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Sensory and Nutritional Characteristics of Thermally Processed Tilapia (*Oreochromis niloticus*) in Coconut (*Coconuts nucifera L.)* Sauce

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Abstract: **This study attempted to develop a food product that is readily available in the locality and thermally process the tilapia in the glass jar added with Coconut Sauce. The final product can be a good viand and an alternative for other protein rich foods, like meat and cheese. Developmental and experimental types of research was uses to produce a new product. Result of the sensory evaluation showed all the treatments were found to be acceptable in terms of their sensory attributes; however the treatments that was processed for 75 minutes at 121 °C (15 psi) was the most preferred having an average rating of 3.87. The product has cream color, distinct fish odor, spice and coconut odor, slightly salty and sour taste, with soft bones, tender flesh and neither thick nor thin consistency of sauce. The processing time affects the sensory attributes of the product. The thermally processed Tilapia in Coconut Sauce has a good taste and was acceptable to the consumer. The new product can provide energy and a good source of nutrients that are needed by the body. Furthermore, the product also had met the requirements for commercial sterility, for not having any growth of organism under various condition of the test. Hence this product can be recommended as part of the daily individual diet**.

Keywords: **Sensory Nutritional Characteristics Locally Produced Thermally Processed Tilapia.**

I. INTRODUCTION

Humans have long relied on fish as source of dietary protein. With the rising cost of meat and cheese protein foods, consumers have increasingly invested in fish as source of dietary protein. In the Philippines, people obtain more than half of the animal protein in their diet from fish. The American Heart Association (AHA)[1] recommends eating fish at least twice a week because it is a good source of protein and low in saturated fat. Fishes are also high in omega-3 fatty acid, which may reduce the causes of heart disease. Furthermore, eating fresh and frozen fish are good ways to obtain omega 3s but for an easy and economical alternative, canned or bottled fish also offers the same health benefit

Tilapia is a healthy food choice for consumers because it is a relatively low-fat fish that is rich in proteins and minerals. Tilapia is the second most cultivated freshwater fish worldwide, typically yielding between 30–40% fillet yield leaving 60–70% processing waste commonly referred as offal (El-Sayed A-FM., 2006 and Silva, JFX, 2014)[2,3]. This has often led to relatively low margins for tilapia fillets compared to other finfish species (El-Sayed A-FM., 2006). However, there is an opportunity for producers to further improve the nutrient value (e.g. healthy fats) of tilapia fillets and offal through manipulations of tilapia feed leading to higher value products in the market place.

Coconut (*Coconuts nucifera L.)* is economically important and generally used in many traditional foods of Pacific and Asian regions (DebMandal & Mandal, 2011)[4]. Asia is the major coconut producer all over the world and 90% of the world's total coconuts are cultivated in Indonesia, Philippines, India, Sri Lanka, and Thailand. About 70% of coconuts are consumed domestically, and over half of the crop is consumed fresh (Grimwood, 1975)[5]. Coconuts also contain proteins with moderately well-balanced amino acid profile in term of nutritive value (Gonzales & Tanchuco, 1977; Gunetileke & Laurentius, 1974)[6-7].

Tilapia is a very important fish in Bicol Region, Philippines and can become more popular in the years to come because it is a productively raised in the fish farms. This means that there is a consistent and constant supply of tilapia year round, thus tilapia can be a substitute to many kinds of fish. If tilapias are properly handled and thermally process with coconut sauce (coconut sauce is mixture of coconut milk, water and spices**),** the product will not only have improved the taste/flavour but become nutritious and can be preserved for a longer period of time. As such, it is not surprising that thermally processed tilapia packed in glass jar can be the most important processed fish used by the rural villager in the region.

Canning is one of the most effective and spreading method of fish preservation Connel,A.,1975)[8]. The pre-cooking and further thermal treatment of fish in hermetically sealed containers eliminate bacterial and autolytic spoilage, and pathogenic microorganisms, particularly the heat resistant Clostridium botulinum that can produce a lethal toxin with extended shelf-life beyond 2 years at ambient temperature(Venugopal V, 2012) [9]. The three (3) most popular species of fish that are canned are tuna, salmon and sardines. However, tilapia can be a good alternative and could be suitable for canning or bottling, since tilapia can be found in tropical water around the world

This study is a sustainable development of agricultural and fishery industry in which its direction is towards the quality and productivity of fishery and agricultural product in the country. Hence, a scientific inquiry on the utilization of Tilapia Nilotica (*Oreochromis niloticus*) and other agricultural products such as, coconut, spices and herbs in thermal processing method were undertaken to evaluate the nutritional and sensory characteristics and its acceptability as new preserved product in the market, the Thermally Processed or Bottled Tilapia in Coconut Sauce.

