Optimization of Bottled Rice-Fish Ready-To-Eat (RTE) Food

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***Abstract*—** Sooner or later most households face a natural disaster that causes a food emergency. A typhoon, earthquake and flooding may create food safety and supply problems never before encountered. The emergency may be more ordinary, such as a power failure during a thunderstorm or severe weather or illness that prevents people from getting to the store. Whatever the cause, emergencies demand a knowledge of food safety. To keep food safe and avoid foodborne illness, people need to know what foods to store before a natural disaster, as well as how to handle food afterwards. It is important to stock food that does not require refrigeration. Canned or bottled foods are best preserved products that can be used during disaster.

The purpose of this new developed food product on Rice-Fish Ready-to-Eat Food is intended to be consumed during disaster. The rice cooked with coconut milk and added with steamed or smoked fish and other spices were packed in bottles purposely to improve the nutritional value and lengthen the shelf life so that it can be used during disaster. The quality of the product was evaluated by sensory assessment. Experimental method was used consisting of two (2) parts. First, optimizing the RTE recipes before using thermal processing, four (4) types of recipes were prepared. The rice-fish based RTE food may be bottled with or without coconut milk and added with steamed or smoked fish. Added spices to the product improve the nutritional value and provide health benefits. The product may be processed at 121oC (Pressure 15 psi) at varying time either 45, 40 and 75 minutes. Subjecting the product to thermal processing, the product is safe and lengthens the shelf life hence it can be used during disaster. Therefore, this new product should highlight the health benefit, the convenience of processing and the sales price also be considered.

***Keywords*—** Optimization, Bottled, Rice-Fish, Ready-Eat. Food.

I. INTRODUCTION

Bottled Rice-fish based Ready-to Eat (RTE) as functional food is a new product from the combination of rice and fish wherein rice is cooked using coconut milk. Cook rice and smoked tilapia were sautéed. Other ingredients and herbs are added to improve the quality and palatability of ready-to-eat food. Products were subjected to sensory evaluation. The present study is similar to “arroz caldo”; the only difference is that the present study was packed in an 8 oz glass jar and subjected to thermal processing.

Canning method was used so that the products will be stable for a long period of time. Canning or thermal process is of great technological importance in many countries of the world particularly in the Philippines. Canning or bottling smoked fish requires a processing (Bigueja, et.al., 2020) [1].

According to Murthy et al., (2011) [2] cited by Bigueja, et.al., (2021)[3]. Tilapia is a popular freshwater fish due to their nutritional benefits and wide availability. Intensive tilapia farming in Asia has increased steadily and become an important source of fish within the last few years. In this study, tilapia became more palatable. Fish smoking is one of the most common methods of fish processing known as “tinapa”. Smoked processing aims to preserve fish by lowering moisture content, enhancing smoke flavor as well as improving its appearance. (Bigueja et.al, 2010)[4]

The Philippines is one of the most disaster-prone countries worldwide. Bicol Region is regularly exposed to a variety of natural hazards including tropical storms, typhoons, droughts, drought spells, flash floods, floods, landslides and volcanic eruptions, causing frequent destruction, damage and losses (Mascarinas, A.M., et.al.2013) [5]. During the disaster, there was no food, limited water, no electricity and no refrigeration. In many cases cooking may be impossible during natural disasters due to the lack of facilities or fuel. Poor sanitation, including lack of safe water and toilet facilities, can compound the risks (INFOSAN, 2005) [6]. Therefore, affected persons during calamities are at risk through malnutrition. Planning of what to eat during a disaster will help assure to provide nutritious and safe food to the affected persons. Moreover, currently the world is suffering from the effect of COVID-19 pandemic aggravated food insecurity and undernourishment through disruptions to food supplies and loss of income, with an additional estimated 83–132

million people becoming undernourished (FAO et al., 2020) [7].

As such, people need to have a full attention in eating one dish meal to provide all the nutrients needed by our body like rice (Oryza sativa). It is a dietary staple food and one of the most important cereal crops, especially for people in Asia, and the consumption outside Asia has increased as reported by Orthoefer, 2005[8]. It provides the bulk of daily calories for many companion animals and humans (Ryan, 2011) [9]. The unique taste of rice provides an easy way to combine rice with the other food to achieve better taste and nutritional balance. In addition, lots of Filipinos are all fond of eating rice fish because they believe that rice provides energy and fish provides protein and many other nutrients which are required by our body.

