Microbiological Analysis And Nutritional Component Of Thermal Processes Of Yellowfin Tuna (*Thunnus Albacares*) With Pilinut (*Canarium Ovatum*) *Oil* And Coconut *(Cocos Nucifera)* Oil

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ABSTRACT : The Thermal Processed of Yellowfin Tuna (*Thunnus albacares*) with coconut oil and Pilinut oil (*Canarium Ovatum) in 8 oz glass jar was developed that aims tosave the surplus catch of tuna at Lagonoy and to provide safe and quality canned tuna in the locality. The products* thermally processed using 8oz glass jar and packed with coconut oil (Sample A) and pili nut oil (Sample B), proximate composition, mineral elements (sodium, potassium, calcium, iron and zinc) and nutrition fact were determined and subjected to commercially sterility test. Both samples have high nutritive value in terms of protein, fats, minerals and carbohydrate. Both samples had adequate percentage amounts of protein adequate for infants and adults; they were low in calories, high in protein, potassium and calcium; with a varied amount of sodium which is of no significant health implications. The product had a satisfactory commercial sterility. Hence this product can be recommended as part of the daily individual diet.

KEYWORDS: Nutrition Fact, Thermal Processes, Yellowfin Tuna, Coconut Oil, Pilinut Oil

I. INTRODUCTION

Yellowfin (Thunnus albacares) are a similar sized tuna to bigeye but mature at around 2 years old [1]. They reproduce throughout the year making them highly productive. They are found throughout the Pacific, Indian and Atlantic Oceans and represent 28% of the world's tuna catch [1]. . Yellowfin meat is firm with a mild taste and can be canned or sold as fresh or frozen fillets [2].Yellowfin Tuna is a fishery commodity with highest export in Bicol Region, Philippines. At Php12.7 billion per year, tuna is an economic driver and the biggest seafood export commodity of the Philippines (BFAR 2011) [3]. Lagonoy Gulf is evolving into a yellowfin tuna (*Thunnus albacares*) hand line fishing ground with great potential to supply international markets. While most of the yellowfin tuna caught is currently utilized for local consumption WWF, 2013) [4]. Linking this resource there is a need to create some innovative products to prevent the losses of surplus catch of yellowfin in the area. Doing this benefits the fishers as well as the local economy around the Gulf.

Tuna contains higher biological protein than beef and is one of the best sources of dietary amino acids. Furthermore, tuna flesh contains substantial quantities of vitamins B12, A and D and is also a rich source of phosphorus, iodine and fluorine [5]. Canned fish may be considered an excellent source of vitamin [6].The pili tree is known for its fruits. These are approximately 4-6cm long and of variable shapes namely, elliptical, oblong, oval, and obovate. In general, the fruit has three parts: the skin, the pulp, and the nut. The nut is composed of the shell, testa, and kernel. The shell is thick because of the hypodermal cells of the endocarp. The more important part of the nut is the large kernel because it is rich in oil that is valued for its quality. This kernel tastes like macadamia and walnut and is used in confections and other food preparations. When the nuts are eaten uncooked, it is said to have a purgative effect [7].Pili kernel oil, however, contains approximately 70% oil and resembles olive oil. However, the oil content varies, depending on several factors such as the extent of dryness of the kernel and the species of pili. The oil has a sweet taste, which makes it suitable for culinary purposes. Because of its resemblance with olive oil, it may replace imported olive oil for sardine's manufacture, salad dressing, and other food preparations [8]. Processing the oil will result in pili butter, which can replace the important cocoa butter. Unlike coconut oil, pili is considered aflatoxin-free. Because of its fatty acid profile, it may be modified into specialty fats and oils. Pili oil could be a source of lipid molecular species which are now the focus of interest because of their nutraceutical application [9].Due to the potential and health benefits of pili nut oil and the availability of tuna in the area pili nut were used. thermal processing of tuna using 8 oz glass jar and was compared to thermal process using the coconut oil. Further the present investigation was based on the fact that there was no tuna processing in Partido area where lagunoy Gulf is located. The only available tuna processed products are smoked tuna locally name as "inagunan" Canned tuna is one way to preserve and store tuna in cans which are hermetically sealed and sterilized so that the tuna will not turn spoiled physically and chemically, or contaminated biologically [10].

