into crackers up to 30% without affecting sensory attributes and physicochemical properties such as color and texture. In addition, Fong-in, Phosri, Suttiaprapa, Pimpangan, & Utama-ang, (2020) did not recommend incorporating more than 30-40% of FBP in cookies because of taste, texture, and overall liking score can drastically be affected. Those changes can be avoided by controlling the quality of FBP because physical and sensory properties should be similar between fortified and non-fortified foods with calcium to be accepted by consumers (Fairweather-Tait & Teucher, 2002). According to physicochemical properties evaluation and

liking scores of CBP fortified catfish sticks, it could be said that CBP can be added up to 20% without compromising physicochemical and sensory properties in fried catfish.

Table 10. Mean consumer liking scores<sup>A</sup> and PI<sup>B</sup> of fried catfish battered with catfish bone powder fortified seasoned fish fry seafood mix

	0CBP	10CBP	20CBP
Visual Quality	7.12 ± 1.34 <sup>a</sup>	7.23 ± 1.34 <sup>a</sup>	6.97 ± 1.54 <sup>a</sup>
Surface Color	7.20 ± 1.36 <sup>a</sup>	7.22 ± 1.27 <sup>a</sup>	7.12 ± 1.38 <sup>a</sup>
Aroma	6.97 ± 1.29 <sup>a</sup>	7.12 ± 1.35 <sup>a</sup>	7.10 ± 1.37 <sup>a</sup>
Surface Crispiness	6.60 ± 1.70 <sup>ab</sup>	6.43 ± 1.87 <sup>b</sup>	6.88 ± 1.69 <sup>a</sup>
Overall Texture	6.57 ± 1.59 <sup>a</sup>	6.54 ± 1.74 <sup>a</sup>	6.85 ± 1.58 <sup>a</sup>
Flavor	6.96 ± 1.56 <sup>a</sup>	6.94 ± 1.55 <sup>a</sup>	7.02 ± 1.64 <sup>a</sup>
Overall Liking	6.80 ± 1.47 <sup>a</sup>	6.87 ± 1.51 <sup>a</sup>	7.00 ± 1.51 <sup>a</sup>
PI (%) <sup>B</sup>			
Before	71.09 <sup>NS</sup>	71.56 <sup>NS, a</sup>	73.93 <sup>NS, a</sup>
After	-	81.04 <sup>b</sup>	83.89 <sup>b</sup>

Mean ± standard deviation from 211 consumer responses (9-point hedonic scale). Mean in the same row followed by different letters are significantly different (p-value < 0.05)

<sup>B</sup> Purchase Intent percentage from 211 consumer responses (yes-no a binomial scale). Values in the same column followed by different letters are significantly different (p-value < 0.05). Values followed by <sup>NS</sup> in the same row are not significantly different (p-value < 0.05).

Penalty (mean drop) analyses for OL scores based on crispiness and brown color JAR responses are shown in figure 2 (for crispiness) and figure 3 (for brown color). A 3-point JAR rating scale was used to evaluate both attributes and determined if those attributes influenced the hedonic results of OL. Penalty analyses combine JAR and OL results to determine if the intensity of a specific attribute affects the hedonic results and whether the new product formulation is desirable (Narayanan et al., 2014; Torrico et al., 2018). In general, fried catfish with CBP was considered to be JAR (78-80%) for brown color in all the treatments (figure 3). Mean drop penalty for overall liking was between 0.08 and 0.77, which was considered a very slight concern, because less than 20% of the consumers selected the product as non JAR for brown color. These results go along with the liking scores of colors shown in table 10, in which the liking scores (table 10) of fried catfish were between 7.12 and 7.20. However, more consumers penalized OL when the

product was not crispy enough (mean drop=1.08-1.45, consumer percentage = 31-41%) than when it was too crispy (mean drop = 0.94-1.63, consumer percentage= 4-9%) for all the treatments (figure 2). Liking scores of surface crispiness (table 10) were lower (6.43-6.60) compared to the other attributes' scores such as OL (6.80-7.00). Crispiness is an important and desirable sensory characteristic in fried products due to the fact that it indicates freshness and good quality of the product. Lauzon et al. (2016) found that adding up to 10% of fish bone on egg-fish noodle did not influence the texture properties. Therefore, it can be seen that consumers perceived differences in crispiness intensity in fried catfish but not for brown color.

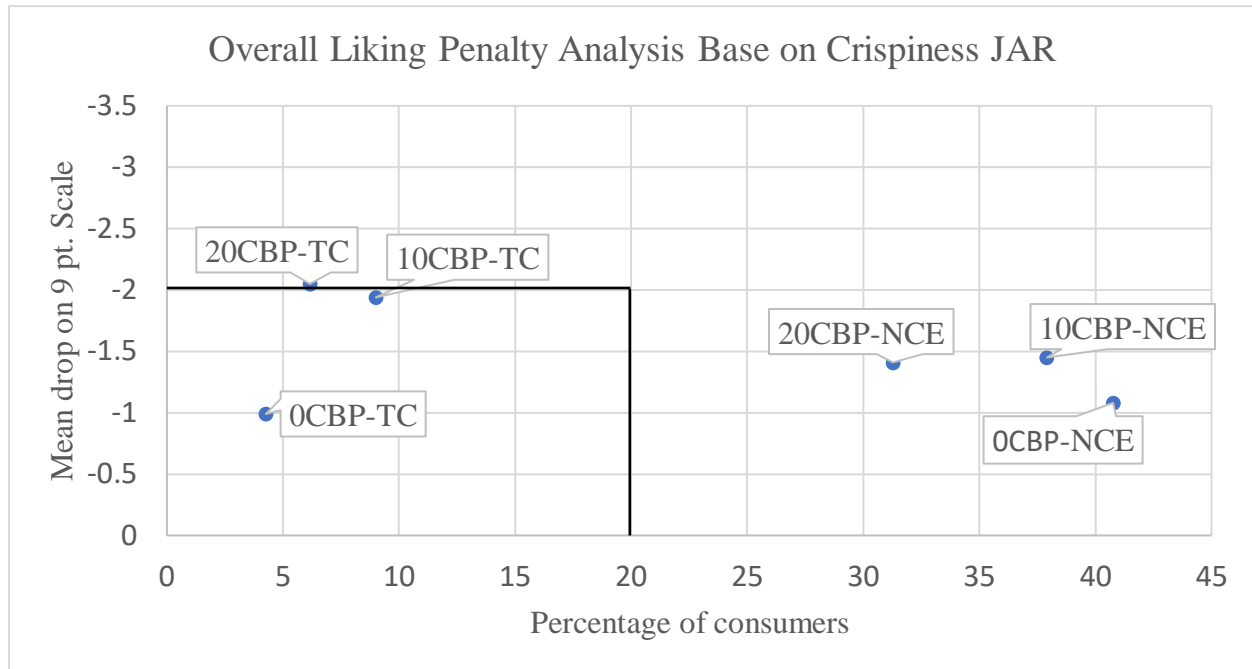


Figure 2. Penalty mean drop plot of OL affected by crispiness non-JAR responses.