Fish plays a significant role in a healthy and balanced diet. Its intake has a lot of health benefits. Fish provides various nutrients, including protein and long-chain omega-3 polyunsaturated fatty acids and micronutrients (Ubaid, Q. et.al.,2020) [10]. Mixing the Rice and Fish as a one dish meal would be more beneficial not only for those people affected by natural disasters but also for the populace.

Ready to eat foods (RTE) are convenience foods, enclosed in aluminum containers or bottled that only need to be cut and heated before being served. Instant vegetables in bottled fall under this category and find application not only as home meal replacement in working class households but also in fast-food restaurants and multi cuisine food joints. These are handy meals for armed forces and paramilitary forces deployed in remote places (Muktawat, P. and Varma, N., 2013) [11]

The idea of producing bottled rice- fish RTE food is purposely intended to supply during the time of disaster wherein the affected individuals will no longer cook their food. These rice- fish RTE foods were developed and intended to be consumed as they do not require reheating before serving, hence for people in the midst of problems during disaster it will be convenient for them to provide food to their children.

II. METHODOLOGY

2.1 Materials and Methods. The researchers applied experimental methods of research. A new Ready–To–Eat (RTE) Food product was developed using the combination of rice and tilapia fish cooked in a coconut sauce pack in a bottle. The new RTE food was subjected to thermal processing. Thermal processing of food is one of the most important preservation methods in food preservation to extend the shelf-life of foods. Likewise, the products will be subjected to determine the effect of different formulations of RTEs food product at different processing time such as 45, 50 and 75 minutes and will be subjected for sensory evaluation.

2.2 Research Procedures. The researchers will formulate four (4) products (as treatment 1, 2, 3 & 4) (Table 1). Treatment (T1) rice cooked without coconut milk and added with steamed tilapia, Treatment 2 (T2) rice cooked with coconut milk added with steamed tilapia and Treatment 3 (T3) rice cooked with coconut milk added with smoked tilapia. Treatment 4 (T4) rice without coconut milk and added with smoked flakes tilapia. All treatments were the same amount as other ingredients and spices to improve its quality attributes. The preferred formulation of the product was determined through evaluation performed by the researchers and selected panelists. This preferred formulation will used to process three (3) samples of Rice and Tilapia in Coconut Sauce at 121oC (Pressure 15 psi) in varying processing time such as: 45, 60 and 75 minutes The finished products were then subjected to sensory evaluation for quality and acceptability of the product. There were 100 persons from different communities which are usually affected by natural disasters evaluated on the finished products.

Table 1. *Formulation for Experimental Trials*

	T1	**T2**	**T3**	**T4**
Rice cooked without coconut milk	300g			300g
Rice cooked with coconut milk		300g	300g	
Steamed tilapia flakes	30%	30%		
Smoked tilapia			30%	30%
vegetable oil	15%	15%	15%	15%
carrots	8%	8%	8%	8%
garlic	10%	10%	10%	10%
Bell pepper	5%	5%	5%	5%
Refine salt	1%	1%	1%	1%

Black pepper	1%	1%	1%	1%

2.3 Methods of Preparing the RTE Food

2.3.1. Raw Materials. That were used are: 2 cups of rice mixed with one cup of water and coconut milk and one ½ kilo fish meat.

2.3.2. Rice Preparation. The 2 cups of rice were thoroughly washed, added with 1 cup of water and coconut milk was cooked for 30 minutes.

2.3.3. Fish Preparation. The tilapia fish was dressed, cleaned, washed and soaked in 10% brine solution. Soaking the fish in brine solution the blood will be removed and add flavor to the fish. The brined fish was steamed and smoked for 45 minutes.

2.3.4. RTE Preparation. The garlic and onion will be sautéed in corn oil until the color becomes light brown and the rice, steamed or smoked flakes tilapia, green peas, pickles, bell pepper, raisin, refined salt and black pepper were added and continue heating for 5 minutes. RTE were set aside.

2.3.5. Filling and Sealing. The RTE food was into 8oz glass jars with ½ head space. The filled glass jars were exhausted for 15 minutes.

2.3.6. Bottling process. After filling the glass jars will be sealed loosely. The jars were processed at 121oC (Pressure 15 psi) with a process lethality (F0) of 5 minutes for 45-60, and 75 minutes in a pressure cooker.