However, in this study glass jar was used due the higher cost of tin containers and limited supply in the region. According to Dayrit, C.S., 2000[11] cited by Bigueja, et.al., 2020[12]. that Coconut oil contains four MCFAs, namely lauric acid (C[1]12, 48-53%), capric acid (C-10, 7%), caprylic acid (C-8, 8%), and caproic acid (C-6, 0.5%). When inside the body, they are transformed into corresponding monoglycerides, namely monolaurin, monocaprin, monocaprylin, and monocaprin, all of which are able to kill pathogenic microorganisms including bacteria, fungi and yeasts, viruses and protozoa. The main problem that often occurs in the process of food canning is safety and quality of food. The nutritional value of foods with high protein content such as fish (pH > 4.5) can be reduced after canning [3]. Changes in nutritional value after canning can be the type of medium used. The medium added in the canning process serves as a conductor of heat, as a preservative and increases the degree of acidity. The medium also serves to give taste to the final product. Xavier K A M, et al. (2015) [11] have examined the effect of added media to heat penetration in canned tuna. The medium used was brine, tomato sauce, and curry and groundnut oil. They concluded that the heat penetration is strongly influenced by the type of media used in the canning process. The fastest heat penetration is found in tuna with a medium of salt solution (brine) then followed by curry, tomato sauce and oil [13]..

Canning improves shelf life enabling storage of the canned product for several years; but the processor, nutritionist, cook and the consumer have a direct interest in the composition of fish, as they are all interested in the nutritional contribution of the fish to the diet as to translate to good health. It is therefore important to assess approximate composition, mineral content (Na, K, Ca, Fe and Zn) and nutrition facts of these newly developed bottled products (Bigueja, M. et.al., 2021) [12]. Researches with regard to canned fish have been done intensively however there was no existing literature that pili nut and coconut oil were used as the media used in the canning process. Hence, this aims to investigate the amount of filling medium and its nutritional value so that existing literature could not be applied directly as general guidelines if important parameters are different. These critical parameters include the can dimension, the amount of filling, the final volume of product, types of medium and types of sterilization equipment. All of these factors will determine sterilization value (Fo), the overall processing time and the profile of heat transfer in the product. Therefore, this study aims to investigate the effect of temperature and time combination for the sterilization process of canned tuna. Different types of medium were also studied and both variables were examined toward the quality of canned tuna. The product quality was determined by chemical analysis for nutritional values. The nutritional changes were also compared between canned, pre-cooked and fresh tuna.Thermal processing technologies are widely used in food manufacturing to render food safe from pathogens and spoilage microorganisms, without affecting the product's organoleptic and nutritional quality. Because absolute sterility cannot be achieved without drastically damaging food integrity, thermal processed products must meet the commercial sterility criterion before being placed on the market (Diep, B., et.al., 2019) [13].

II. METHODOLOGY

Research Procedures- on the previous study on bottled tuna conducted by bigueja, m. et.al. (2020) [12]. found out that the Pili nut and coconut milk can be good ingredients in processing fish and other fishery products. In this present study, yellowfin tuna (*Thunnus albacares*) was used and compared the palatability, commercial sterility and nutritional fact of bottled yellowfin tuna (Thunnus albacares) with coconut oil (*Cocos Nucifera)* and bottled yellowfin tuna (*Thunnus albacare*s) with pili nut oil with the additional of the same amount of ingredients and processed at 121ºC (Pressure 15 psi) for 75 minutes with a process lethality (F_0) of 5 minutes The finished products were then subjected for, chemical analysis and commercial sterility.

Raw Materials- Twenty (20) kilos of Yellowfin Tuna (Thunnus albacares) was purchased directly to fisherman at Nato, Sagñay Camarines this is to ensure that the products are still fresh. The fish was packed in a cooler with a chilling temperature.

Steaming process - The tuna fish was steamed for 30 minutes and removed the skin and the block meat. The tuna meat were cut according to the desired size or to the size of the glass jar.

