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EFFECT OF THERMAL PROCESSING ON THE SENSORY QUALITY, PHYSICO-CHEMICAL PROPERTIES AND STORAGE STABILITY OF THE CANNED AND POUCHED FORMULATED CONGEE

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ABSTRACT

This research was conceptualized to develop locally available cheaper meat product and under-utilized grains as the main ingredient in formulating congee as a disaster food product. The potential of formulated congee packaged in tin can and retort pouch to be a suitable emergency relief food during and after disaster were studied through evaluation of its sensory quality and storage stability. But the presence of microorganism and bacteria are dangerous for human health, usually observed in canned and pouched product. It is important that strict hygienic procedures be followed when process food was packed in cans or pouches. One way to address these problems is through thermal processing. Furthermore, processed samples were analyzed for their physico-chemical and microbial properties to facilitate the factors ensuring nutritional and safety for consumption. Commercial sterility test showed negative results, indicates that samples were commercially sterile and efficient processing was achieved. The established processing schedule at 121.1ºC retort temperature were 46 and 37 minutes for canned and pouched congee, respectively. Changes in their physico-chemical properties and highly acceptable rating for sensory attributes were observed significantly after thermal processing. At 30ºC storage temperature, the estimated shelf-life (Q10 approach) of the canned and pouched formulated congee were 169 and 288 days, respectively. Thus, thermal processing extend the storage stability of the product.

Keywords: Commercial sterility, formulated congee, heat penetration, ready to eat meals, storage stability, thermal processing, sensory quality

1. INTRODUCTION

In essence, natural disasters, namely: earth quakes, typhoons, floods and volcanic eruption, tremendously hits many Southeast Asian countries such as Philippines which is predominantly affected and is termed by United Nations as the third of the most disaster-prone counties in the world [1]. One of the needs for attention is the difficulty in preparing food because of the absence of electricity, clean water, and fuel. Most of the products given to disaster victims are canned sardines, canned corn beef, and instant noodles. These lack nutritional value. Therefore, it is important to find other suitable food products. Distribution of relief goods is also a primary concern. There were four categories of relief foods: Types A, B, C and D. Type A products are readily consumed without drinkables and are advantageous when electricity and water utilities are unavailable. Those food products that do not require preparation but require drinkables fall under type B; examples of which are canned foods. Type C relief goods specifically require hot water in food preparation, for instance, cup noodles. On the other, type D foods are those that require cooking and are typically distributed only when water and other utilities are accessible. Congee is a type D relief good which is commonly served at evacuation areas. Noodles and canned products are commonly distributed during relief operations but do not provide the necessary daily nutrient intake. Hence, there is a need to distribute ready-to-eat foods that do not compromise nutritional needs despite unforeseen circumstances.

In response to the challenge of food security during and after disasters this research addresses to transform Type D products into Type A products to provide shelf-stable ration, nutritious, safe and adequate grain-based food that does not need cooking and can be immediately opened then eaten. Thus, this research was conceptualized to develop locally available cheaper meat (duck) product and under-utilized grains (adlai and glutinuos rice) as the main ingredient in formulating congee as a disaster food product. Congee is one of the food products that can be used as food rations. Congee is a rice-based porridge usually made up of glutinous rice cooked in excess water with a range of spices depending on the location. Typically, eaten during morning and served to sick persons for they can easily be swallowed due to its thin soup characteristics. It is consumed in Asian countries particularly in China, Japan and Philippines and it contains high amounts of calories. Congee is well-known in Philippines termed as “Lugaw”. Nevertheless, it has a relatively short shelf-life and cooking it is a drawback with the occurrence of electrical and water interruption. For these reasons, the Department of Science and Technology developed a canned chicken *arroz caldo* to resolve the immediate need of calamity victims [2]. Moreover, the Philippines is also experiencing rice shortage despite being an agriculture-based country thus emphasizing the need to find ways to lessen the consumption of rice products. Therefore, it is only practical to explore possible food applications of other indigenous materials with reasonable shelf life.

Adlai (*Coix lacryma-joibi L.*) may be an indigenous and unfamiliar cereal grains grown in the Philippines but this plant could address the food requirement of Filipinos especially, during calamities. Some local tribes and farmers from Zamboanga del Sur have been planting and eating adlai just like same manner as rice. *Adlai* can be dish up as an alternative for rice-based food product. It is also used in making porridges, pastas and bread when ground into flour. Adlai seed can also be processed to make tea. According to farmers, its production was traditional yet sustainable,[3].There have also reports that it was being planted in some parts of the country however it has not yet been well documented and given priority until now. It is potentially suitable for use hence this crops resembles and tastes like rice. It contains higher food energy, carbohydrates, protein, fat and dietary fiber directly compared to rice and corn. *Adlai* is packed with other minerals also, such as: calcium, phosphorus, iron, niacin, thiamine, and riboflavin.

Improvement on the utilization and consumption of these cereal grains will significantly contribute to the household food security and nutrition of the Filipino people.

On the other hand, the meat from duck (*Cairina moschata*) contains protein, fats, and minerals. It helps boost protein intake which supports the immune system as well as aid in the regulation of hormomes and enzymes for growth and maintain body tissues. The fat composition of duck meat is mostly unsaturated fat which has a function in lowering cholesterol level and as an antioxidant. Duck meat also increase minerals ingestion such as selenium and zinc, both of which play a role in enzyme function and activation needed for cellular metabolism. Zinc boost the immune system while selenium helps maintain the thyroid.

Adlai, glutinous rice and duck meat can provide several desirable compounds. The combination of the three main ingredient may have a synergistic advantage and strengthens one's health during disaster. Development of food product such as canned and pouched disaster-based product could provide the immediate concern of distributing food rations during calamities. But the presence of microorganism and bacteria, usually observed in canned and pouched food product, are dangerous for human health. *Bacillus cereus* is usually observed in spoiled bread dough or rice-based products [4], thus the possibilities of this bacteria may also be detected in the *adlai*-based food product. This microorganism is capable of forming endospores which can resist high temperature and dry environment. Also Botulism is a disease caused by the bacterium *Clostridium botulinum*. This organism thrives in environments which lack oxygen, such as improperly canned and pouched goods, and produces a nerve toxin that can cause paralysis, including respiratory paralysis. It is important that strict hygienic procedures be followed when process food are canned and packed in pouches. One way to address these problems is through thermal processing of canned and pouched foods. Thermal processing lengthens the shelf-life of foods while ensuring its safety for consumption. In order to establish optimum thermal process conditions for canned and pouched formulated congee and facilitate the factors ensuring the safety of the food product for consumption commercial sterility test was conducted. Furthermore, cooked samples were analyzed for their microbiological properties and sensory qualities. Samples were subjected to thermal processing method and analysis. Changes in their properties and attributes were monitored in the different stage of thermal processing.