2.4 Sensory Analysis. The four (4) formulations were subjected to a preference test and determined using the 9-point hedonic scale (1-dislike extremely, 5-neither like nor dislike and 9-like extremely). The most preferred formulation was used in the determining the characteristics or attributes of the products such as: color, salinity, spiciness and pili nut, coconut, garlic, chili flavor and softness of the product using the just about right scale (1-not enough, 3-just about right or JAR and 5-too much).

III. RESULTS AND FINDINGS

3.1 The Standard formulation in processing the Rice-Fish RTE Food in Glass Jars.

Four formulations were prepared to develop and optimize RTE rice-fish as functional to be used during disaster. In this study, the desired amount of ingredients was achieved processed at 121oC (Pressure 15 psi) with a process lethality (F0) of 5 minutes for 60 minutes in a pressure cooker. Laboratory trials were conducted to determine the appropriate process and proportion of all ingredients. Three (3) products were prepared with or without coconut milk and steamed or smoked tilapia. The products were subjected to consumer testing, a total 30 persons evaluated the products using the 7-point hedonic scale. The results cited in Table 2. The chosen proportion was used in manufacturing products at the same temperature but of different processing / cooking time; 60 minutes, 75 minutes and 90 minutes respectively. The products were then subjected to sensory evaluation, specifically the descriptive evaluation and preference test.

Table 2. *Mean Scores on the Results Sensory Evaluation of the Four Treatments of Bottled Rice-fish RTE food*

Attributes	T1	Description	T2	Description	T3	Description	T4	Description
Odor	4.87	Slightly strong	4.57	Slightly strong	4.07	Ideal	5.43	Moderately strong
Flavor	4.20	Slightly Sweet	4.30	Slightly Sweet	4.07	Slightly Sweet	5.45	Slightly Salty
Taste	4.85	Slightly Strong	4.52	Slightly Strong	3.96	Ideal	5.42	Slightly Strong
Texture	4.85	Moderately tender	4.49	Moderately tender	4.07	Slightly tender	5.00	Moderately tender
Color	4.84	Liked	4.52	liked	4.08	Neither or dislike	5.47	liked extremely
Gen. Acceptability	4.77	liked	4.43	liked	4.02	neither or dislike	5.50	liked extremely

Legend: T- Treatment

To determine the best treatment of rice-fish RTE food the Table 2 showed the summary of mean scores on the sensory attributes of Treatments of processing bottled RTE food. It was noted that the odor and taste of T3 was rated ideal with the rating of 4.07 and 3. 96 respectively. The flavor of T1, T2 and T3 was rated slightly sweet while T4 was rated slightly salty. The texture T1, T2 and T4 rated moderately tender and, On the other hand, the color treatment without coconut milk and added with smoked tilapia was rated extremely. These results may be that the stability of coconut milk was not achieved since emulsification of coconut milk was not applied in this study. Some researchers stated that the most commonly used methods to improve the stability of coconut milk are using emulsifying agents and surface-active stabilizers such as protein, sucrose esters, Tween, sodium carboxymethyl cellulose, and sodium dodecyl sulfate (Ariyaprakai et al., 2013; Thanatrungrueang & Harnsilawat, 2019; Tangsuphoom & Coupland, 2008) [12,13,14]. Hence, to improve the color and appearance of the present, developing RTE using coconut milk should undergo a process of emulsification of the coconut milk. On the other hand, Odor of T3 and T4 was ideal and moderately strong respectively; this may be due to the effect of smoked odor since T3 and T4 were added with smoked tilapia.

Generally, this result indicates that among the three treatments, the RTE without coconut milk and smoked tilapia are the most acceptable. Hence, the preferred formulation of bottling RTE was 300 grams cooked rice without coconut, 30% of smoked tilapia, 15% vegetable oil, 8% carrots, 10% garlic. 5% bell pepper and 1% refined salt and black pepper. The best treatment was then undergoing several treatments at the different time and the same temperature (121oC (Pressure 15 psi).