Preparation of the Filling Media – for both products for every 140 grams of tuna meat were added the same amount of ingredients like: garlic, red paper, black pepper, lemon grass and salt. Product/Sample A added 40 ml coconut milk and Product/Sample B added 60 ml grounded pilinut.

Filling the Glass Jars - The 140 grams' tuna meat was filled to the 8 oz glass jar added with the filling media leaving a 1-inch headspace between the pieces and the top of the jar.

Bottling Process - After filling the glass jars will be sealed loosely. The jars were processed at 121ºC (Pressure 15 psi) with a process lethality (F_0) of 5 minutes for, 75 using the pressure canner. The process was replicated three times.

Microbiological - All samples were subjected for commercially sterility tests at the Department of Science in Technology Laboratory.

Chemical Analysis & Nutrifact Analysis - Proximate composition and nutrifact analysis of all the content of the thermal process tuna with coconut and pili nut oil in bottled 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

III. RESULTS AND FINDINGS

Commercial sterility of the Thermal Process of Yellowfin Tuna (*Thunnus albacares*) in coconut oil and with Pilinut oil (*Canarium Ovatum)* in 8 oz glass jar. Commercial sterility refers to the absence of microorganisms capable of growing in the food at normal non-refrigerated conditions at which the food is likely to be held during distribution and storage (Codex Alimentarius; CAC/RCP 40–1993 (Anonymous, 1993) [14]. This is achieved by robust process design based on Hazard Analysis Critical Control Point (HACCP) principles (Sperber, 2005) [15] and the verification of the implemented controls measures (Ropkins & Beck, 2000) [16] via commercial sterility testing. In the past, thermal processed products referred mostly to canned products. Today, thermal processes in combination with other preservation processes are applied to a wide range of products and packaging formats (Sanchez-Madrid, 2003; Datta, 2018) [17-18].In this study samples were subjected for commercial sterility tests. Thermally processed **Yellowfin** (*Thunnus albacares*) in an 8 oz glass jar with pili nut oil (Sample 1) and coconut oil (Sample 2). Sterility test was repeated 6 times for every sample. results showed that for sample 1 and sample 2 there was no growth of anaerobic or aerobic microorganisms at 35ºC and 55ºC. In accordance with TM-M-008 with reference to AOAC 990.12, 21st Ed Anonymous, (2019) [19]. all formulations used in this investigation for not having growth in any of the conditions are considered to have had a satisfactory commercial sterility test.

Chemical Analysis of Fresh White Meat of Yellowfin Tuna (*Thunnus Albacares*) Caught in Lagonoy Gulf

Generally, fish is made up of 70-84 percent water, 15-24 percent protein, 0.1-22 percent fat and 1-2 percent minerals and 0.1-1 percent carbohydrate[19,21,22]. Fats from fatty fish species contain polyunsaturated fatty acids (PUFAs) namely, EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) (omega 3 fatty acids) which are essential for proper growth of children and prevent the cardiovascular diseases such as coronary heart disease [6,20,21].

Table 1. Chemical Composition of Yellowfin Tuna Caught in Lagonoy Gulf

Parameters	Quantity (%)
Ash %	1-2.5
Total Fat %	.64-2%
Protein %	27-29%.
Moisture %	71-72 %.

Moisture content of white tuna meat was found to be in the range of 71-72 %. Crude protein content of freshly caught yellowfin was found to be between 27-29%. Crude fat in the samples were found to be between .64-2%. Ash content in the samples ranged from 1-2.5%. Similarly, this result is similar to the findings Hadinoto and Idrus (2018[20]) in their research explained that the protein content of yellowfin tuna was 28.34% and lipid content of yellowfin tuna was 0.51%. Kusuma et al (2017[21]] stated that lipid content dropped during the process and frozen storage due to loss of triglyceride fraction caused by lipid oxidation. Generally, Fats from fatty fish species contain polyunsaturated fatty acids (PUFAs) namely, EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) (omega 3 fatty acids) which are essential for proper growth of children and prevent the cardiovascular diseases such as coronary heart disease [22,23,24]. Furthermore, ash content contained in fish bodies is influenced by mineral content found in live fish habitat (Suwandi et al 2014) [25].