Even though adequate thermal processing is done on the product, it naturally undergoes deterioration and later on, spoilage. Therefore, it is important to determine the shelf life of the product or the length of time in which the product is safe for consumption. Moreover, the packaging of the product must be considered because it has the ability to control the shelf life of the product by preventing deteriorative reactions. Retort pouch and metal tin can is the type of packaging material most commonly used by the food processors. Both are shelf-stable pack that is a good barrier against oxygen and water [5]. Part of the product development process is assessing the strength of packaging to withstand several hazards that it may encounter during processing, warehousing, transportation, and distribution [6]. Seals of pouches can easily be disrupted during the processing of the food product especially during commercial sterilization in which retort pouches experience high pressure[7]. Furthermore, the storage condition is a critical factor for the strength of seals in pouches and lacquer quality of cans. In terms of transportation hazards, the formulated food product may undergo over-the-road truck transportation, rail transportation, and aircraft transportation. Throughout the course of distribution, packaged products are exposed to different stresses like shock, vibration, and compression. Cracks and pinholes could arise from the packaging due to the stated transportation hazards [8]. This could lead to decrease in product integrity, product loss and providing an appropriate environment for the onset of food deteriorative reactions. It is vital that the packaging material be evaluated in terms of its performance to respond on the various transportation hazards to ensure that the product arrives in good quality to intended consumers. The study also aims to provide a comprehensive information about its storage stability, and develop appropriate packaging for disaster-based food.

2. MATERIALS AND METHODS

2.1 Materials

The ingredients, spices and condiments used were obtained from grocery stores, supermarket and wet market in Los Baños, Laguna, Philippines.

2.2 Methods

Preparation of Canned and Pouched Congee. Several combination of ingredients, spices and condiments were prepared before achieving the final product formulation for adlai, glutenuos rice and duck congee. Product sensory characteristics and nutritional composition are the basis of the formulation.

Heat Penetration Test. Heat penetration study was conducted using an Ecklund-Harrison needle-type thermocouple connected to the geometric center of the cans and pouches. The tin cans were filled with 220 grams of congee (0.6 cm headspace for can) and were exhausted for 20 min. by placing them in boiling water with sample having temperature reached 80 ^{o}C or higher before sealing the can. For laminated retortable pouches (width: 4", length: 7.5" and gusset: 1.25") same amount 220 grams of congee were filled then immediately sealed. With the use of temperature data logger for heat penetration, sufficient data was obtained for every time interval to construct reliable heat penetration curves. The temperature of the water retort was measured and recorded through the digital temperature indicator. The temperature was set up to 121.1 ^{o}C or 250 ^{o}F and then canned and pouched congee were processed separately until the temperature inside the product reaches 121.1 ^{o}C or 250 ^{o}F. After processing, canned and pouched product were cooled in cold water and at the same time cooling data were also gathered. Data gathered during heat penetration study for time and temperature of processing for canned and pouched congee were graph in an inverted semi- logarithmic paper. General method and Formula method were used to calculate for parameters such as thermal death time (TDT or F_o values), come up time (CUT), heating rate (*fh*), cook time (B) and the corrected cook time (B_B).

Test for Commercial Sterility. The commercial sterility test was carried out according to the standard AOAC method [9] with some modifications . Three (3) samples each of two packaging treatments for formulated congee were incubated for 10 days at 30°C before examination. After incubation, 2 grams of the samples were transferred to 3 tubes each of tryptone broth and modified PE-2 medium. This served as an aerobic medium while the latter was for anaerobic microorganisms. The tubes containing the anaerobic medium were sealed with solidified agar and stored in anaerobic jar to achieve the required condition. Nevertheless, all tubes were incubated for 2 days at 35°C. Another 10 g of each sample was placed into dilution bottles and refrigerated. This served as sample for confirmatory testing if any abnormal growth, odor, pH, and number of bacteria in microscopic examination were observed.

Microscopic examination of the incubated samples was done by heat fixing a thin smear of food on a microscope slide, followed by staining of smear with 1% crystal violet, and washing under running tap water. The adhered smear on the slide was viewed using a compound microscope under oil immersion objective. The possible presence of microorganisms in the incubated samples was determined and the observation was compared to the newly prepared sample. In addition, the pH was also analyzed using a pH meter; the odor was evaluated by sniffing test; and the appearance of the product and the condition of packaging after incubation were assessed visually. The interpretation of the results were done based on the Compendium of Methods for the Microbiological Examination of Foods [10].

Sensory analysis. Affective test in the form of consumer testing was conducted to assess the degree of liking of average Filipino consumers of various age group to the newly developed product. One hundred twenty-five (125) untrained panelists were selected from nearby areas of UP Los Baños that belonged to a specific age group: school children (4-12 y/o), adolescents (13-19 y/o), young adults (20-35 y/o), adults (36-64 y/o), and elderly (>65). The samples were heated before serving, coded, and served to the panelists. A nine-point hedonic scale, ranging from 1 (extremely dislike) to 9 (extremely like) was used to assessed the tasters evaluation of color, aroma, flavor, texture, and aftertaste as well as determine the overall acceptability of the product and the panelists' chosen packaging material (can or pouch).

A spider web plot graphic presentation of all characteristics was used to illustrate the differences and similarities of the descriptive profiles of congee evaluated. This was accomplished by plotting the mean score for a given attribute on an axis that represents the 9-point hedonic scale used on the score sheet. Each axis extended from a center point and depicted a single attribute. The center point was equivalent to the low intensity origin of the hedonic scale, and the highest intensity was equivalent to the end of the axis.

Storage Study. The shelf life of ready-to-eat duck meat congee packaged in can and pouch was determined using temperature accelerated shelf life test (ASLT) [11]. The product was subjected to the following temperatures: 35, 45 and 55°C, with a target shelf-life of 12 months at 30°C. Three representative samples were selected for each incubation temperature according to its pre-determined schedule. In order to estimate the shelf life of the canned and pouched product the parameters evaluated were sensory characteristics and physico-chemical properties such as pH, water activity, color, and consistency. The sampling time and frequency of assessment in each incubation temperature was based on Q_{10} value which was assumed to be 2.5. Microbial analyses (total plate count, yeast and mold count and thermophilic spores) were also conducted at 3 time points, beginning (time 0), mid and end of storage, for each temperature condition. Shelf life was estimated through data extrapolation from the Arrhenius plot wherein the equation of the line was obtained from the rate of reaction and the inverse of storage temperature.

2.3. Experimental Design and Statistical Analysis. All laboratory analyses were expressed as mean values of at least triplicate determinations ± standard deviations. One-way analysis of variance was used to determine the significant differences of all data gathered. The least significant difference test was used to compare treatment means at 5% level of significance using Statistical Package for the Social Sciences (SPSS). An independent-sample t-test was done to compare the sensory characteristics, physicochemical compositions, and shelf life of canned and pouched samples. Completely staggered design was used in the stability study of formulated disaster food packaged in pouches and cans with sub-sampling and repetitions. Random samples were collected every sampling period. A regression analysis was run for each temperature treatment to estimate the shelf life of the product.