Table 3. *Summary Descriptive Characteristics of Bottled Rice-Fish RTE Food process at 2500F at Varied Processing*

Characteristics	**Processing Time**					
	45 Minutes		60 Minutes		75 Minutes	
Saltines	2.4	Just Right	2.0	Just Right	2.4	Just Right
Color	2.8	Just About Right	2.4	Just About Right	3.5	Brown yellow
Rice Flavor	2.8	Just About Right	2.4	Just About Right	2.9	Just About Right
Chili Flavor	2.5	Just About Right	2.5	Just About Right	2.5	Just About Right
Coconut Odor	3.6	Moderately Distinct	2.5	Just Right	2.5	Just About Right
Appearance	2.8	Just About Right	2.4	Just Right	2.9	Just About Right
Firmness	3.6	Moderately Firm	2.2	Just Right	1.6	Just Right
Mean	2.93	Just About Right	2.34	Just Right	2.61	Just About Right

3.2 Sensory Evaluation of Bottled Rice-Fish RTE food at varying temperature time

The results of the sensory evaluation on the descriptive test on the different attributes are presented in Table 3 likewise the result of the Analysis of Variance (ANOVA) or F – test is presented in Table 4. Thermal processing is applied in this new develop RTE food to ensure food safety without sacrificing the quality of the product. Hence it is necessary to undergo experimental procedures to ensure that the products are safe and quality. According to Dewan, F, (2020) [15] that Thermal treatment uses the application of heat to preserve food by destroying pathogenic and spoilage microorganisms, and denaturing the toxins and enzymes present in food. Sterilization is a high heat treatment practiced mainly in canned food for long time preservation. Sterilization implies the complete destruction of all living microorganisms including spores (Kumar & Sandeep, 2014) [16]. This term is commonly used in case of canned or bottled food products.

Table 3 shows characteristics of bottled products in varied processing. The come up time for the product to reach 121°C was 5-10 minutes. After attaining 121°C the product was subjected to steam-air mixture (10Psi + 5Psi) until the product temperature reached 118°C in 15 minutes.

The results of sensory evaluation on coconut odor showed that processing time changed its coconut odor. The products processed in forty-five (45), sixty (60) and Seventy-five (75) minutes were rated 2.9 (Just About Right), 2.4(Just Right) and 2.8 (Just About Right) respectively. It can be deduced that coconut was identified regardless of the length of time it was processed. However, 60 minutes of processing is just right. It also indicates that the color of the product at 75 minutes was rated 3.5 or brown yellow. Similar findings were discussed by Chiewchann, N., (2006) [17]. Sterilizing at 121.1°C for 60min could provide an acceptable color compared to fresh coconut milk while heating at lower temperature but for a longer time permitted more browning reaction and resulted in

an increase of b value. Overall, the results suggested that quality of canned high fat coconut milk in terms of rheological and optical properties was influenced by both homogenizing pressure and sterilizing condition.

The firmness of the product shows that in all levels of processing time it was described by the panelists that the product is tender or Just about right this means that although the products were subjected to various processing times the flesh remains tender, therefore the flesh has a good texture. Bao J.S., (2016)[18] explained that Rice eating quality depends on the texture and flavor of the cooked rice or rice products. The texture of the cooked rice can be expressed in terms of hardness or firmness and stickiness or adhesiveness and moistness to touch, while the flavor can be expressed in terms of aromatics, taste, and mouthfeel. The eating quality can be directly characterized and measured with descriptive sensory analysis and textural instruments or indirectly predicted with a series of physicochemical property evaluations. Similarly, Luh, B.S., 1994 [19] stated that there are types of canned rice products on the market including soups with rice, meat and rice dinners, casseroles, Spanish rice, unflavored cooked rice, fried rice, and rice pudding.

Rice with a high protein content takes a long time to cook because of the physical barrier to water absorption created by the protein matrix around starch granules. Low-protein rice is more tender, more cohesive, and sweeter than high-protein rice. Parboiled rice is often used in preparing canned-rice products because of the stability of the kernel and the retention of its shape without disintegration under rigid retorting and heating conditions. Other factors that may affect the quality of canned rice include pH, fat content, salt concentration, and blanching time19].

Consumers always look for appealing attributes on new foods (Zhao, S. et.al., 2019) [20]. Therefore, this new product should highlight the health benefit, the convenience of processing and the sales price also be considered.