II. METHODOLOGY

Research Procedures. The researchers applied developmental, experimental, descriptive – evaluative and descriptive – analysis methods of research. A new product was developed using the combination of tilapia fish, coconut milk, spices and herbs into canned good. Experimental method is an approach wherein the study is described in the future on what will be, when certain variables are carefully controlled or manipulated. Several formulations on the coconut milk concentration were tested to achieve the desired and preferred proportion of ingredients. Likewise the products were subjected to various processing time to differentiate the effect of the processing time on the sensory attributes of the product. Descriptive – evaluative method was used to appraise carefully the worthiness of the current study. The finished product underwent sensory evaluation in which the worth of the new product was assessed if it is acceptable to the consumers in terms of appearance, texture, flavor and aroma. Descriptive – analysis method is the method, which determines or describes the nature of an object by separating it into its part. Its purpose is to discover the nature of thing. In this study, sensory, nutritional content were analyzed and commercial sterility test was conducted to determine the storage stability of the product.

Bottling/Canning Process. The most preferred formulation were used in the thermal process of tilapia with coconut sauce into Treatments and were replicated. Dressed tilapia were packed in an 8oz glass jar, added with coconut sauce and thermally process using the pressure Cooker. Treatment 1, 2 and 3 were thermally process at 60, 75 and 90 minutes respectively. All treatments were process at 121^{o}C (Pressure 15 psi).

Chemical Analysis. Proximate composition of all the content of the thermally processed tilapia were determined according to the method of Association of Official Analytical Chemistry (AOAC, 2016), Microwave Plasma-Atomic Emission Spectroscopy (MP-AES) and USFDA- NLR and DOST-FNRI-PDRI, 2015, respectively

Statistical Analysis. Data collected were subjected to statistical analysis using t test at $p < 0.05$ level of significance. The software used for the analysis was Statistical Package for Social Sciences (SPSS version 21).

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III. RESULTS AND FINDINGS

Sensory Evaluation of Thermally Processed Tilapia in Coconut Sauce

The acceptance or rejection of food entirely depends on whether it corresponds to consumer expectations and needs (Mosca et al., 2015) [10] Sensory characteristic of the product are important quality parameters, which influence on status of the finished product on the market, and whether consumers, whom it is intended, will like and buy the product. Food acceptability directly relates to the interaction it has with the consumer at a given moment in time. The key factors that determine food acceptability are the sensory characteristics of food since consumers seek foods with specific sensory properties. Other critical factors that directly dictates food acceptability are consumer characteristics and enjoyment of food (Maina, J, 2018) [11]. Results of scientific research have shown that quality and important sensory characteristics of the product, can be identified and controlled with the descriptive II International Congress "Food Technology, Quality and Safety" 326 analysis or by consumers testing can be examined if the overall product quality or the selected property of the product were affected by carried out modification (Bahamonde et al., 2007; Grunert et al., 2008; Grujić and Spaho, 2010; Grujić and Grujić, 2011)[12,13,14,15]. As one of the aim of this research new develop quality thermally processed tilapia to harmonized with market needs and consumers' expectations. Expected quality and nutrients were identified and described.

Descriptive Characteristics of Thermally Processed Tilapia in Coconut Sauce

The results of the sensory evaluation on the descriptive test on the different attributes and the result of the Analysis of Variance (ANOVA) or F – test are presented in the succeeding tables.