3. RESULTS AND DISCUSSIONS

3.1. Formulated Canned and Pouched Congee. Several combination of ingredients, spices and condiments were prepared before achieving the final product formulation for *adlai*-glutinuos rice and duck congee. Product sensory characteristics and proximate composition were the basis of the formulation. The product have grainy smooth and sticky appearance. Also it exhibited a savory aroma and flavorful taste, thus, concluded with high acceptability. The proximate compositions and the caloric values of *adlai*-glutinuos rice-duck meat congee packaged in can and pouch are shown in Table 3. Based on the results, the congee was composed mostly of water as the moisture content ranged from 83.33 to 84.15g/100g. This means that the ready-to-eat food can be consumed even without any water accompaniment. Next to moisture content, the samples were found to contain a large proportion of carbohydrates (approximately 14%). On the other hand, protein, fat, fiber, and ash were relatively low which obtained values of less than 1g/100g. The computed calorie contents using the general factors, 4, 9, and 4 calories per gram of protein, fat and carbohydrate, respectively, were 63.23 kcal/100g for canned and 64.80 kcal/100g for pouched congee. The differences in the compositions of canned and pouched samples may probably reflect the variation in the amount of each ingredient transferred in the packaging materials during the filling process. For a 220-g serving amount, the product can contribute a caloric value of approximately 140 kcal. This means that the product can be used as an immediate response at the onset of the emergency when general food distribution systems are not adequate and no other foods are available. Percent daily value is part of the labeling that gives the necessary information about the recommended daily values of nutrients for growth and development. It represents the amount of nutrient per daily basis provided by a single serving. Canned and pouched *adlai* - glutinous rice and duck meat congee can provide 2 and 3% daily

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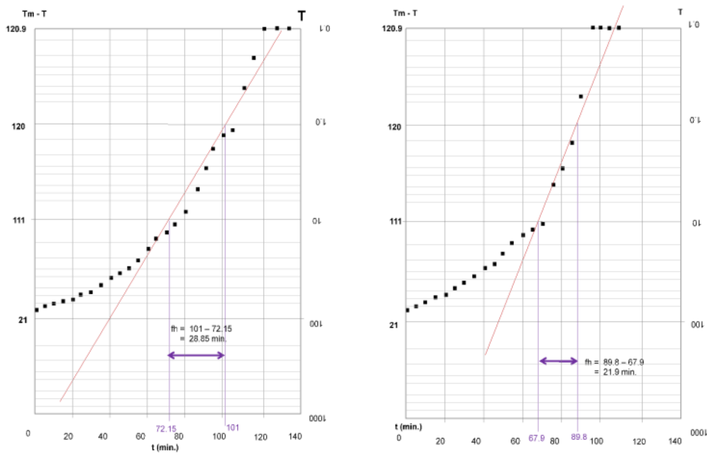
values, respectively. The duck meat which contains mostly of monounsaturated diet when incorporated to the diet at limited amount can be beneficial to the body. Also, it can be inferred from above that both the canned and pouched formulated congee were low in fat and protein content. The variation on the nutrients of the canned and pouched are not significant. The type of packaging does not have an effect on the nutrition retention. Hence, the product is a suitable for distribution during disaster and calamities.

3.2. Heat Penetration. Heat penetration test for the canned and pouched disaster based food product were processed at 121 ºC. At time 0 minutes, the product temperature had small increments until it reached the retort temperature of 121ºC at time 68 and 72 minutes for canned and pouched disaster food product, respectively. This were considered as the come-up time (CUT) for both canned and pouched product during processing. After the CUT, the product temperature continuously increased in larger increments until it reaches the processing temperature of 121 ºC. The length of time at a certain temperature of a particular product packed in a specific container must be established due to the danger posed by improperly processed low acid foods. This time-temperature combination is called the process schedule. Adequate knowledge on the nature of the product, dimension of the container, details of thermal processing procedure and thermal resistance of the containing microorganism is vital. Through formula method the established process schedule for canned and pouched disaster food were calculated to have 46.16 min and 37.32 min, respectively.

The method was used to integrate the lethal effect of a time or temperature history resulting from a thermal process at a position located in the slowest heating zone in the container. Formula method allowed the estimation of both process time and sterilizing value. A difference existed for the F_o values obtained at different packaging materials. A large F_o value of 26.5 minutes was observed on the formulated disaster food that is packed in cans than those product packed in retortable pouches that has 13.34 minutes.

Graph of time and temperature data in an inverted semi-logarithmic paper resulted in the achievement of f(h) values were shown in figure 1. The factor f(h) values for product packed in can and pouches were close to each other. The f(h) value is the slope of the straight line portion of the heating curve. A larger f(h) value indicates a slower rate of heating. The slowest heating point of product packed in can and pouches is at their geometric center of the packaging.



(A) (B)

Figure 1. Heat penetration curve for canned (A) and pouched (B) formulated congee.

3.3. Commercial Sterility.

Commercial sterility test was used to determine whether the canned and pouched formulated congee was commercially sterile and efficient processing was achieved. After 10 days of incubation at 30°C, the packaging were, first, visually examined. The manifestation of swells or bulges in food packaging that could indicate presence of *Clostridium botulinum*, a bacteria of concern in processed food products. It is an anaerobic microorganism that is capable of H_2S and CO_2 gas production when digestion of protein occurs. This results to the bulging and swelling of food packaging. Cans and pouches could also manifest a flat can condition in which both ends of packaging are in concave. The one responsible for the development of this kind of packaging condition is thermophilic spore-forming *Bacillus* spp., like *B. acidurans* and *B. coagulans* [12] . As for the canned and pouched formulated *formulated congee* as a disaster food product, no leaks, dents and bulging were observed on the canned samples. Similar findings were noticed in pouched samples; wherein, no pinholes and destruction of side seams were detected. The condition of the packaged congee remained the same after incubation for 10 days. Packaging inspection was followed by product examination. Presence of spoilage organisms in processed food can cause changes on the sensory modalities of the product such as blackening of contents, formation of rotten egg odor, and compaction of the product [13]. Cans and pouches disaster food product were opened aseptically using bacteriological can opener. The samples' appearance, odor, and consistency were detected to be normal. The pH of the product was also tested hence, abnormality in pH levels (acquiring a very low pH of 4) could indicate growth of spoilage bacteria due to fermentation of glucose [14]. The canned and pouched disaster food product have pH ranged from 6.1-6.5 which was still in the category of low-acid food. Moreover, insignificant difference was observed in the pH of the product when compared to the newly prepared sample.

Cultural examination was also done to detect the presence and absence of microorganisms. Tryptone broth was used to examine for the presence of mesophilic aerobic microorganism, most belong to *Bacillus* species. It contains peptone as a source of carbon, nitrogen, and vitamins; as well as, dextrose as a source of carbohydrates in which microorganism readily ferments to produce acid. To detect acid production, bromocresol purple dye was added. Indicators can act as both weak acid and weak base. It will react with H^+ or OH^- and dissociate causing color changes. In the case of bromocresol purple, decrease in pH will turn the dye into yellow [15]. The modified PE-2 medium, on the other hand, isolates and detects mesophilic anaerobic spore-formers, mostly from *Clostridium* species. Modified PE-2 medium contains peptic digest and yeast extracts that provide nitrogenous source and B-vitamins of clostridia species. Usually, untreated Alaska seed pea was added to create an anaerobic environment; however, due to the lack of that ingredient, agar plug was used instead. The medium can also be used to detect whether there is formation of H_2 and CO_2 gases. Bromocresol purple dye was also added in order to determine acid production. All inoculated tubes were negative for bacterial growth. No change in color was observed, and no rising in agar plug was detected in all tubes inoculated with the formulated congee. Table 1 presented the summary of observations and findings during the commercial sterility test .