TC= Too Crispy; NCE= Not Crispy Enough  
 0CBP=Control, 10CBP= 10% CBP, 20CBP= 20% CBP

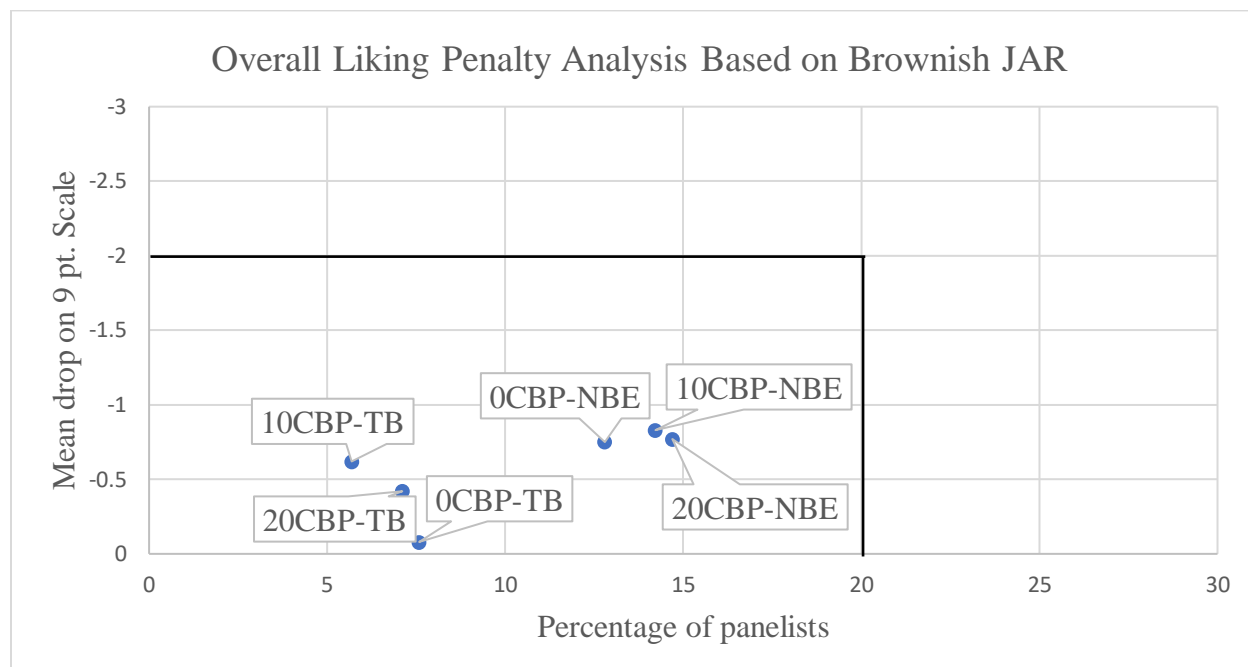


Figure 3. Penalty mean drop plot of OL affected by color (Brownish) non-JAR responses.

TB= Too Brown; NBE= Not Brown Enough

0CBP=Control, 10CBP= 10% CBP, 20CBP= 20% CBP

### Effect of catfish bone powder and calcium health benefit statement on PI

Table 10 shows the results of PI of fried catfish with CBP in which the calcium health benefit statement given to consumers impacted positively the purchase intent of fried catfish with 10 and 20% of CBP. PI significantly increased after the consumers were informed about the health benefits of CBP (Based on McNemar's test;  $P < 0.05$ ) from 71.56 to 81.04 and 73.93 to 83.89 10CBP and 20CBP in treatments, respectively. This positive increase in both treatments was about 10%. Coleman, Miah, Morris, & Morris (2014) stated that claims with nutritional information can positively affect PI. Furthermore, there was no significant difference between 0CBP, 10CBP, and 20CBP treatments for PI before the claim was given to consumers (Based on Cochran Q' test;  $P < 0.05$ ). These results can be explained by the fact that the liking scores (table 10) in this study were high and not different for all the treatments. Bower, Saadat, & Whitten (2003) found that liking scores, gender, age, and health concern were related to PI. His research found that higher



scores in liking lead to a positive increase in PI of health fat spread products. Hence, the PI of fried catfish was not affected by the addition of CBP at any levels and showed a positive increase after the health benefit claim was given to consumers.

### **Effect of catfish bone powder on consumer emotional responses**

Consumers evaluated emotions for 0CBP, 10CBP, and 20CBP in a CATA format which contained 25 emotions from the Essence Profile<sup>®</sup> (Nestrud et al., 2016) with slight modifications. Previous studies had found that the term safe is more appropriate for food products than the term secure, additionally, to this modification, the term safe had been changed to unsafe when it is related to the safety of consumption of food products (Sukkwai et al., 2017; Wardy et al., 2015; Poonnakasem et al., 2016). Therefore, in this research, as in previous research, the term safe was modified to unsafe to reflect the emotion associated with safe consumption of fried catfish containing CBP.

The results of emotions listed by the consumers about the fried catfish with CBP are presented in table 11. It can be seen from the data that the CATA emotional profiles for all treatments were similar. The most selected positive emotions elicited by fried catfish with CBP were calm, good, satisfied, pleasant, happy, and interested with 40% to 60% of the consumers selected those terms. Other emotional terms such as mild, active, joyful, and warm were enlisted by at least 20% of the consumers. Negative emotions such as unsafe, worried, and guilty were selected by the <4% of the consumers. One of the criteria to select a term by King & Meiselman (2010) is frequency; emotions selected by >20% of consumers are considered emotions evoked by the food product. Lagerkvist, Okello, Muoki, Heck, & Prain (2016) confirmed the association between nutritional promotion messages and positive emotions when vitamin A-biofortified sweet potatoes were analyzed. In their study, all negative emotions were higher than  $\geq 20\%$ . Our results

demonstrated that catfish byproducts such as bones can be exploited in different types of food products without evoking highly negative emotional values like other unusual food sources like insects (Schouteten et al., 2016; Looy et al., 2014). Even adventurous and understanding were not among the topmost selected emotions, and they were significantly different among treatments based on Cochran-Q test (p-value 0.0167). The term adventurous and understanding significantly increased up to 10% when CBP was added. In accordance with previous research, adventurous and interested are the two top emotions associated with insect consumption, and curiosity was selected by 50% of the consumers as a good reason to include insects in their diets (Tuccillo et al., 2020). Moreover, Sogari, Menozzi, & Mora (2017) stated that unfamiliar food sources can evoke curiosity and interest. This can be the reason why once consumers knew that the product contained CBP, they became more aware of these emotions. Taken together, these results show that the addition of CBP in fried catfish elicited more positive than negative emotions for fried catfish.