Proximate Chemical Analysis of Thermal Processed of Yellowfin with Coconut and Pilinut Oil in 8 oz glass jar

Table 2. Comparison of Proximate Chemical Analysis of Thermal Processed **Thermal Processed of Yellowfin** with Coconut and Pilinut **Oilin 8 oz glass jar**

Parameters	Thermal Processed Tuna in Coconut Oil (Sample A)	Thermal Processed Tuna in Pilinut Oil (Sample B)
Ash %	1.54	1.74
Total Fat %	20.40	21.97
Protein %	19.18	21.61
Moisture %	55.01	51.27
Carbohydrates %	3.87	3.41

The proximal chemical analysis for thermal processed tuna in 8 oz glass jars were carried out by the AOAC methods (Table 2). Results showed that thermal processed in pili nut oil has lower moisture content (51.27) as compared to thermal processed in coconut oil (55.01) (Table 2). The data also revealed that the total fat percentage for both products is very much higher that ranges from 20.40 to 21.97, respectively. This is attributed to the use of coconut and pili nut oil as the filling medium. According to Saoud et al., 2008; Rafflenbeul, 2001 cited by Bigueja, et.al, 2021[the percentage fat content observed during this study indicates that different canned fish have very high percentage of fat, one of the most important natural sources of polyunsaturated fatty acids and a rich source of vitamins A, D, E, and K which are soluble in oil, have been proven to have useful effects on human health and metabolism[26,27,12]. When oil is employed as a filling medium, interactions between fatty acids from the filling oil and the lipid fraction of the fish muscle occurs. There is in the flesh lipids a steep increase of the relative proportion of fatty acids abundant in the filling oil (Aubourg, S. P., 2000) [28]. The average protein content of the two samples was 19.18% and 21.61% for sample A and Sample B. respectively, however this result satisfies the criteria specified for high-quality animal products {WHO, 20077} [29]. Further this percent amount of protein is lower as compared to the average protein content of fresh tuna due to the application of thermal treatment like pre-cooking and heat sterilization. Aubourg SP. (2001); Bindu J. (2009) stated that thermal treatment denaturates the muscle proteins and thus decreases their water holding capacity which results in releasing a considerable amount of water to the surrounding medium [30,31].For ash content of the final product, Sample A & B was 1.54% and 1.74% respectively, these results could be attributed to the use of salt added to the filling medium.

Interestingly, Carbohydrates content in both samples were traced at minimal amounts ranging from 3.41 to 3.87, this may be due to the use of nut oil and other ingredients used as the filling medium in the bottled products. Carbohydrates are the main source of energy for the body which occurs naturally in fruits, vegetables, nuts, seeds, beans, and whole grains (Kubala, J. (2020) [32].

3.4 Mineral Composition of Thermal Processed of Yellowfin with Coconut and Pilinut Oil in 8 Oz Glass Jar

Table 3. Comparison of the Mineral Composition of Bottle Smoked Sardines in Oil and Tomato Sauce

Parameters	Thermal Processed Tuna in Coconut Oil (Sample A)	Thermal Processed Tuna in Pilinut Oil (Sample B)
Sodium, mg/100g	566	1,352
Potassium, mg/100g	206	352
Calcium, mg/100g	383	680
Iron, mg/100g	1.6	2.71
Zinc, mg/100g	1.25	1.69

Mineral composition was determined using the Microwave Plasma-Atomic Emission Spectroscopy (MP-AES). It was observed the sodium is very much higher in Sample B (1,352) which may have been attributed to the addition of sodium chloride (salts) and other condiments during thermal processing of the products. The main role of these minerals can be described as structural and functional. Structurally, they stand out for their role as integrators of organic compounds in the body, while functionally, they are important in controlling biological functions (Ozden et al., 2010 cited by Bigueja, et.al. 2020) [33,12].