TABLE 1. Summary Descriptive Characteristics of Thermally Processed Tilapia in Coconut Sauce at Varied Processing Time

Characteristics	Processing Time					
	60 minutes		75 minutes		90 minutes	
	WM	D	WM	D	WM	D
Color	2.33	Light cream	3.2	Cream	3.4	Cream
Fish Odor	2.77	Distinct	3.23	Distinct	3.77	Moderately distinct
Spice Odor	2.8	Distinct	3.2	Distinct	3.33	Distinct
Coconut Odor	2.57	Distinct	2.87	Distinct	2.83	Distinct
Saltiness	2.23	Just right	2.5	Slightly salty	2.8	Slightly salty
Sourness	1.63	Slightly sour	2.03	Slightly sour	2.1	Slightly sour
Softness of Bones	2.57	Soft	2.83	Soft	2.8	Soft
Firmness of Flesh	2.63	Tender	3.07	Tender	2.9	Tender
Consistency of the Sauce	2.80	Neither thick nor thin	3.07	Neither thick nor thin	3.03	Neither thick nor thin

A review of commercial process time and temperature (Tsutsumi, 1972)[16] indicated that Fo values suitable for commercially canned products are generally adequate for retort pouch products. In this study pressure cooker is used which is suitable for thermal processing of tilapia with coconut sauce in a glass jar.

Table 1 shows characteristics of thermally processed tilapia in varied processing time. The result of the color implies that the longer the processing time the darker the color of the product. Hence, the time of processing affects the color of the products. It was noted that when the product was processed at longer time the fish odor is more distinct than processed at shorter time. Therefore processing time influences the level of fish odor of the product. On the other hand, the length of time does affect spice and coconut odor of the product. It was revealed that the processing time changed the saltiness of the product, as the length of time of processing increases the saltiness of the product is more distinct. As regard to the softness of the bones, results imply that in sixty (60) minutes at at 121^{o}C (Pressure 15 psi) bones are already soft which means bones can be eaten. Therefore the various processing time were enough to make the bone soft and the product became acceptable. On the firmness of flesh of the fish shows that in all levels of processing time it was described by the panellists that the flesh is tender this means that although the products were subjected to various processing time the flesh remain tender, hence the flesh of the product has a good texture. The consistency of the finished product in all levels of

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processing time was described by the panellist as neither thick nor thin. This finding revealed that the processing time did not affect the consistency of the product's sauce.

Significant Difference on the Sensory Attributes of Thermally Processed Tilapia in Coconut Sauce

TABLE 2. Analysis of Variance (ANOVA) on the Sensory Attributes of Thermally Processed Tilapia in Coconut Sauce

Attributes	F_{C*}	F_t	Decision
Color	29.29	3.15	Reject H_O
Fish odor	10.01	3.15	Reject H_O
Spice odor	2.72	3.15	Accept H_O
Coconut odor	1.09	3.15	Accept H_O
Saltiness	3.35	3.15	Reject H_O
Sourness	4.09	3.15	Reject H_O
Softness of bones	1	3.15	Accept H_O
Firmness of flesh	1.78	3.15	Accept H_O
Consistency of sauce	**1**	3.15	Accept H_O

Table 2 shows that the color, fish odor, saltiness and sourness of the product there is no significant difference between the treatments. For color, the F_C which is equal to twenty-nine point twenty-nine ($F_C = 29.29$) is greater than F_t which is equal to three point fifteen ($F_t = 3.15$). This implies that the longer the duration of time the product was processed the color became darker, and thus processing time affects the color of the product. In terms of fish odor F_C is equal to ten point zero one ($F_C = 10.01$) and is greater than F_t which is equal to three point fifteen ($F_t = 3.15$). This means that the different processing time resulted to the fish aroma to come out even more, therefore processing time affects the fish odor of the product. Furthermore, as to the spice odor, coconut odor, softness of bone, firmness of flesh and consistency of the sauce showed that there was a significant difference between samples. These results implied that despite the differences in the ratings of the different samples, these are considered as the same. Therefore the extent of processing time does not affect those attributes of the product.

General Acceptability Thermally Processed Tilapia in Coconut Sauce Processed at Varied processing Time

TABLE 3. General Acceptability of Thermally Processed Tilapia in Coconut Sauce

Characteristics	Processing Time					
	60 minutes		75 minutes		90 minutes	
	WM	D	WM	D	WM	D
Appearance	3.4	Like Moderately	3.67	Like Moderately	3.7	Like Moderately
Aroma	3.83	Like Moderately	3.87	Like Moderately	3.77	Like Moderately
Taste	4.00	Like Moderately	3.97	Like Moderately	3.63	Like Moderately
Firmness of Flesh	3.63	Like Moderately	3.90	Like Moderately	3.70	Like Moderately
Consistency of the Sauce	3.97	Like Moderately	3.93	Like Moderately	3.83	Like Moderately
Average	3.77	Like Moderately	3.87	Like Moderately	3.73	Like Moderately