It was noted that the processing time does not change the saltiness, Spiciness, Garlic Flavor and Chili Flavor of the product. Spices were used in these Rice-Fish based RTE products not only to enhance the flavor but also for medical purposes. Food safety and unhealthy food have been the issues during the disaster. Hence, adding species to the processed products like RTE food would be beneficial to those people affected by disasters (natural calamities and pandemic). Spices and herbs have been in use for centuries both for culinary and medicinal purposes. Spices not only enhance the flavor, aroma, and color of food and beverages, but they can also protect from acute and chronic diseases (Jiang, T. A. 2019) [21]. Culinary herbs and spices are foods that are a rich source of bioactive molecules such as sulfur-containing compounds, tannins, alkaloids, phenolic triterpenes, and vitamins, especially flavonoids and polyphenols (Yashin, A. et.al., 2017; Opara, E.I., 2014)[22, 23]. There is now ample evidence that culinary herbs and spices are sources of constituents that possess antioxidative, anti-inflammatory, antitumorigenic, anticarcinogenic, and glucose- and cholesterol-lowering activities as well as properties that affect cognition and mood, which are actively used in preclinical, clinical, and therapeutic trials investigating new treatments of diseases.

Furthermore, It was found that frequent consumption of spicy foods was also linked to a lower risk of death from cancer, ischemic heart diseases, and respiratory diseases, and this was more evident in women than in men. People who consumed fresh chili tended to have a lower risk of death from cancer, ischemic heart disease, and diabetes (Chopan, M., & Littenberg, B.,2017; Chen, Y.H., et.al., 2017) [24,25]. Black pepper contains from 5 to 9% piperine, the major active constituent. Black pepper also contains alkamides, piptigrine, wisanine, and dipiperamide (Kapoor, I.P.,et.al., 2009)[26]. Black pepper or piperine treatment has also been evidenced to lower lipid peroxidation in vivo and beneficially influence cellular antioxidant status in a number of experimental situations of oxidative stress (Kaleem, M., et.al., 2005; Vijayakumar, R.S., & Nalini, N.,2006)[27,28]. Garlic has traditionally been used to promote cardiovascular health through a variety of mechanisms (Butt, M.S., Sultan, M.T., Butt, M.S., & Iqbal, J.,2009; Blumenthal, M., Busse, W., & Goldberg, A., 1998; Kwak, J.S., 2014)[29,30,31] Evidence from in vitro, animal, and human research has shown that taking garlic may slow the development of atherosclerotic process (hardening of the arteries; (Budoff, M.J., et.al., 2009; Efendy, J.L., et.al., 1997) [32,33], a condition that can lead to heart attacks and strokes, by beneficially reducing fatty streak formation in blood vessels and atherosclerotic plaque size (Ferri, N et. al., 2003; Durak, I et.al., 2002) [34,35]. With the health benefit of spices used in this new developed product this can be of benefit to be served to people affected with natural calamities and pandemics where there is a lack of food or sometimes no food supply. Hence this can be reduced to the problems of the government on food security during disaster and pandemic.

Table 4. *Results of Analysis of Variance (ANOVA) on the Different Sensory Attributes of Bottled Rice-Fish RTE Food*

Attributes	F	P-value	Decision
Saltines	4.110532	0.024667	Not Significant
Spiciness	6.657534	0.003466	Not Significant
Garlic Flavor	3.56087	0.038807	Not Significant
Appearance	0.346154	0.709732	Not Significant
Coconut Odor	0.346154	0.709732	Not Significant
Texture	0.346154	0.709732	Not Significant

3.3 Significant Difference on the Sensory Attributes of Bottled Rice-fish RTE food in Coconut Sauce

The result of the sensory evaluation was subjected to the F – test and it was computed using a five percent (5%) level of significance. The results of the F – test of the sensory attributes of the Rice-Fish Ready-to-Eat Food are shown in Table 4.

As reflected in Table 4, the p-value of all Attributes are greater than the ($p<0.05$) level of significance therefore the null hypothesis is accepted. Hence, the RTE food processed at different times has no significant difference. This result implied that RTE food can be processed at 45, 60 and 75 minutes and is acceptable to the consumers. However, it is also recommended that products should be subjected to shelf life analysis because storage time can affect the keeping quality of the product.

VI. CONCLUSIONS

The rice-fish based RTE food may be bottled with or without coconut milk and added with steamed or smoked fish. Added spices to the product improve the nutritional value and provide health benefits. The product may be processed at 121oC (Pressure 15 psi) at varying time either 45, 40 and 75 minutes. Subjecting the product to thermal processing, the product is safe and lengthens the shelf life hence it can be used during disaster. Therefore, this new product should highlight the health benefit, the convenience of processing and the sales price also be considered.

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