Table 11. Consumer emotion responses (%) evoked by fried catfish with CBP

Emotion	0CBP	10CBP	20CBP	Cochran-Q Test
Active	23.7	21.33	22.27	0.7396
Adventurous	10. <sup>43b</sup>	18.96 <sup>a</sup>	19.43 <sup>a</sup>	<b>0.0024</b>
Aggressive	3.32	2.37	5.69	0.1284
Bored	17.06	12.8	10.9	0.1496
Calm	39.34	40.28	30.33	0.0192
Disgusted	5.69	8.06	7.58	0.5836
Enthusiastic	18.01	18.96	20.38	0.7813
Free	13.74	17.06	19.91	0.0994
Good	57.82	61.61	60.19	0.6326
Good-natured	15.64	19.43	19.91	0.3139
Guilty	3.79	1.9	1.42	0.1738
Happy	49.29	45.97	49.29	0.6299
Interested	46.45	52.61	54.5	0.1002
Joyful	21.33	19.91	26.54	0.127
Loving	10.43	9.48	9.95	0.9105
Mild	26.54	30.33	24.64	0.2881

(table cont'd.)

Emotion	0CBP	10CBP	20CBP	Cochran-Q Test
Nostalgic	13.74	12.32	12.8	0.8139
Pleasant	45.97	49.29	51.66	0.3844
Satisfied	54.5	52.61	51.18	0.749
Unsafe	4.27	2.84	4.27	0.5488
Tame	16.11	11.85	9.95	0.0852
Understanding	11.37 <sup>b</sup>	20.38 <sup>a</sup>	17.54 <sup>a</sup>	<b>0.0083</b>
Warm	29.86	24.64	26.07	0.2975
Wild	7.58	5.69	7.58	0.5866
Worried	6.16	6.16	4.74	0.7251

<sup>ab</sup> Significant differences according to McNemar test (p-value <0.05)

Bold print (P<0.0167) indicates significant differences between the treatments according to Cochran-Q test (Bonferroni test adjustment p-value 0.0167)

### Overall product differences and discriminating sensory attributes

MANOVA was performed to determine whether all treatments differed simultaneously when all the sensory attributes were evaluated (OVQ, Color, Aroma, Crispness, Texture, Flavor, and OL). Overall, there were no significant differences among all the treatments (Wilk's Lambda p-value = 0.057). However, DDA was conducted to determine which attributes contributed to some differences between the fried catfish with CBP samples, and only sensory attributes were considered. The first canonical dimension was slightly significant (p-value 0.057) and explained 75.5% of the variance. DDA identified that for the first canonical dimension with 75.5% of variance explained with crispiness and texture (cc = 0.61 and 0.47) being the main sensory attributes contributing to overall product differences. Aroma, flavor and OL (cc = 0.0032, 0.1232, 0.2428 respectively) did not contribute significantly to overall product differences. These results are comparable to liking scores (table 10), in which crispiness was significantly different for fried catfish, and the other attributes did not show any differences.

Table 12. Canonical structure matrix of sensory attributes describing group differences among fried catfish with CBP.

Attribute	Can 1	Can 2
OVQ	-0.4700	0.0483
Color	-0.1933	-0.0051
Aroma	0.0032	0.5707
Crispiness	0.6115	0.0853
Texture	0.4743	0.3137
Flavor	0.1232	0.0850
OL	0.2428	0.4498
Cumulative variance explained	75.5	24.5
Manova Wilk's p-value	0.057	

### **Predicting PI of fried catfish sticks using logistic regression analysis (LRA)**

Logistic Regression Analysis was used to predict PI of fried catfish with CBP before and after a health benefit claim was given to consumers (Table 13). Prior studies showed that including health benefit claims had a positive effect on PI (Poonnakasem et al., 2016; Wardy et al., 2018). The model was performed with gender (N=211; female=48.35% and male=51.66), race (N=211; Latin=24.64%, Asian=12.80%, and US=52.13% consumers), and all the sensory attributes evaluated during the consumer study (overall visual quality, color, aroma, texture, flavor, and crispness). Before the consumers received the benefits health claim; texture, flavor and crispiness were significant predictors of PI ( $p < 0.05$ ). For every 1-unit increase of texture, flavor, and crispiness liking (on a 9-point hedonic scale), the probability of the product being purchased would be, respectively, 1.386, 2.171, and 1.618 times higher than not purchased. After the health benefit claim was given to consumers, texture and crispiness were not significant predictors; however, flavor was still a significant predictor for PI (OR=1.530,  $p < 0.05$ ). Race became a significant predictor in which Hispanic consumers were more likely to purchase the products 2.51 times than Caucasians. However, Asian consumers did not show any association with PI after the claim. Cross-cultural differences in likeness, consumer preference, consumer acceptability, and PI have

been explained in prior studies. Torrico et al. (2015) found that consumer acceptability and PI of forage-finished rib-eye steaks were different between Hispanic, Asian, and US consumers; Dubé et al. (2016) studied Westerner and Easterner consumers perception of a nutritious agricultural product at different food processing levels. They found that Eastern and Western cultures held a positive association between health and taste, but this association was stronger for the Eastern consumers. Additionally, for the processing level, the association is significantly stronger for the Western consumer. Hemmerling et al. (2013) found differences between consumers from European countries toward the sensory image of the organic food label. Together these results provide important insights into how cultural differences need to be explored deeply to develop new products that will be more appropriate to each market niche.