Sample	**Appearance**	**Odor**	**pH**	**Number of (+) tubes for aerobic medium (tryptone broth)**	**Number of (-) tubes for anaerobic medium (PE-2 medium)**
A1	Normal	Normal	6.13	0/3	0/3
A2	Normal	Normal	6.20	0/3	0/3
A3	Normal	Normal	6.23	0/3	0/3

B1	Normal	Normal	6.20	0/3	0/3
B2	Normal	Normal	6.15	0/3	0/3
B3	Normal	Normal	6.25	0/3	0/3

Table 1. Condition of packaging, appearance, odor, number of positive and negative tubes, and pH of the formulated congee packaged in can (A) and pouch (B) after incubation.

To further confirm the result of the cultural examination of the sample, microscopic examination was done. Direct smears were prepared and stained with crystal violet. Crystal violet stain is a basic stain and has an affinity towards negatively-charged molecules like polysaccharide, proteins, and nucleic acids. It allows to distinguish the morphology of the bacteria. Smears of the incubated samples were compared with the smears of the original product microscopically examined right after processing (Figures 2 and 3). The smears from the original product and the incubated samples showed a similar number of occasional cells that can be identified as *Bacillus* spp. due to its rod-shaped structure. Since the packaging condition remained the same even after incubation, product appearance and odor was normal, pH was within the range of low-acid food product, cultural evaluation showed negative growth in tubes and microscopic examination of the formulated congee showed similar number of occasional cells before and after incubation, therefore it can be concluded that both products were commercially sterile.

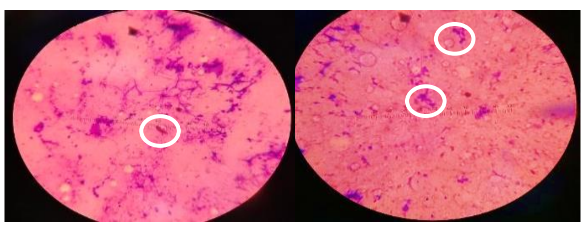


Figure 2. Photomicrograph of rod-shaped cell

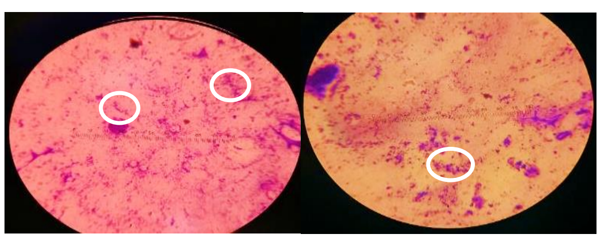


Figure 3. Photomicrograph of rod-shaped cell

3.4. Effect of Thermal Processing on Physicochemical Properties and Proximate Composition.

The proximate compositions and the caloric values of the formulated congee from *adlai*, glutinuos rice and duck meat packaged in can and pouch before and after thermal processing are shown in Table 2. Based on the result, the congee was composed mostly of water as the moisture content before thermal processing is at 83.16 g per 100g however after processing it ranged from 83.33 to 84.15 g/100g for canned and pouched congee. This means that the ready-to-eat food can be consumed even without any water accompaniment. There was no significant change on the moisture content before and after thermal processing. Moisture reduction is related to the type of cooking process [16]. Moisture loss in canned fowl meat products was due to over- processing [17]. Due to insignificant change in moisture content, it can be concluded that the products were not over-processed. Next to moisture content, the samples were found to contain a large proportion of carbohydrates (approximately 14%). On the other hand, protein, fat, fiber, and ash were relatively low which obtained values of less than 1g/100g

Table 2. Proximate composition per 100 grams of *adlai*- glutinuos rice and duck meat congee before (A) and after thermal processing for packed in can (B) and pouch (C).

Treat-ments	PROXIMATE COMPOSITION					
	Moisture Content (g)	Ash (g)	Crude Fiber (g)	Crude Protein (g)	Crude Fat (g)	Carbohydrates (g)
A	82.83 $\pm$ 0.08[a]	0.95 $\pm$0.01[a]	1.62 $\pm$ 0.28[b]	9.18 $\pm$ 0.07[b]	0.94 $\pm$0.03[a]	4.48 $\pm$ 0.01[b]
B	83.16 $\pm$ 0.22[a]	0.94 $\pm$ 0.19[a]	0.86 $\pm$ 0.43[a]	1.82 $\pm$ 0.13[a]	0.81 $\pm$0.06[b]	12.41 $\pm$ 0.23[a]
C	83.67 $\pm$ 0.02[a]	0.93 $\pm$ 0.17[a]	0.43 $\pm$ 0.24[a]	1.53 $\pm$ 0.00[a]	1.00 $\pm$0.03[a]	12.44 $\pm$ 0.14[a]

Means followed by the same letter in each column are not significantly different at $p \leq 0.05$

Ash Content. The recovered ash content (Table 2) of the canned and pouched formulated congee could come majority from *adlai*, glutinous rice, and duck meat. *Adlai* contains phosphorus, magnesium, calcium, and traces of iron [18]. On the other hand, duck meat contains high amount of iron [19]. The effect of thermal processing on the ash content of formulated congee before and after thermal processing was not significant. This indicated that the temperature during thermal processing was not sufficient enough to destroy the minerals [20]. In addition, to that minerals have high resistance to heat. It requires elevated temperature and pressure for the degradation of these minerals.

Crude Fiber. The fiber content (Table 2) of the canned and pouched formulated congee ranges from 0.4 to 1.6 %. *Adlai* grains were the major contributor of fiber with at most value of 0.365% [21]. However, the product utilized dehulled grains, wherein the fiber is found abundantly. Likewise, the crude fiber may come from other ingredients such as garlic, onion, and ginger. In addition, there is lower insoluble carbohydrate in legumes and starchy food than in fruits and vegetable [22]. In the study, there was no significant difference on the fiber content before and after thermal processing. Water-soluble fiber becomes more soluble in the food after canning[23].

Crude Protein. The protein content of the formulated canned and pouched formulated congee could come majority from *adlai* grains, duck meat, onion, garlic, ginger, and fish sauce. The *adlai* grain is made up of about 13% protein [21]. There was a significant difference between the protein content of formulated congee before and after thermal processing. As observed, the protein content decreased after thermal processing. There were possible reasons for the change in the crude protein of the formulated congee, namely protein denaturation, maillard reaction, and ingredient distribution in the samples. However, no significant difference was observed on canned and pouched samples.