Nutrition Facts of Thermal Processed of Yellowfin with Coconut and Pilinut Oil in 8 oz glass jar(%Daily Value)

Table 3. Nutrition Facts Computation (%Daily Value) Bottled tuna with Coconut oil

Nutrition Facts Serving size 1/3 cup (55g) Serving per container 4			
Amount Per Serving		**Per 100g**	
Calories 150		**Calorie** 280	
Calories from Fat 100	**% DV**	**Calories from Fat** 180	**% DV**
Total fat 11g	17%	20g	31%
Sodium 105mg	4%	190mg	8%
Potassium 250mg	7%	450mg	13%
Total Carbohydrates 2g	1%	4g	1%
Protein 11g		**19g**	
Calcium	0%		2%
Iron	6%		10%
Zinc	4%		8%
*Percent daily values are based on 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie need			
Calories	**2,000**	2,500	
Total Fat	Less than 20g		25g
Cholesterol	Less than 300g		300g
Sodium	Less than 2,400g		2,400g
Total Carbohydrates	300g		375g
Dietary fiber	25g		25g
Calories per gram:			
Fat 9	*** Carbohydrates 4**		***Protein 4**

Table 4. Nutrition Facts Computation (%Daily Value) Bottled tuna with and pili nuts oil

Nutrition Facts Serving size 1/3 cup (55g) Serving per container 4			
Amount Per Serving		**Per 100g**	
Calories 150		**Calorie** 280	
Calories from Fat 100	**% DV**	**Calories from Fat** 180	**% DV**
Total fat 11g	18%	20g	34%
Sodium 105mg	4%	160mg	7%
Potassium 250mg	7%	470mg	13%
Total Carbohydrates 2g	1%	3g	1%
Protein 12g		**22g**	
Calcium	20%		2%
Iron	6%		10%
Zinc	4%		8%
*Percent daily values are based on 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie need			
Calories	**2,000**	2,500	
Total Fat	Less than 20g		25g
Cholesterol	Less than 300g		300g
Sodium	Less than 2,400g		2,400g
Total Carbohydrates	300g		375g
Dietary fiber	25g		25g
Calories per gram:			
Fat 9	*** Carbohydrates 4**		***Protein 4**

The nutrition facts were computed on the Percentage daily value. Nutrition facts are usually found on the labels of food products. The nutritional information found on a food label is based on one serving of that particular food. In this study, the serving size is 1/3 cup (55g) and serving per container is four (4) and percent daily values are based on a 2,000 calorie diet. However, your daily values may be higher or lower depending on your calorie needs (bigueja, et.al, 2020) [12]. The calorie in this study per serving is 220 and 410 per 100 grams. Since there are 4 servings per container therefore if you eat the content of the container you have an equivalent of 880 calories which is less than the daily values of 2,000. Hence, eating these products can be attributed to good daily consumption. Interestingly, based on the USFDA- NLR, the daily recommended value for fat, sodium and carbohydrates is less than 20g, 2,400g and 300g respectively. In this study, the total fat is 25g, sodium is 300g and carbohydrates is300g which results is within the recommended limit. Hence this Thermally processed yellowfin tuna with coconut and pili nut oil in 8 oz glass jar can be recommended as part of the diet of an individual.

Both samples contained appreciable concentrations of sodium, calcium, potassium, iron and zinc which indicates that these fish are a good source of minerals. In this present study, bottled tuna in coconut and pili nut oil has about 250mg potassium per 100 gm. Potassium is a vasodilator which helps lower blood pressure. Tuna fish is an excellent source of niacin and other Vitamin B complexes that support healthy functioning of the heart. The American Heart Association (AHA) recommends 1 gram of Eicosapentaenoic (EPA)+Docosahexaenoic (DHA) per day for people with heart disease. Doses between 2 to 4 grams **per day** are recommended to lower triglycerides. 100gm tuna fish have hardly 0.5gm fat and 0.1gm of EPA+DHA Thus, it is far-fetched to say that tuna supports the heart due to its omega-3 fatty acids. (Meeta Agarwal.,2017) [34].
Zinc is also traceable in the sample. (Vidyavati, etal., 2016 cited by Bigueja, et.al, 2020) [35-12] Stated that zinc is also an essential trace element for health used in diarrhea, respiratory infections & malaria too. Zinc is essential for the body's good immune system, hormone secretion, mental wellbeing, fetal growth, and normal body development. Further, calorie content is very limited which can be recommended to be added in daily food intake.