Table 13. Odds ratio estimates and probabilities for predicting PI of fried catfish with CBP by consumers

Variables	PI Before		PI After	
	Pr > ChiSq	Odds ratio	Pr > ChiSq	Odds ratio
Gender	1.1562	1.417	0.8020	1.081
Nationality	0.7029	-	0.0017	-
Overall Visual Quality	0.9527	1.008	0.7514	0.949
Color	0.9702	1.005	0.249	1.233
Aroma	0.1399	0.852	0.2468	0.865
Texture	0.0049	1.386	0.0769	1.289
Flavor	<.0001	2.171	0.0002	1.530
Crispiness	<.0001	1.618	0.0997	1.217

Significance odds ratios in bold print (P<0.05)

Latin vs Caucasian consumers Pr>ChiSq=0.0195, Odds=2.51

#### 4.4. Conclusion

This study evaluated the effect of incorporation of CBP at 0%, 10%, and 20% in a seasoned commercial breeding on consumer acceptance, emotions, and PI of fried catfish before and after a calcium health benefit statement was given to consumers. The results pointed out that CBP could be incorporated up to 20% in fish fry breeding powder without compromising the sensory liking

of fried catfish. Catfish bone powder evoked more positive emotional terms than negative ones. Crispiness and texture contributed more to the underlying differences among fried catfish with CBP than the appearance attributes. Purchase intent of fried catfish with CBP increased significantly (about 10% more) after the benefit message about CBP was given to consumers. Overall, flavor and race were significant predictors for PI after the claim was given to consumers. Race became a predictor after the claim in which Hispanic consumers were more likely to purchase products than Caucasian. Future research should be focused on cross-cultural differences in terms of consumer perception toward the utilization of catfish byproducts for human food ingredients.

## **CHAPTER 5. SUMMARY AND CONCLUSION**

Food waste is a global issue that carries a lot of social and environmental problems. Using seafood byproducts as high-value ingredients to be incorporated into novel food products will support sustainability concept and help industries to increase their profits. Two independent studies were conducted to address the objectives of this thesis. First, we evaluated Willingness-to-try, product appropriateness, and perceived risks associated with foods containing seafood byproducts as affected by gender and race. Asian consumers were more WTT seafood byproducts followed by Hispanic, and WTT increased after a CSS was given to consumers. The most appropriate products were salty products, with the first selected category being fish products. However, 31.74% of the consumers selected sensory properties as the most concerning aspect for not to consume seafood byproducts. At the same time, negative emotions were more predominant in Asian consumers.

To follow the previous results, the next part of this research was aimed to evaluate the first most appropriate product to incorporate seafood byproducts selected by 68.26% of consumers. This study consisted of developing a clean label CBP and evaluated acceptance, emotions, and PI of fried catfish with CBP. The clean boiling water method recovered up to 20% of calcium. The addition of 20% of CBP did not affect sensory liking of fried, PI significantly increased after a health statement containing nutritional information about calcium was given to consumers, and the addition of CBP evoked more positive than negative emotions.

## APPENDIX A. IRB APPROVAL FOR CHAPTER 3



LSU AgCenter Institutional Review Board (IRB)  
Dr. Michael J. Keenan, Chair  
School of Nutrition & Food Sciences  
209 Knapp Hall  
225-578-1708  
mkeenana@agctr.lsu.edu

### Application for Exemption from Institutional Oversight

All research projects using living humans as subjects, or samples or data obtained from humans must be approved or exempted in advance by the LSU AgCenter IRB. This form helps the principal investigator determine if a project may be exempted, and is used to request an exemption.

- Applicant, please fill out the application in its entirety and include the completed application as well as parts A-E, listed below, when submitting to the LSU AgCenter IRB. Once the application is completed, please submit the original and one copy to the chair, Dr. Michael J. Keenan, in 209 Knapp Hall.
- A Complete Application Includes All of the Following:
  - (A) The original and a copy of this completed form and a copy of parts B through E.
  - (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1 & 2)
  - (C) Copies of all instruments and all recruitment material to be used.
    - If this proposal is part of a grant proposal, include a copy of the proposal.
  - (D) The consent form you will use in the study (see part 3 for more information)
  - (E) Beginning January 1, 2009: Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing and handling data, unless already on file with the LSU AgCenter IRB.  
Training link: (<http://grants.nih.gov/grants/policy/hs/training.htm>)

1) Principal Investigator: Dr. Witon Prinyawiwatkul Rank: Professor Student? Y/N NO  
Dept: School of Nutrition & Food Sciences Ph: (225)578-5188  
E-mail: wprinya@lsu.edu

2) Co-Investigator(s): please include department, rank, phone and e-mail for each  

- If student as principal or co-investigator(s), please identify and name supervising professor in this space
  - Ashley Gutierrez, Research Associate, School of Nutrition & Food Sciences
  - (225)578-5423, [agutierrez@agcenter.lsu.edu](mailto:agutierrez@agcenter.lsu.edu)

3) Project Title: Consumer Acceptance and Perception of New and Healthier Food Products

4) Grant Proposal?(yes or no) NO If Yes, Proposal Number and funding Agency  
Also, if Yes, either: this application completely matches the scope of work in the grant Y/N OR  
more IRB applications will be filed later Y/N OR

5) Subject pool (e.g. Nutrition Students) LSU Faculty, Staff, Students and off-campus consumers  

- Circle any "vulnerable populations" to be used: (children<18, the mentally impaired, pregnant women, the aged, other). Projects with incarcerated persons cannot be exempted.

6) PI signature [Signature] \*\*Date 8/23/18 (no per signatures)  
 \*\*I certify that my responses are accurate and complete. If the project scope or design is later changed I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU AgCenter institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at the LSU AgCenter for three years after completion of the study. If I leave the LSU AgCenter before that time the consent forms should be preserved in the Departmental Office.

Committee Action: Exempted ☒ Not Exempted ☐

IRB# HE18-22

Reviewer Michael Keenan Signature Michael Keenan Date 9-5-2018



## APPENDIX B. QUESTIONNAIRE FOR CONSUMER STUDY FOR CHAPTER 3

### BY-PRODUCTS SURVEY

---

#### Start of Block: Consent

Q1

If you agree to participate in this survey based on the terms below, select "I agree to participate" at the bottom of this page.

Consent to Participate in the Survey. I agree to participate in the research entitled "How emotional stage affects consumer perception toward the use of seafood or aquacultural byproducts" conducted by Dr. Witoon Prinyawiwatkul, Professor of the School of Nutrition and Food Sciences at Louisiana State University, Agricultural Center, phone number (225) 578-5188. Participation is entirely voluntary and the respondent may withdraw consent and exit the survey at any time without penalty. The survey will take about 10-15 minutes of participation.