Protein denaturation is the destruction of the secondary and tertiary structure of protein. Heat is one of the primary causes of protein denaturation. It interferes the linkage between hydrogen bonding and non-polar hydrophobic interactions [24]. The myofibrillar proteins in duck meat such as myosin and actin are destroyed by temperatures of about 40 to 60 ^{o}C and 80 ^{o}C, respectively[25]. Likewise, it was observed in the study that further heating of meat products reduced the myosin chains[26]. During denaturation of proteins, about 10-20% of the amino acids in canned foods are lost during heating[27]. Amino acids such as methionine and lysine may be lost at most of 9% and 25%, respectively. The latter is the predominating amino acid in duck meat. Lysine is the most sensitive amino acid that can be an indicator of damage during processing [28]. Also, heat sterilization reduces the digestibility of the proteins and amino acids in meat products. Protein content is also affected by maillard reaction. Boiling of duck meat promotes and maximizes the occurrence of maillard reaction [29]. A higher prevalence of maillard reactions in meat products than fish products cooked at elevated temperature [30]. Amino acids and proteins were reduced due to the proliferation of the maillard reaction which was responsible for the subsequent decreased in lysine content.

Crude Fat. The fat content (Table 2) of the canned and pouched formulated congee could come from duck meat and cooking oil used. The duck meat contributed the biggest portion of the fat.

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The broth, where the duck meat was cooked until softened, was discarded; thus, some of oil coming from the duck meat was lost. Boiling the duck meat leads to fatty acid degradation [31]. The fat content of duck meat products differ on the type of processing employed [32]. In seal meat, some of the fatty acids were lost in conventional cooking at 100 ^oC, [33] thus, it was possible that prolonged processing time at elevated temperature resulted in decreased fat content. There is a significant difference on the fat content of canned and pouched samples. The changed in the fat content of canned products was often observed in seafood [34]. However, in canned poultry meat, limited studies were found. Therefore, the changes may be attributed to the longer processing time of canned congee compared to pouched congee.

Total Carbohydrate. The total carbohydrate content (Table 2) of the canned and pouched formulated congee was determined by subtracting the sum of other components from 100. The combination of the cooked *adlai* grains and glutinous rice provided majority of the carbohydrates. As observed, the product has a low amount of carbohydrate before thermal processing. Likewise, there was a significant difference on the carbohydrate content in formulated congee before and after thermal processing. This difference may be accounted to the changes in the amount of protein detected before and after thermal processing.

Table 3. Physicochemical properties of the formulated congee before (A) and after thermal processing for packaged in can (B) and pouch (C).

Treat-ment	PHYSICOCHEMICAL PROPERTIES				
	Free Fatty Acid (mg/g)	Peroxide Value (mEq/kg)	pH	Water Activity	Consistency (cm/s)
A	0.06±0.00^a	0.22±0.002^a	6.23±0.00^a	0.94±0.01^a	0.02±0.00^c
B	0.06±0.00^a	0.22±0.002^a	6.20±0.00^a	0.93±0.00^a	0.28±0.00^a
C	0.06±0.00^a	0.22±0.002^a	6.19±0.00^a	0.93±0.00^a	0.24±0.00^b

Means followed by the same letter in each row are not significantly different at $p \leq 0.05$.

Fatty Acid. As seen in Table 3, no changes were observed in free fatty acid and peroxide value. The free fatty acid was expressed in terms of % oleic acid since it is the predominating fatty acid in the duck meat. It can be inferred that the oxidation process was still in the initiation process. The free fatty acid in duck meat product increased depending on the type of thermal processing but the study did not consider canning of duck meat. Temperature is one of the factors that can hasten the development of free fatty acid. A free fatty acid beyond 0.2 mg/ g is considered rancid. Both canned and pouched samples had free fatty acid value of 0.06 mg/g which indicated that the samples were not yet rancid at the time of analysis.

Peroxide Value. There was a slight increase in the peroxide value of products that undergone canning [35]. Peroxide value of products after thermal processing may also depend on the type of canned product and its composition. As presented in Table 2, the peroxide value of formulated disaster food remains the same before and after thermal processing. Both canned and pouched samples showed a value less than 10 mEq/kg. A peroxide value of 0.22 mEq/kg indicates that the product is still fresh; value between 10 and 20 meq/kg means the product is undergoing oxidation; and beyond 20meq/kg is already considered rancid [36].

pH. The type of cooking process can decrease or increase the pH after processing depending on the composition of the food sample. The increase in pH after processing was observed for those grilled and roasted meat products [37] while chicken steaks which utilized oven and pressured cooker showed no significant change [38]. There was no significant difference in the pH before and after thermal processing of the formulated disaster food. These trends observed on pH of meat products may be associated with the effect of rate of heating on the composition of the products [39].

Water Activity. The effect of temperature on water activity is product dependent. The elevated temperature during thermal processing can also affect the water activity. There was no significant change on the water activity of formulated congee before and after processing. Likewise, negligible impact on water activity was observed for high moisture foods when exposed to elevated temperature [39].

Consistency. There was a significant difference on the consistency of the congee before and after thermal processing of the canned and pouched disaster food. These may be accounted to longer time of pressure cooking that influenced the degree of gelatinization. The consistency of congee was influenced by the gelling properties of *adlai* grains and glutinous rice. The higher degree of gelatinization resulted in further break down of intermolecular bonds that increased water absorption during swelling [40]. Likewise, grains exposed to elevated temperature had a greater extent of water uptake [41]. Thus, canned formulated congee that had longer exposure to heat, has high consistency value of 0.28 cm/s.

3.5. Effect of Thermal Processing on Sensory Attributes

Color. The color of formulated congee may be associated to the duck meat that contains high amount of myoglobin and hemoglobin which are responsible for its color [42]. Moreover, the characteristic color of the duck meat was also attributed to its high fat content[43]. The color of the formulated disaster food intensified after thermal processing which may be accounted to maillard reaction. The amount of maillard reaction products present in meat products were directly proportional to temperature [30]. Maillard reaction products such as heterocyclic amine were found to increase with increasing temperature [29]. The type of processing may also be a factor on the extent of maillard reaction. It was observed that the production of heterocyclic amines were higher in boiled and pan- fried duck meat than roasted duck meat [29]. However, no significant difference on the color was observed between canned and pouched formulated disaster food as indicated in Table 4.

Table 4. Means (±SD) values of the sensory attributes of the formulated congee (A) prior and after retort processing [canned (B) and pouched (C)].

SAMPLE	SENSORY ATTRIBUTES			
	Color	Texture	Aroma	Flavor
A	5.63 ±2.17[b]	6.63 ±2.81[b]	7.99 ±3.18[a]	6.96 ±3.02[a]
B	8.68 ±2.77[a]	9.34 ±1.69[a]	9.13 ±2.71[a]	8.28 ±2.60[a]
C	8.24 ±2.04[a]	9.09 ±3.06[a]	8.95 ±3.25[a]	8.56 ±3.21[a]

Means followed by the same letter in each row are not significantly different at $p \leq 0.05$.

Range of scores: Color: 0=light 15= dark; Aroma : 0= bland 15= strong; Texture: 0=very thin 15= very thick; Flavor: 0=Bland 15= Strong; Aftertaste: 0=weak 15=strong; General Acceptability: 0= not acceptable 15: extremely acceptable

Texture. There was a significant change in the texture of the formulated congee before and after thermal processing. The perceived sensory scores (Table 3) for texture were 6.63 and 9.09 to 9.34 for the samples before and after processing, respectively. A 41% increase in the mean score of texture was observed after processing which may be accounted to denaturation of proteins. Protein denaturation is one of the primary causes of textural changes in food. A slight elevation in temperature during heating lead to protein denaturation. The hydrogen bonding ruptures and rearranges which may result in changes in solubility, flexibility, and elasticity of foods. Generally, protein denaturation initiates firming and gelling of the product. In addition, the change in texture can be associated with gelatinization of starch. Starch gelatinization begins at different temperatures depending on the product. It was found out in similar studies of development of ready-to-eat porridge that starch gelatinization remains in an uneven distribution and will not be affected by other macromolecules at temperature above the gelatinization temperature.