*WM-weighted Mean, D-description,

Table 3 presents the summary and the average score of the Thermally Processed Tilapia in Coconut Sauce. The product processed at seventy-five (75) minutes cooking time was considered as the most preferred as revealed in weighted mean of three point eighty-seven (3.87) or Like moderately. Although, in terms of descriptive analysis all products were rated like extremely but with regards to the score or weighted mean the product treated in seventy-five (75) minutes processing

time had a score higher than those samples treated in sixty (60) and ninety (90) minutes. As revealed in Table 3, the product processed in sixty (60) minutes was rated three point seventy-seven (3.77) and in ninety (90) minutes rated three point seventy-three (3.73). These values demonstrated that the preference of consumers was more pronounced towards the thermally processed tilapia processed at 121^{o}C (Pressure 15 psi) for 75 minutes. Furthermore, result may revealed the product quality is safe and could be kept for longer period time. Raptopoulou, K.G, etal., 2017 stated that the high-pressure (HP) processing is a novel technique used to prolong the shelf life of foodstuffs keeping the original sensory and nutritional properties as high as possible [17]. The HP processing occurs at 100-1000 MPa and between -20 ^{o}C and 60 ^{o}C resulting in a reduction of microbial loads without heating and therefore the method could be useful for preserving the antioxidant capacity of the foods, and other heat affected nutritional compounds [18, 19].

Nutritional Analysis of Thermally Processed Tilapia in Coconut Sauce

Fish and seafood products, have a high nutritional value regarding beneficial amounts of protein, lipids as well as essential micronutrients. Aquatic animal foods are a rich source of protein and have a lower caloric density, and have a high content of omega 3 long chain polyunsaturated fatty acids (n-3 LC PUFA) compared to land living animals (Tacon and Metian, 2013)[20]. Strong links between fish and seafood consumption and positive health effects, especially with the decreased risk of coronary heart and cardiovascular diseases, decreased inflammatory disease as arthritis and prevention of cancer have been shown by many researchers (Dyerberg, 1985; Calder, 2004; Rudkowska et al.; 2010; Lund, 2013)[21,22,23,24].

Proximate composition of Thermal Process Tilapia in Coconut Sauce Processed at the Different Time

TABLE 4. Proximate Chemical Composition of Thermal Process Tilapia in Coconut Sauce

Parameters		Processing Time	
	60 minutes (Treatment 1)	75 minutes (Treatment 2)	90 minutes (Treatment 3)
Ash %	5.01	4.40	2.62
Total Fat %	14.98	14.68	14.38
Protein %	11.74	11.84	11.83
Moisture %	65.74	65.05	65.99
Carbohydrates %	4.73	3.73	5.18

The proximal chemical analysis was carried out by the AOAC methods. Results of proximate composition showed that there were no significantly difference ($P< 0.05$) on the percentage of total fat, protein and moistures. Among the three Treatments, Treatment 3 has the lowest percentage of ash content (2.62) and Treatment 2 has the lowest percentage of Carbohydrate (3.73). Al treatments contained the following nutritional values, ranges from 65.05% to 65.99% of moisture, 11.74% to 11.84 of protein, 14.38% to 14.98% of fat (Table 4).

The protein content in the three treatments of thermally processed or bottled tilapia is lower as compared to the study conducted by (Dhanya *et al.* 2010, and George, 1987)[25,26] it indicates that there was a loss of protein during processing. Loss of protein can be due to three possible reasons which are pre-cooking, diffusion into liquid and heat destruction during thermal processing (Bindu1, J., etal., 2014)[27] .Commercial thermal processing of canned fish products will not destroy significant amount of amino acid except cystine, which is not an essential amino acid (Dunn et al., 1949) [28]. Lepkowski (1953) [29] reported the beneficial effects of heat treatment of fish which is due to the inactivation of thiaminase enzyme in some fishes. The effect of canning on the extractable nitrogen fractions s an increase in the total extractable nitrogen, especially in the exuded liquid (Hughes, 1961) [30]. Exposure to canning conditions does not significantly affect the dietary value of protein (Bender, 1972) [31].