The objective of this research is to study how your emotional stage (i.e., how you are feeling) affects your perception toward the use of seafood or aquacultural byproducts. The results of this study will not be released in any individual identifiable form without my prior consent unless required by law.

This research is carried out under the oversight of the Institutional Review Board. Questions or problems regarding the survey should be addressed to Dr. Michael Keenan, Chair of LSU AgCenter IRB, (225) 578-1708.

☐ I agree to participate. (4)

☐ I do not agree to participate. (5)

Q2 Are you at least 18 years of age?

☐ Yes (3)

☐ No (2)

*Skip To: End of Survey If Are you at least 18 years of age? = No*

---

Q4 Do you consume seafood or fish products?

☐ Yes (1)

☐ No (2)

Q3 Age

- ☐ 19 - 25 years (5)
  - ☐ 26 - 35 years (6)
  - ☐ 36 - 45 years (7)
  - ☐ 46 - 55 years (8)
  - ☐ 56 - 65 years (9)
  - ☐ > 65 years (10)
- 

Q6 Gender

- ☐ Female (1)
  - ☐ Male (2)
- 

Q7 Have you lived in the United States of America for the last three years?

- ☐ Yes (1)
  - ☐ No (2)
- 

Q8 Select your race

- ☐ White (4)
- ☐ Black/African American (9)
- ☐ Hispanic/Latin/Spanish origin (5)
- ☐ Asian (6)
- ☐ Other (8)

---

Q9 Highest education level attained

- ☐ High School diploma or below (1)
- ☐ College or equivalent (4)
- ☐ Graduate degree (MS, PhD, ED) (2)

---

Q10 Which was your employment status before COVID-19 outbreak

- ☐ Unemployed (1)
- ☐ Employed part-time, on-site (4)
- ☐ Employed part-time, work from home (2)
- ☐ Employed full time, on-site (3)
- ☐ Employed full-time, work from home (5)
- ☐ Retired (6)

---

Q11 Which is your employment status during COVID-19 outbreak?

- ☐ Unemployed (1)
- ☐ Employed part-time, on-site (4)
- ☐ Employed part-time, work from home (2)
- ☐ Employed full time, on-site (3)
- ☐ Employed full-time, work from home (5)
- ☐ Retired (6)

Q12 Are you aware of the current pandemic of COVID-19 in the US and worldwide?

☐ Yes (1)

☐ No (2)

Q13 Are you feeling safe during this COVID-19 pandemic in the US and worldwide?

☐ Yes, very much (1)

☐ Yes, slightly (3)

☐ Not sure (4)

☐ No, slightly (6)

☐ No, very much (7)

Q14 Are you afraid of consuming foods prepared outside your home?

☐ Yes for sure (1)

☐ Maybe yes (2)

☐ Maybe no (3)

☐ No for sure (4)

Q15 Is the current COVID- 19 pandemic affecting your emotion and wellness?

☐ Yes (1)

☐ No (2)

---

Q16 How have you been feeling during the COVID-19 pandemic?

Click to write Column 1

	Not applica ble (1)	Disagre e extreme ly (2)	Disagr ee very much (3)	Disagree moderat ely (4)	Disagr ee slightl y (5)	Neithe r disagr ee or agree (6)	Agre e slight ly (7)	Agree moderat ely (8)	Agr ee very muc h (9)	Agree extreme ly (10)
--	---------------------------	-----------------------------------	-------------------------------------	--------------------------------	----------------------------------	--	-------------------------------	-----------------------------	-----------------------------------	-----------------------------

Active (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adventurous (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aggressive (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bored (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Calm (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eager (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Energetic (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enthusiastic (11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Free (12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Friendly (13)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Glad (14)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Good (15)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Healthy (42)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Happy (18)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Loving (21)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nostalgic (24)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Peaceful (25)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pleased (27)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Satisfied (30)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unsafe (31)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Worried (39)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

End of Block: EMOTIONS

Start of Block: Segmentation

Q17 Are you typically willing to try new foods?

- ☐ Yes (1)
- ☐ Not sure (3)
- ☐ No (2)

Q18 Do you know what food byproduct is?

- ☐ Yes (1)
- ☐ No (2)

Page Break

Q19 *“Related to seafood and aquacultural products, a byproduct is something (for example, bone, skin, gut) which is produced during the manufacture or processing of another product (for example, catfish fillet)”*

---

Q20 Have you ever eaten food products that contain or are fortified with seafood or aquacultural (farm-raised) byproducts such as head, bones, gut, or skin?

- ☐ Yes (1)
- ☐ Not sure (3)
- ☐ No (4)
- 

Q21 Would you be willing to try new products containing a small portion of seafood byproducts such as bone and skin?

- ☐ Yes (1)
- ☐ Maybe (2)
- ☐ No (3)
- 

Q22 Would you be willing to try new products containing a small portion of seafood byproducts such as bone and skin, **knowing it is safe for consumption?**

- ☐ Yes (1)
- ☐ Maybe (2)
- ☐ No (3)
-

Q23 Would you be willing to try new products fortified with safe seafood byproducts that are claimed to provide health benefits?

- ☐ Yes (1)
- ☐ Maybe (2)
- ☐ No (3)

Q24 Why? Please Check all that apply

- ☐ Taste (1)
- ☐ Appearance (2)
- ☐ Odor/aroma (3)
- ☐ Texture/mouthfeel (4)
- ☐ Safety (6)
- ☐ Nutrition (7)
- ☐ Negative emotions (boredom, disgust, fear, guilty, worry, etc) (8)
- ☐ Social acceptability (9)
- ☐ Cultural or religious beliefs (10)
- ☐ Unfamiliar with byproducts (11)
- ☐ Price (12)
-



Q25 Which group of products would you be willing to try if they contain seafood byproducts?

- ☐ Dairy Products (1)
- ☐ Bakery products (3)
- ☐ Meat and meat products including poultry and game (4)
- ☐ Fat and Oil, and fat products (5)
- ☐ Drink and beverages (10)
- ☐ Snack and energy/protein bars (11)
- ☐ Candy and confectionery (6)
- ☐ Cereals and cereal products (7)
- ☐ Seasoning mix, sauces and dressings (8)
- ☐ Soup and gravy products (canned and frozen) (12)
- ☐ Fish and fish products including mollusks, and crustaceans (2)
- ☐ Pasta and noodles (13)

End of Block: Segmentation

---

Start of Block: Email

Q26 If you would like to participate in future food taste testing studies, please enter your email address.