Taste (aroma and flavor*).* Based on the panelists, the formulated disaster food had meaty (due to duck meat) and pungent (due to garlic) aroma characteristics. Cooked meat products have at least 1000 volatile compounds [44]. These volatile compounds are induced upon exposure to thermal processing [45]**.** But in the study, no significant difference on the perceived aroma of the formulated congee before and after thermal processing. This means that the additional processing did not induced the release of significant amount of volatile compounds in the final product.The volatile compounds remained the same when there was an insignificant change in the lipid oxidation activity during processing [44]. The perceived flavor of the developed disaster food was associated with the toasted garlic, added spices, and duck meat. Based on the sensory scores (Table 4), there was no significant difference on the flavor of the samples before and after thermal processing. The flavor of meat and meat products are associated with the amount of phospholipid composition which measures the extent of lipid oxidation during processing [46]. Hence, the flavor remained the same since no significant change in lipid oxidation was observed. Aside from the phospholipid composition, the protein content of the product is associated with the characteristic flavor. The structural changes in the amino acids present in duck meat results in changes in flavor compounds [47]. Since the protein structure may have undergone conformational changes, it is also possible that some of these amino acids are responsible for the enhanced flavor. The aftertaste is associated with flavor and lipid oxidation [48]. In this study, there was no significant difference on the perceived flavor and lipid oxidation; consequently, no significant difference in aftertaste upon exposure to thermal processing. Based on the results, there was no significant difference in the mean scores of canned and pouched *adlai*- duck meat. However, the mean scores were significantly different with the sample that did not undergo thermal processing.

General Acceptability. One hundred twenty-five (125) consumer panelists, 81 females and 44 males, were taken as respondents to evaluate the acceptability of canned and pouched formulated congee. They were selected in a randomly stratified way using age group as the stratum [children (4-12 y/o), adolescents (13-19 y/o), young adults (20-35 y/o), adults (36-65), and elderly (>65)]. The judges assessed the samples based on color, aroma, flavor, aroma, aftertaste, and general acceptability. In addition, the panelists were asked to evaluate their personal acceptance between the two packaging materials of the developed product.

Figure-4: Spider plot of consumer's evaluation on canned and pouched formulated congee based on age groups.

Figure 4 illustrates the average evaluation of each age groups per sensory attribute. Adults and elderly had the highest average score in general acceptability of 7.8 and 7.6, respectively, while the adolescents had the lowest average of 6 for the formulated congee packaged in tin can. This was also true for all the specific attributes with the adults and elderly having an average rating range of 7-8 whilst adolescents had 5-6. As shown in figure 2, the canned samples results were comparatively similar to the samples packaged in pouches. Based on the consumer test, 78.4% of the panelists accepted formulated congee packaged in tin can while 80.6% of them liked the formulated congee packaged in retort pouch. Most of the age groups had a unanimous preference for retort pouch over tin cans. Out of 125 panelist, 94 preferred retort pouch as packaging material for the formulated congee from adlai, glutinous rice and duck meat as a disaster food product.

3.6. Effect of thermal Processing on Storage Stability. Microbial, physico-chemical and sensory tests are used alternatively in the determination of the storage stability of different food products. In this study, accelerated shelf life testing was conducted in which the main concept was to analyze the shelf stability of food products via the use of accelerated storage conditions and to predict the real shelf life of the product using Arrhenius equation and Q10 approach. The study measured several parameters: water activity, consistency, pH, color, and sensory evaluation as the deteriorating quality attribute. These parameters was used to predict shelf-life of the adlai- glutinous rice and duck meat congee.

Water Activity. At the start of the experiment the **w**ater activity value was determined as 0.918. however it was found that the average value was 0.95±0.01 at the end of storage. At different storage temperature the water activity of formulated congee packaged in can and pouch were increased prominently. Figure 5 shows the Changes in water activity during storage of the formulated congee packaged in can and pouch at different storage temperature. Present study proved that at different temperature conditions, changes in water activity were significant (p= 0.002 to p=0.006) with respect to the storage time. Moreover, the calculated r^2 of the different linear regression plots indicated that variation in the change in water activity was explained by the increase in storage time.

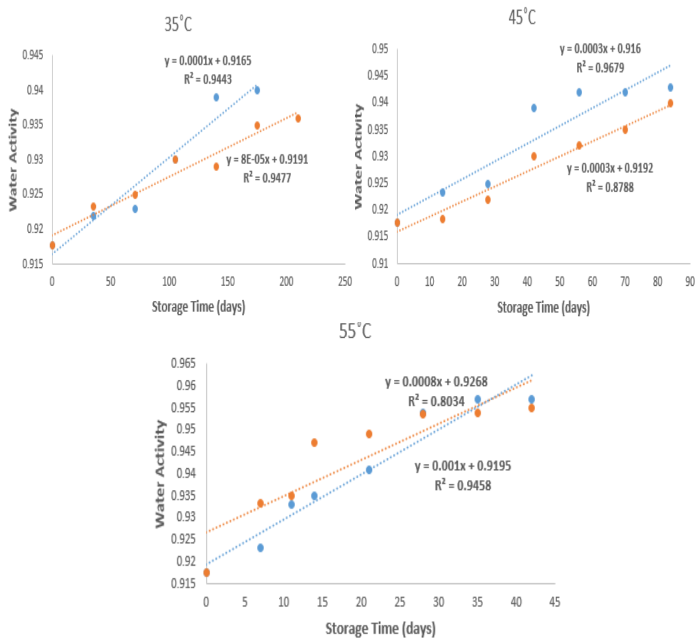

Figure-5: Effect of temperature in the water activity of the canned (●) and pouched (♦) formulated congee during storage.

The crystalline state as compared to the amorphous one has a higher water activity value.The structure of crystalline starch does not allow water molecules to access the starch's gel junction zone, thus bounding water only to the surface of the granule[27]. This causes reduction of energy of water, thereby decreasing the humidity of the food as compared to the pure water. Another contributing factor to the increase in water activity is conversion of amorphous starch granules to its crystalline state because of the onset of retrogradation. Starch granules that has undergone heating then retrogradation are mostly likely to be converted from its amorphous state into its water-impenetrable crystalline state. As storage time increases, so does retrogradation. This was supported by the study of the quality changes of ready-to-eat ginseng chicken porridge packaged in retort pouches during storage at 25°C in which the retrogradation value of the sample increased significantly with prolonged storage[16]. The retrogradation occurred in the formulated congee during the shelf life monitoring; as retrogradation proceeds, exudation of water starts to occur. The released water and some of the surrounding water molecules could be adsorbed to the surface of starch granules.