Fat in this study there was just a slight difference in the fat content of the three treatment. However, fat content of this new product, the bottled tilapia is higher as compared to the raw tilapia this is probably due to the coconut sauce added to the products. On the other hand, it was reported by other authors that there was an increase in lipid content in a study on the utilization of tilapia by canning and also in studies on the canning of pink perch (Santha, 2004; Suresh, 1984)[32-33]. As expected moisture content is lower as compared to the fresh tilapia. The result is an agreement to the moisture content of canned tuna as stated by Bahurmiz, OB., etal.,(2018)[34]. In bottling or thermal processing of tilapia there are many steps to be done which contributed to the reduction of moisture content in the final product. The thermal treatment (pre-cooking

and heat sterilization) denaturize the muscle proteins and thus decrease their water holding capacity which results in releasing a considerable amount of water to the surrounding medium (Aubourg SP., 2015, Bindu J, 2014)[35-36]. Ash content to both sample is high but there was significant difference ($p<0.05$) indicates that thermally processed tilapia is a good source of minerals. Carbohydrate contents were relatively high for the three (3) treatments and was significant difference ($p<0.05$) this may due the addition of coconut sauce and other ingredients.

Mineral Composition of Thermal Process Tilapia in Coconut Sauce Processed at the Different Time

TABLE 5. The Mineral Composition of Thermal Process Tilapia in Coconut Sauce Processed at the Different Time

Parameters		Processing Time	
	60 minutes (Treatment 1)	75 minutes (Treatment 2)	90 minutes (Treatment 3)
Sodium, mg/100g	560	600	661
Potassium, mg/100g	299	301	321
Calcium, mg/100g	856	826	187
Iron, mg/100g	2.53	2.13	.98
Zinc, mg/100g	2.10	1.20	.94

Mineral composition was determined using the Microwave Plasma-Atomic Emission Spectroscopy (MP-AES). Results of mineral content showed statistically differences ($P< 0.05$) among the three samples in all nutritional components (Table 5). Fish is an excellent source of most of the minerals which the body needs to develop properly and perform its functions. Calcium and phosphorus (without which proper development of bones and teeth is impossible) occur in fish fillets in about the same quantities as in beef round (FAO, 2009) [37]. Although fish contain less iron than the amount found in red meat, iron in white fish is well absorbed and so is a useful source of iron. The soft bones in the samples are especially valuable sources of calcium. In this study both samples contained appreciable concentrations of sodium, calcium, potassium, iron and zinc which indicates that thermally processed tilapia in coconut sauce are good source of minerals. Calcium content was observed to be higher in Treatment 1 and 2 which indicates that the longer the product process at 121^0C calcium content is affected.

TABLE 6. Results of the Commercial Sterility Test of the Thermally Processed Tilapia in Coconut Sauce.

Cooked Meat Medium				BCP Dextrose Medium			
35 °C, 120 hours incubation		55 °C, 72 hours incubation		35 °C, 120 hours incubation		55 °C, 72 hours incubation	
Aerobic	Anaerobic	Aerobic	Anaerobic	Aerobic	Anaerobic	Aerobic	Anaerobic
No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth	No Growth

The results showed that when the product was incubated in Cooked Meat Medium at 35 °C, one hundred twenty (120) hours incubation and 55 °C, seventy-two (72) hours incubation there was no growth of both aerobic and anaerobic organisms. The product was incubated in BCP Dextrose Medium at 35 °C, 120 hours incubation and 55 °C, 72 hours incubation, there was also no growth of both aerobic and anaerobic organisms. From the results obtained and presented in Table 6 it showed that the product under various condition of the test, met the requirements for commercial sterility. Considering the results of the Commercial Sterility Test, the Thermally Processed Tilapia in Coconut Sauce processed at 121^oC (Pressure 15 psi) for seventy-five (75) minutes is safe for consumption and can be stored at room temperature. Hence, at 121^oC (Pressure 15 psi) for seventy-five (75) minutes is enough or just right in bottling tilapia.

4. CONCLUSIONS AND RECOMMENDATION

The selection of raw materials and other ingredients were important to produce a quality product. The procedural steps should be followed and observed properly. Each sample processed in varied length of processing time had different descriptive characteristics. The processing time affects the sensory attributes of the product. The thermally processed or bottled tilapia in Coconut Sauce has a good taste and was acceptable to the consumer. Therefore, the product can provide energy and a good source or nutrients that are needed by the body. Furthermore, the product also had met the requirements for commercial sterility, for not having any growth of organism under various condition of the test. Hence this product can be recommended as part of the daily individual diet.

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