---

End of Block: Email

---

Start of Block: Duplicate

Q27 Do you think you've already taken this survey before today?

☐ Yes (1)

☐ No (2)

End of Block: Duplicate

---

## APPENDIX C. R CODES FOR CHAPTER 3

Maxwell test

```
Test <- as.table(matrix(c(x1,x2,x3.....x9), nrow=3))  
Stuartmaxwelltest(test)
```

Mcnemar test

```
Test <- matrix(c(x1.....x4),  
  nrow = 2,  
  dimnames = list("before" = c("y", "mn"),  
    "after" = c("y", "mn")))
```

Test

```
Testmcnemar<-mcnemar.test(test)  
Testmcnemar
```

Cochran q test

```
Matrix<-cbind(ctotal$wt1, ctotal$wt2, ctotal$wt3)  
Cochrans.q(matrix)
```

Logistic regression analysis

```
Model <- glm(taste ~ factor(gender)+factor(race), family=binomial, data=gr)  
Model  
Summary(model)  
Exp(coef(model))
```

Cumulative regression analysis

```
Cummodel2 = vglm(wtt ~ gender + race, family=cumulative(parallel=true), data=cm2)
```

Anova

```
Emotions2goodg.aov<- aov(good~race, data=emotions2)  
Goodracet<-tukeyhsd(emotions2goodg.aov, conf.level = 0.95)
```

Manova

```
Emotionsmanova <- manova(cbind(active, adventurous, aggressive, bored, calm, eager,  
energetic, enthusiastic, free, friendly, glad, good, healthy, happy, loving, nostalgic, peaceful,  
pleased, satisfied, unsafe, worried) ~ race, data = emotions2)  
Summary(emotionsmanova, test = "wilks")  
Summary.aov(emotionsmanova)
```

Dda

```
Ddarace$structure  
Ddarace$coeffs.raw  
Ddarace$coeffs.std
```

## APPENDIX D. IRB APPROVAL FOR CHAPTER 4



LSU AgCenter Institutional Review Board (IRB)  
Dr. Michael J. Keenan, Chair  
School of Nutrition & Food Sciences  
209 Knapp Hall  
225-578-1708  
mkeenana@agctr.lsu.edu

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- A Complete Application Includes All of the Following:
  - (A) The original and a copy of this completed form and a copy of parts B through E.
  - (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1 & 2)
  - (C) Copies of all instruments and all recruitment material to be used.
    - If this proposal is part of a grant proposal, include a copy of the proposal.
  - (D) The consent form you will use in the study (see part 3 for more information)
  - (E) Beginning January 1, 2009: Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing and handling data, unless already on file with the LSU AgCenter IRB.  
Training link: (<http://grants.nih.gov/grants/policy/hs/training.htm>)

1) Principal Investigator: Dr. Witton Prinyawiwatkul Rank: Professor Student? Y/N NO  
Dept: School of Nutrition & Food Sciences Ph: (225)578-5188  
E-mail: wprinya@lsu.edu

2) Co-Investigator(s): please include department, rank, phone and e-mail for each

- If student as principal or co-investigator(s), please identify and name supervising professor in this space
  - Ashley Gutierrez, Research Associate, School of Nutrition & Food Sciences  
(225)578-5423, [agutierrez@agcenter.lsu.edu](mailto:agutierrez@agcenter.lsu.edu)

3) Project Title: Consumer Acceptance and Perception of New and Healthier Food Products

4) Grant Proposal?(yes or no) NO If Yes, Proposal Number and funding Agency

Also, if Yes, either: this application completely matches the scope of work in the grant Y/N

OR

more IRB applications will be filed later Y/N

5) Subject pool (e.g. Nutrition Students) LSU Faculty, Staff, Students and off-campus consumers

- Circle any "vulnerable populations" to be used: (children<18, the mentally impaired, pregnant women, the aged, other). Projects with incarcerated persons cannot be exempted.

6) PI signature [Signature] \*\*Date 8/23/18 (no per signatures)

\*\*I certify that my responses are accurate and complete. If the project scope or design is later changed I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU AgCenter institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at the LSU AgCenter for three years after completion of the study. If I leave the LSU AgCenter before that time the consent forms should be preserved in the Departmental Office.

Committee Action: Exempted ☒ Not Exempted

IRB# HE18-22

Reviewer Michael Keenan Signature Michael Keenan Date 9-5-2018

## APPENDIX E. QUESTIONNAIRE FOR CONSUMER STUDY FOR CHAPTER 4

### Fish Bone Powder Project

---

#### Start of Block: Welcome message

Welcome message   Welcome to the LSU Sensory Lab   Click the right arrow button below to begin the test.

---

#### End of Block: Welcome message

---

#### Start of Block: Consent Form

Consent Form Research Consent Form   I, \_\_\_\_\_, agree to participate in the research entitled **"Consumer Acceptance, Liking, Emotions, and Purchase Intent (PI) of Fried Catfish"** conducted by Dr. Witoon Prinyawiwatkul, Professor of the School of Nutrition and Food Sciences at Louisiana State University, Agricultural Center, phone number (225) 578-5188.   I understand that participation is entirely voluntary and whether or not I participate will not affect how I am treated on my job. I can withdraw my consent at any time without penalty or loss of benefits to which I am otherwise entitled and have the results of the participants returned to me, removed from the experimental records, or destroyed. Up to 100 consumers will participate in this research. For this particular research, about 10-15 minutes of participation will be required for each consumer.   The following points have been explained to me:   1.   In any case, it is my responsibility to report prior to participation to the investigator any food allergies I may have.   2.   The reason for the research is to gather information on sensory acceptability, liking, emotion, and purchase intent of fried catfish. The benefit that I may expect from it is a satisfaction that I have contributed to the quality improvement of these products.   3.   The procedures are as follows: 3 coded samples will be placed in front of me, and I will evaluate them by normal standard methods and indicate my evaluation on score sheets. All procedures are standard methods as published by the American Society for Testing and Materials and the Sensory Evaluation Division of the Institute of Food Technologists.   4.   Participation entails minimal risk: The only risk which can be envisioned is that of an allergy to catfish and common breeding mixes. However, because it is known to me beforehand that the food to be tested contains common food ingredients, the situation can normally be avoided.   5.   The results of this study will not be released in any individual identifiable form without my prior consent unless required by law.   6.   The investigator will answer any further questions about the research, either now or during the course of the project.   The study has been discussed with me, and all of my questions have been answered. I understand that additional questions regarding the study should be directed to the investigator listed above. In addition, I understand the research at Louisiana State University, Agricultural Center, which involves human participation, is carried out under the oversight of the Institutional Review Board. Questions or problems regarding these activities should be addressed to Dr. Michael Keenan, Chair of LSU AgCenter IRB, (225) 578-1708. I agree with the terms above and acknowledge.   Please, type your first and last name:

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#### End of Block: Consent Form

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#### Start of Block: Demographic

Q1 Gender Gender

- ☐ Male (1)
  - ☐ Female (2)
- 

Q2 Age Age

- ☐ 18-25 (1)
  - ☐ 26-35 (2)
  - ☐ 36-45 (3)
  - ☐ 46-59 (4)
  - ☐ 60 + (5)
- 

Q3 Nationality Ethnicity/Nationality

- ☐ U.S. American (1)
  - ☐ Latin American or Hispanic (2)
  - ☐ Asian (3)
  - ☐ European (4)
  - ☐ African (5)
  - ☐ Australian (6)
  - ☐ Other (7)
-

Q4 Have you ever consumed fried catfish nuggets?

☐ Yes (1)

☐ No (2)

End of Block: Demographic

---

Start of Block: Sample 321

Q5 Please drink water and eat unsalted crackers to cleanse your palate between samples

Samples 321 PLEASE CLOSELY OBSERVE THE FRIED CATFISH SAMPLE 321. Please answer the following questions BY VISUAL EVALUATION ONLY (DO NOT TASTE THE SAMPLE YET):

---

Q6 Please rate your liking of the **OVERALL VISUAL QUALITY** of sample 321

☐ Dislike Extremely (1)

☐ Dislike very much (2)

☐ Dislike moderately (3)

☐ Dislike slightly (4)

☐ Neither Like or dislike (5)

☐ Like slightly (6)

☐ Like moderately (7)

☐ Like very much (8)

☐ Like extremely (9)

---

Q7 Please rate your liking of the **SURFACE COLOR** of sample 321

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q8 Based on your preference, please rate the **BROWNISH COLOR** of sample 321

- ☐ Not Brown enough (1)
  - ☐ Just about right (2)
  - ☐ Too Brown (3)
- 

Q19 PLEASE TAKE A PIECE OF SAMPLE 321 AND SMELL IT. AFTER THIS, ANSWER THE FOLLOWING QUESTION:

---



Q20 Please rate your liking of the **AROMA** of sample 321

- ☐ Dislike Extremely (1)
- ☐ Dislike very much (2)
- ☐ Dislike moderately (3)
- ☐ Dislike slightly (4)
- ☐ Neither Like or dislike (5)
- ☐ Like slightly (6)
- ☐ Like moderately (7)
- ☐ Like very much (8)
- ☐ Like extremely (9)

---

Page Break

Q21 PLEASE TASTE A PIECE OF SAMPLE 321 AND ANSWER THE FOLLOWING QUESTIONS:

---

Q22 Please rate your liking of the **SURFACE CRISPINESS** of sample 321

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q23 Base on your preference, please rate the **SURFACE CRISPINESS** of sample 321

- ☐ Not crispy enough (1)
  - ☐ Just about right (2)
  - ☐ Too crispy (3)
-

Q24 Please rate your liking of the **OVERALL TEXTURE** of sample 321

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (7)
  - ☐ Dislike moderately (8)
  - ☐ Dislike slightly (9)
  - ☐ Neither Like or dislike (10)
  - ☐ Like slightly (11)
  - ☐ Like moderately (12)
  - ☐ Like very much (13)
  - ☐ Like extremely (14)
- 

Q25 Please rate your liking of the **FLAVOR** (taste and aroma) of sample 321

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
-

Q26 Please rate your **OVERALL LIKING** of sample 321.

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q27 How likely would you purchase this product?

- ☐ Yes (1)
  - ☐ No (3)
-

Q28 Emotions After visual, aroma and taste evaluations of sample 321, how does this fried catfish make you feel?  
Select the emotions that you associate with this fried catfish. Check all that apply.

- ☐ Active (1)
- ☐ Adventurous (2)
- ☐ Aggressive (3)
- ☐ Bored (4)
- ☐ Calm (5)
- ☐ Disgusted (6)
- ☐ Enthusiastic (7)
- ☐ Free (8)
- ☐ Good (9)
- ☐ Good natured (10)
- ☐ Guilty (11)
- ☐ Happy (12)
- ☐ Interested (13)
- ☐ Joyful (14)
- ☐ Loving (15)
- ☐ Mild (16)
- ☐ Nostalgic (17)

- ☐ Pleasant (18)
- ☐ Satisfied (19)
- ☐ Unsafe (related to nutrition) (20)
- ☐ Tame (21)
- ☐ Understanding (22)
- ☐ Warm (23)
- ☐ Wild (24)
- ☐ Worried (27)

End of Block: Sample 321

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Start of Block: Sample 852

Q29 Please drink water and eat unsalted crackers to cleanse your palate between samples

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Page Break

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Q30 PLEASE CLOSELY OBSERVE THE FRIED CATFISH 852. Please answer the following questions BY VISUAL EVALUATION ONLY (DO NOT TASTE THE SAMPLE YET):

---

Q31 Please rate your liking of the **OVERALL VISUAL QUALITY** of sample 852

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
-

Q32 Please rate your liking of the **SURFACE COLOR** of fried catfish sample 852

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q33 Based on your preference, please rate the **BROWNISH COLOR** of sample 852

- ☐ Not Brown enough (1)
  - ☐ Just about right (2)
  - ☐ Too Brown (3)
-



Q34 PLEASE TAKE A PIECE OF SAMPLE 852 AND SMELL IT. AFTER THIS, ANSWER THE FOLLOWING QUESTION:

---

Q38 Please rate your liking of the **AROMA** of sample 852

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
-

Q39 PLEASE TASTE A PIECE OF SAMPLE 852 AND ANSWER THE FOLLOWING QUESTIONS:

---

Q40 Please rate your liking of the **SURFACE CRISPINESS** of sample 852

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q41 Base on your preference, please rate the **SURFACE CRISPINESS** of sample 852

- ☐ Not crispy enough (1)
  - ☐ Just about right (2)
  - ☐ Too crispy (3)
-

Q42 Please rate your liking of the **OVERALL TEXTURE** of sample 852

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (7)
  - ☐ Dislike moderately (8)
  - ☐ Dislike slightly (9)
  - ☐ Neither Like or dislike (10)
  - ☐ Like slightly (11)
  - ☐ Like moderately (12)
  - ☐ Like very much (13)
  - ☐ Like extremely (14)
- 

Q43 Please rate your liking of the **FLAVOR** (taste and aroma) of sample 852

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
-

Q44 Please rate your **OVERALL LIKING** of sample 852.