Consistency. The consistency of the formulated congee increases (Figure 6) because of the increase in water content due to exudation of water from the crystallized food components. It can be attributed to the rate of retrogradation and formation of amylose-lipid complex. The increase in consistency was related to the water exudates from the crystallized food components. This creates additional moisture to the product allowing for easier flow of the congee.

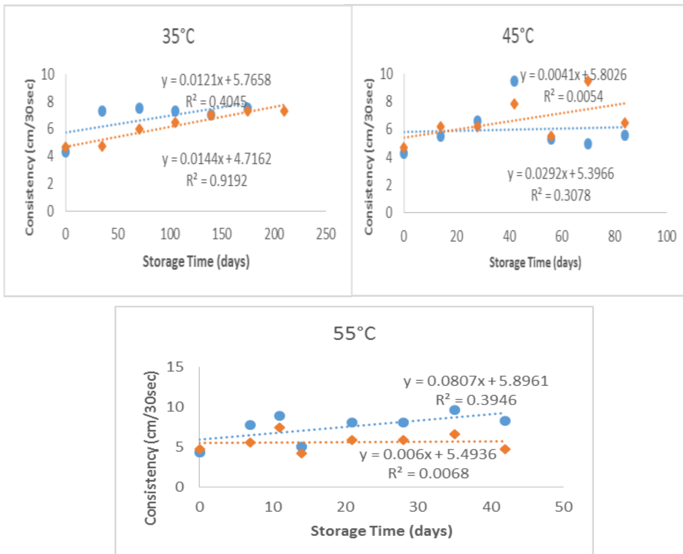

Figure-6: Effect of temperature in the consistency of the canned (●) and pouched (♦) formulated congee during storage.

pH. One of the factors that determines the quality of a product exposed in various conditions is pH. Moreover, this factor can vary depending on other parameters that are present in the internal and external environment of a processed food product. The changes in pH of adlai-duck meat congee packaged in can and pouch as a result of storage at different temperature treatments, the effect of packaging itself, and the presence of microorganisms. The initial pH of the product was approximately 6 which was categorized as low acid. At the end of storage, the pH showed decreasing trend and reached to a value of below 5 for both can and pouch samples. The changes in the pH of the samples during storage at 45°C and 55°C were shown to be linearly dependent with time (p= 0.002 to p= 0.014). Moreover, the high r^2 which ranged from 0.7931 to 0.9203 of various linear regression lines at different kinetic orders indicated that variation in the change in pH was explained by the increase in storage time.

The pH values are accounted thru the amount of hydrogen ions (H^+) in a solution [49]. Likewise, it is essential to determine the amount of dissociated acids in the samples as the product ages because this parameter greatly affects the sensory evaluation of panelists as well as shelf life of the formulated congee. The pH results showed that at all accelerated temperatures, canned and pouched congee's pH did not show any difference at $p \leq 0.05$. Typically, as temperature increases, molecular vibrations also increases inhibiting the formation of hydrogen bonds, increasing the number of observable and free H^+ ion molarity and decreasing the pH value. Moreover, time-temperature interaction exhibits rapid pH decrease [50]. Thus, the longer storage time, the longer the exposure to the accelerated temperatures means constant molecular vibrations with increasing protein deterioration releasing free ions, such as glutamic acid, aspartic acid, lysine and methionine in duck, that will decrease the pH.

Color. Table 5 shows significant difference between the two packaging materials in terms of color of the packed formulated congee. This can be due to variety of possible deterioration mechanisms, like package-food interactions (lacquer failure), Maillard reaction, residual oxygen, and severe heat treatment. Since tin can is a heat-labile material, one possible color deterioration mechanism is internal corrosion/lacquer failure due to foods with high content of sulfur containing amino acids. It was a result of uncommon aggressive reaction between can and its food components [51]. This type of deterioration in canned foods is an electrochemical reaction depending mostly on pH and type of food, presence of oxidants, storage temperature and time, and air in the head space which critically create limiting factors on the shelf life of canned products, such as affecting its organoleptic properties, i.e. color [52]. Moreover, this can integrity problem, in the literature reports, is said to be one of the most common observations in processed canned foods due to appearance of black stains on both the internal surface of the can body and occasionally on the product surface. Duck meat, in general, contains glutamic acid, aspartic acid, lysine, and methionine (sulfur-containing amino acids) at significant levels, with highest concentrations present in the breasts and thighs [53]. With that, dissolution of lacquer takes place and the occurrence of sulfur blackening/staining was due to production of tin sulfides and tin oxides, formed by decomposition of food with sulfide compounds (H_2S or other products containing thiol (-SH) group) to the tin layer of the metal can which occurs in products having pH over 5 [54]. Formulated congee having a duck ingredient may have experienced this type of degradation and the dark and brown precipitates observed at the top of the sample after opening the can were the by-product of the reaction of sulfur to the iron and tin content (FeS and SnS precipitate). One way to prevent these freed and loosely bounded sulfur compounds is to use zinc oxide, which can absorb the compounds during thermal processing [55].

Table-5: Mean (±SD) Delta L* values of canned (A) and pouched (B) formulated congee at different storage temperatures.

TEMPERATURE (°C)	TREATMENT	
	A	B
35	3.117±2.027[a]	7.456±2.077[b]
45	1.762±2.615[a]	9.111±2.455[b]
55	5.197±2.026[a]	8.560±2.227[b]

Means values with different letters in the same row per storage temperature are significantly different from each other at $p \leq 0.05$.

Delta L* represents a lightness difference between sampling data and baseline data (Can-50.429; Pouch-46.675).

The intrinsic darkening of the samples inside the can material can be caused by maillard reaction. It is a type of non-enzymatic browning that is initiated by the condensation of the carbonyl group of reducing sugars with the free amino groups and/or proteins. Likewise, this chemical process produces brown color (melanoidins) in foods without the participation of enzymes [56]. The dark-brown appearance of the product was caused by thermal application and long-term storage of the food containing reducing sugars. Hence, color can be determined as the primary characteristic of maillard reaction.

As for the formulated congee, the duck component has a very high lysine content (9.21±0.38 per 100 g protein of duck meat) [53]. This lysine can react with the reducing sugar brought about by the adlai component. Adlai has a high amount of carbohydrate content which will be degraded upon exposure to high thermal application. At high temperatures, hydrolysis of carbohydrates happens and it releases reducing sugars and these monosaccharides will then react to the free amino acids exuded by the duck meat yielding brown pigments or melanoidins[57]. This brown color in the samples had provided undesirable perception and therefore resulted to failing remarks from the trained panelists in the canned samples. Possible presence of residual oxygen must have accelerated the degree of corrosion as iron will automatically react with oxygen yielding iron oxide (FeO) compounds which are also black precipitates [58].

In addition, color dictates the severity of heat treatment and can be utilized to determine the quality deterioration from heat exposure [59]. This statement was proven true as seen in the samples inside the can packaging material. The part of congee that is in contact and exposed to the tin can showed considerable dark appearance as compared to that of those parts in the center. This may be due to longer processing time of canned samples compared to pouched counterpart. Thus, this samples closely in contact with the metal barrier of the tin can changes the overall chromatic property of the product in the said packaging and significantly widened the two treatment's color measurements by the color meter.