Nutrition Facts Thermal Processed of Yellowfin with Coconut and Pilinut Oil in 8 oz glass jar(%RENI)

Table 5. Nutrition Facts Computation (%RENI) Bottled tuna with Coconut oil

Nutrition Facts Serving size 1/3 cup (55g) Serving per container 4		
Amount Per Serving	%DV	%RENI
Calories 150		
Calories from Fat 100	8%	6%
Total fat 11g	17%	
Sodium 105mg	4%	
Potassium 250mg	7%	
Total Carbohydrates 2g	1%	
Protein 11g	15%	27%
Calcium	0%	0%
Iron	6%	8%
Zinc	4%	10%
*****Percent daily values are based on 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie need *Percent RENI values are based on a 2015 PDRI reference of a male adult 19-29 years of age with 2530 calorie need.		
Calories	2,000	2,500
Total fat	20g	25g
Sodium Less than	300 mg	300mg
Potassium Less than	2,400mg	2,400 mg
Total Carbohydrates	300 g	375mg
Dietary Fiber	25g	30g

Table 6. Nutrition Facts Computation (%RENI) Bottled tuna with and pili nuts ..

Nutrition Facts Serving size 1/3 cup (55g) Serving per container 4		
Amount Per Serving	%DV	%RENI
Calories 160		
Calories from Fat 110	8%	12%
Total fat 12g	18%	
Sodium 90mg	4%	
Potassium 260mg	7%	
Total Carbohydrates 2g	1%	
Protein 11g	17%	31%
Calcium	0%	2%
Iron	6%	8%
Zinc	4%	10%
*****Percent daily values are based on 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie need *Percent RENI values are based on a 2015 PDRI reference of a male adult 19-29 years of age with 2530 calorie need.		
Calories	2,000	2,500
Total fat	20g	25g
Sodium Less than	300 mg	300mg
Potassium Less than	2,400mg	2,400 mg
Total Carbohydrates	300 g	375mg
Dietary Fiber	25g	30g

In this study, the computation for RENI was based on a 2015 PDRI reference of male adult 19-29 years of age with 2530 calorie needs. The calorie in this study per serving is 220 and 410 per 100 grams. Since there are 4 servings per container therefore if you eat the content of the container you have an equivalent of 880 calories which is less than the daily values of 2530. Hence, this product is recommended for daily consumption particularly for adult male 19-29 years old. Moreover, based on the standard of other mineral elements, the sample is within the standard. Hence, this is good to be included for daily intake of an adult individual. Sample B (Table 5). has about 12 g per 55g which is higher to Sample A (Table 6). which has 11g per 55 gram. (Table 6) the total fat (4g) is lesser than Sample A (20g) (Table 5). On the other hand, sodium has 105mg per 55gram for Sample A and 90mg per 55g for Sample B. this result indicates within the range of the standard (Philippine Dietary Reference Intake (PDRI), 2015) [36]. Sodium is a compound of many foodstuffs, for instance of common salt, it is necessary for humans to maintain the balance of the physical fluids system, and is also required for nerve and muscle functioning. Too much sodium can damage our kidneys and increase the chances of high blood pressure. The amount of sodium a person consumes each day varies from individual to individual and from culture to culture, some people get as little as2g\day, some as much as 20-gram e. Sodium is essential, but controversially surrounds the amount required (Munteanu, C and Iliuta, A., 2011) [37]. Hence, this product can be recommended as part of the diet of an adult individual**.**

IV. CONCLUSION

Theproducts were thermally processed with Coconut and Pilinut Oil in 8 oz glass jaratthe same time and time and temperature. The product had a satisfactory commercial sterility. The BottledYellowfin with Coconut oil and Pilinut Oil have high nutritive value in terms of protein, fats, minerals and carbohydrate. Both samples had adequate percentage amounts of protein adequate for infants and adults; they were low in calories, high in protein, potassium and calcium; with a varied amount of sodium which is of no significant health implications. Hence this product can be recommended as part of the daily individual diet.

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