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q45 How likely would you purchase this product?

- ☐ Yes (1)
  - ☐ No (3)
- 

Page Break

---

Q46 The breeding mix was supplemented with edible and safe fish bone powder to increase calcium, which may provide health benefit. Knowing this information, how likely would you purchase this product?

- ☐ Yes (11)
- ☐ No (13)

Q46 After visual, aroma and taste evaluations of sample 852, how does this fried catfish make you feel? Select the emotions that you associate with this fried catfish supplemented with fish bone powder. Check all that apply.

- ☐ Active (1)
- ☐ Adventurous (2)
- ☐ Aggressive (3)
- ☐ Bored (4)
- ☐ Calm (5)
- ☐ Disgusted (6)
- ☐ Enthusiastic (7)
- ☐ Free (8)
- ☐ Good (9)
- ☐ Good natured (10)
- ☐ Guilty (11)
- ☐ Happy (12)
- ☐ Interested (13)
- ☐ Joyful (14)
- ☐ Loving (15)
- ☐ Mild (16)
- ☐ Nostalgic (17)

- ☐ Pleasant (18)
- ☐ Satisfied (19)
- ☐ Unsafe (related to nutrition) (20)
- ☐ Tame (21)
- ☐ Understanding (22)
- ☐ Warm (23)
- ☐ Wild (24)
- ☐ Worried (25)

End of Block: Sample 852

---

Start of Block: Sample 753

Q47 Please drink water and eat unsalted crackers to cleanse your palate between samples

---

Page Break

---

Q48 PLEASE CLOSELY OBSERVE THE FRIED CATFISH 753. Please answer the following questions BY VISUAL EVALUATION ONLY (DO NOT TASTE THE SAMPLE YET):

---

Q49 Please rate your liking of the **OVERALL VISUAL QUALITY** of sample 753

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
-

Q50 Please rate your liking of the **SURFACE COLOR** of sample 753

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q51 Based on your preference, please rate the **BROWNISH COLOR** of fried catfish sample 753

- ☐ Not Brown enough (1)
  - ☐ Just about right (2)
  - ☐ Too Brown (3)
- 

Page Break

---



Q52 PLEASE TAKE A PIECE OF SAMPLE 753 AND SMELL IT. AFTER THIS, ANSWER THE FOLLOWING QUESTION:

---

Q53 Please rate your liking of the **AROMA** of sample 753

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Page Break

---

Q54 PLEASE TASTE A PIECE OF SAMPLE 753 AND ANSWER THE FOLLOWING QUESTIONS:

---

Q55 Please rate your liking of the **SURFACE CRISPINESS** of sample 753

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q56 Base on your preference, please rate the **SURFACE CRISPINESS** of sample 753

- ☐ Not crispy enough (1)
  - ☐ Just about right (2)
  - ☐ Too crispy (3)
-

Q57 Please rate your liking of the **OVERALL TEXTURE** of sample 753

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (7)
  - ☐ Dislike moderately (8)
  - ☐ Dislike slightly (9)
  - ☐ Neither Like or dislike (10)
  - ☐ Like slightly (11)
  - ☐ Like moderately (12)
  - ☐ Like very much (13)
  - ☐ Like extremely (14)
- 

Q58 Please rate your liking of the **FLAVOR** (taste and aroma) of sample 753

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
-

Q59 Please rate your **OVERALL LIKING** of sample 753.

- ☐ Dislike Extremely (1)
  - ☐ Dislike very much (2)
  - ☐ Dislike moderately (3)
  - ☐ Dislike slightly (4)
  - ☐ Neither Like or dislike (5)
  - ☐ Like slightly (6)
  - ☐ Like moderately (7)
  - ☐ Like very much (8)
  - ☐ Like extremely (9)
- 

Q60 How likely would you purchase this product?

- ☐ Yes (1)
  - ☐ No (3)
- 

Q61 The breeding mix was supplemented with edible and safe fish bone powder to increase calcium, which may provide health benefit. Knowing this information, how likely would you purchase this product?

- ☐ Yes (1)
  - ☐ No (3)
-

Q62 After visual, aroma and taste evaluations of sample 753, how does this fried catfish make you feel? Select the emotions that you associate with this fried catfish supplemented with fish bone powder. Check all that apply.

- ☐ Active (1)
- ☐ Adventurous (2)
- ☐ Aggressive (3)
- ☐ Bored (4)
- ☐ Calm (5)
- ☐ Disgusted (6)
- ☐ Enthusiastic (7)
- ☐ Free (8)
- ☐ Good (9)
- ☐ Good natured (10)
- ☐ Guilty (11)
- ☐ Happy (12)
- ☐ Interested (13)
- ☐ Joyful (14)
- ☐ Loving (15)
- ☐ Mild (16)
- ☐ Nostalgic (17)

- ☐ Pleasant (18)
- ☐ Satisfied (19)
- ☐ Unsafe (related to nutrition) (20)
- ☐ Tame (21)
- ☐ Understanding (22)
- ☐ Warm (23)
- ☐ Wild (24)
- ☐ Worried (25)

End of Block: Sample 753

---

## APPENDIX F. SAS CODES FOR CHAPTER 4

Manova

```
Proc glm;  
    class sample;  
    model ovq color aroma crispiness texture flavor ol = sample;  
    manova h=_all_;  
Run;
```

Dda

```
Proc candisc data=work.hedonics;  
    class sample;  
    var ovq color aroma crispiness texture flavor ol;  
Run;
```

McNemar

```
Proc freq;  
    table pib*pba/agree expected norow nocol;  
    by sample;  
Run;
```

Cochran-q

```
Proc freq data=work.emotion;  
    tables active1 active2 active3 / nocum;  
    tables active1*active2*active3/ agree noprint;  
Run;
```

Lra

```
Proc genmod data=work.hedonics descending;  
    model pba = ovq color aroma texture flavor crispiness/ type3 dist=bin link=logit  
    aggregate;  
Run;
```

Proc logistic data=work.hedonics descending;

```
    model pba = ovq color aroma texture flavor crispiness/ link=logit aggregate;  
Run;
```

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