Lacquer failure, maillard reaction, residual oxygen and heat treatment greatly affected the samples in can which resulted in a significant deviation of chromatic data between the two packaging in the analysis. This can be due to retort pouches being non-corrosives and have no any inner coatings that can react to the product; thus, during storage, no unwanted precipitates can form. And since retort pouches have thin specifications, its thermal processing to reach the critical point was less than those of can which prevents overcooking; thus, it produces better color than those samples on can [60], [61], [62] confirmed that retort pouches' flat shape reduces processing time and thus heat exposure which provides opportunity to process heat-sensitive products, which are not suitable for conventional cylindrical canned processing.

Microbial Analysis. At the storage temperatures of 35°C, 45°C, and 55°C, there were no coliforms and thermophilic spore formers detected on canned and pouched formulated congee. According to the FDA Circular No. 2013-010, the coliform level and APC level of ready-to-eat foods should not exceed 10^2 cfu/g and 10^4 cfu/g, respectively. In the study, the coliform and APC counts for both the canned and pouched formulated congee were within the allowable limits for ready-to-eat foods. Based on the results, less than 10 to no growth was observed in canned and pouched samples stored at 35°C, 45°C, and 55°C. Therefore, both samples were microbiologically acceptable as there were no any significant microbiological changes that happened in the products during storage. Moreover, the number of detected coliforms and APC were within the allowable limits. There were also no thermophilic sporeformers detected which proved that the time and temperature employed in the thermal processing of the product was effective to destroy the pathogenic microorganisms.

Sensory Evaluation. The sensory evaluation for canned and pouched samples stopped before its possible last sampling point due to the development of off-odor, as observed on the periodic sensory assessment at 55°C. While for the sensory testing at 35°C, canned formulated congee ended earlier than the pouched samples because of the poor condition of the tin can. As observed, black deposits were found on the canned samples making it unfit for consumption. This was supported by the statement that internal corrosion in can affects the sensory properties of the product such as color, flavor, and texture[63]. While, at the end sampling day for 45°C, neither like nor dislike descriptive score value for sensory evaluation was verdict.

Shelf Life Estimate. The shelf life of both packaging ended earlier than the estimated shelf life which is one year. The possible reason for this was the early ending of shelf life testing on the basis of the development of off-odor. The formation of sour odor in the food product could be connected to the increasing off-flavor of adlai duck-meat congee. As mentioned earlier, the observed trend in the off-flavor parameter was due to the build-up of oxidative secondary by-products such as 2,4-decadienal and 2-furfurylthiol. Both are types of unsaturated volatile aldehyde that contributes to the production of "cardboard" flavor and "sour" flavor of the duck meat; as well as, the development of unpleasant odor [64]. Accumulation of sulfide compounds due to the continual degradation of proteins can also contributed to the formation of off-odor to the product. Hydrogen sulfide, one of the products of protein degradation, is an organic volatile compound that is associated with rotten egg odor. Furthermore, hydrogen sulfide could react with aldehydes, ketones and furans to form sulfur derivatives that can also cause off-odor to the product [65]. The two methods of estimating shelf-life generated the same results that the canned samples have lower shelf life than the pouched samples. Since most of the rate of change in the measured deteriorating attributes of formulated congee was not significantly different when packaged in can and pouch, the contributing factor for the difference in the shelf life of canned and pouched samples was the development of off-odor in the sensory evaluation part and formation of the black deposits in the can body.

Table-6: Shelf life estimation of formulated disaster food packaged in can (A) and pouch (B) using Arrhenius equation and Q_{10} approach.

TREATMENT	ESTIMATED SHELF-LIFE (Days)		
	Arrhenius Equation[1]	Arrhenius Equation[2]	Q_{10} Approach
A	262	457	169
B	350	538	288

A= canned sample; B= pouched sample

[1] Based on water activity, estimated at first order reaction

[2] Based on pH, estimated at first order reaction

4. CONCLUSION

The integration of duck meat in one of the popular Filipino dishes, particularly *congee*, can be the start of popularizing the use of this meat in the food industry. Recent studies have been made concerning the development of disaster foods product that are healthy, tasty and safe to eat. The study was conducted at 121ºC processing temperatures. Two packaging materials were used, tin cans and retort pouches. These parameters are used to determine the effect of thermal processing on the formulated congee.

At 121ºC processing, the established processing schedule is 46.16 minutes and 37.32 minutes for canned and pouched formulated congee, respectively. Commercial sterility test for the packaged formulated congee from *adlai*, glutinous rice and duck meat as a disaster food product, no leaks, dents and bulging were observed on the canned samples. Similar findings were noticed in pouched samples; wherein, no pinholes and destruction of side seams were detected. Therefore, it can be concluded that the disaster food product packed in cans and retort pouches are commercially sterile since it did not manifest any significant changes during the incubation period.

Changes in their physico-chemical properties and highly acceptable rating for sensory attributes were observed significantly after thermal processing. Based on the Q_{10} approach, at 30ºC storage temperature, the estimated shelf-life of the canned and pouched formulated congee were 169 and 288 days, respectively. Thus, thermal processing extend the storage stability of the product.

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Abstract: The quality properties of probiotic yogurt samples made with banana marmalade (BM), which can be a probiotic product, were examined.Â Varieties of fruit yogurts have been formulated as probiotic fruit yogurts, and the survival of probiotic bacteria in yogurts has been investigated during cold storage (13). Banana (Musa sp.) fruit contains considerable amounts of amylose, starch, dietary fiber, protein, vitamins, and minerals (14,15).Â Physical and chemical analysis. The pH value of the yogurt samples was measured at 17-20 Â°C with a digital pH meter (pH 211, Hanna Instruments, Amorim, Portugal).Â At the beginning of storage, all yogurts were superior, mainly because of their more intense flavor and better consistency. Black Soldier Fly (Hermetia Illucens) as Dietary Source for Laying Quails: Live Performance, and Egg Physico-Chemical Quality, Sensory Profile and Storage Stability. Antonella Dalle Zotte 1,*, Yazavinder Singh 1, Joris Michiels 2 and Marco Cullere 1. 1.Â Results of the present study showed that the insect meal can technically be applied to laying quailsâ€™ feed formulations, providing optimal performance and health status. Egg nutritional quality and sensory profile too did not worsen when quails were fed with the insect meal supplementation.Â Dalle Zotte, A.; Singh, Y.; Michiels, J.; Cullere, M. Black Soldier Fly (Hermetia Illucens) as Dietary Source for Laying Quails: Live Performance, and Egg Physico-Chemical Quality, Sensory Profile and Storage Stability. 2. To evaluate the physico-chemical and organoleptic attributes of wheat bread substituted with different percentages of pumpkin flour. 3. To evaluate the microbial load of yeast and mould in the bread during storage. -3-. CHAPTER [2].Â The stability of carotenoids during processing and storage is crucial for product attractiveness and acceptabilility. Pigment degradation will affect the natural colour, nutritive value and flavour in vegetable. The common degradation pathways are isomerization, oxidation and fragmentation of the carotenoid molecules which are promoted by heat, light and acids (Bonnie and Choo, 1999; Bao and Chang, 1994; Martins and Silva, 2002; Muftugil, 1986; Sims et al., 1993).