UTILIZATION OF PAPAYA (*Carica papaya L.*) EXTRACTS IN THE PRODUCTION OF YOGHURT DRINK

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ABSTRACT

This study was conducted to develop a flavored yoghurt using papaya (*Carica papaya L.*) and evaluate its physical, chemical, and microbiological qualities and sensory acceptance. Yoghurt is known for its benefits in digestion because of the bacterial cultures like *Lactobacillus bulgaricus* and *Streptococcus thermophillus,* which were used in this study. Papaya yoghurt was made with different proportions of the extract: 10%, 15% and 20%. Papaya-flavored yoghurt and plain samples (no extract added) were analyzed for physico-chemical and microbial quality, and sensorial acceptance using a 9-point hedonic scale. The packaging of the finished product was also discussed. The sensory evaluation showed that the added papaya extract improved the sensory and nutritional property of the yoghurt compared to the control. It showed statistical difference in flavor, taste and odor but showed no statistical difference in color and overall acceptability of the samples. The flavored yoghurt with 20% of papaya extract was the most preferred than other formulations. The fat reduced in value (2.8 g/100mL) when the papaya extract was incorporated together with the protein (3.3 g/100mL) and ash (0.91 g/100mL). While the carbohydrates increased in the experimental (9 g/100mL) due to higher sugar than in milk alone, it added on the nutrient content of the yoghurt. The microbiological requirement of all the yoghurt samples falls within the acceptable standards. The required lactic acid bacteria count was reached. It survived more in the experimental ($1.5x10^6$) compared to plain yoghurt ($1.1x10^6$). This study confirms that the production of papaya yoghurt is acceptable to the consumer.

Keywords: *Fruit Yoghurt, Papaya, Lactic Acid Bacteria*

INTRODUCTION

Yoghurt is a unique dairy product that can be found in the market today. There is a particular ingredient that makes its taste distinct and significant among other dairy products. The most intricate and active in natural components of all foods is the yoghurt that is seen in the grocery stores. To give account on the value of yoghurt, the three factors should be taken into consideration: milk, industrial bacteria, and consumer, and also the variation of man and addressing the extent of diversity (German, 2014). In other words, it is the dairy product that came from the lactic acid fermentation of milk and the most popular fermented dairy product. It is also known for its nutritional value that is essential mineral in the human diet, especially the daily requirements of calcium and magnesium in maintaining the physiological process.

Yoghurt has different varieties that make it palatable among all ages, like fruit-flavored yoghurt (Teshome et al., 2017). Moreover, yoghurt is not only beneficial to the consumers but also to the country. As of 2017, the growth of the yoghurt and sour milk products recorded was 5% retail value, which was faster than in 2016. Also, the capacity of drinking yoghurt, especially fruit-flavored yoghurt, is reported to improve. As a result, there are wider choices for the consumers (Euromonitor Interntional, 2017).

This dairy product is appealing to the consumers because of its health claims and at the same time its flavor. Because of this, it is suggested to incorporate affordable source of nutrients in yoghurt to make it an almost complete food, as said by the nutritionists (Hossai, Islam, and Fakruddin, 2012). Consumers have more complex way in choosing foods to eat. They want delicious but at the same time healthy for their diet. The foods like dairy products are developed to be a functional food such as cheese, curd and yoghurt. For yoghurt, it is a probiotic carrier that is abundant in protein, milk fat, potassium, magnesium, Vitamin B2, Vitamin B6, and Vitamin B12 (Thomas and Wansapala, 2017).

Like other foods, it undergoes processes to ensure the quality. Because of advancements from different fields like biochemistry, microbiology and food engineering, the procedure of making yoghurt became more reasonable. There are two different groups of yoghurt, namely standard culture yoghurt and bio- or probiotic yoghurt.

The standard yoghurt was made with *Lactobacillus bulgaricus* and *Streptococcus thermophilus,* which are said to restore the friendly microflora present in the stomach and aids in sustaining the overall intestinal health. While the bio-yoghurt are those made by culturing *Bifidobacteria* and *Lactobacillus acidophilus,* which are known to have numerous health benefits but should remain live culture at a specific amount to claim its health benefits (Weerathilake, Rasika, Ruwanmali, and Munasinghe, 2014). In the study of Rahman, Gul, and Faruqi, an equal ratio of *L.bulgaricus* and *S. thermophilus* showed to have the best quality of yoghurt while a ratio of 2:1, *L.bulgaricus:S. thermophilus,* had a potential in having antibacterial activity.

Moreover, probiotics products like yoghurt are known for its benefit on digestion. There are many studies about the positive health effects of yoghurt, especially the bacterial cultures used in making yoghurt. This includes lactic acid bacteria, which are the *Lactobacillus* and *Streptococcus* species. Studies showed the potential of yoghurt to benefit patients with gastrointestinal conditions such as lactose intolerance, constipation, diarrheal diseases, colon cancer, inflammatory bowel disease, *Helicobacter pylori infection*, and allergies (Adolfsson, Meydani, and Russell, 2004). As mentioned earlier about the health claims, the function of yoghurt as probiotic carrier improved lactose intolerance, metabolic disorder and prevention of gastrointestinal disorders. Because of these known health advantages, the demand for yoghurt increased and grew fast in the global market (Yadav et al., 2015). The lactic acid-producing bacteria in yoghurt have a therapeutic effect on the gut health because it prevents enteric infection and reduce chemically the Carcinogen that causes tumorization in the gastrointestinal tract (Mazahreh and Mamdoh, 2009). But the dosage of particular probiotic to which it is effective should be taken into consideration for safety and limitations (Kechagia et al., 2013). According to Kligler and Cohrssen, the common dosage for children is 5 to 10 billion colony-forming units (CFU), and for adults, 10 to 20 billion CFU.

As said earlier, fruit yoghurts can be made to add variety to it. The introduction of various fruit yoghurts has significantly contributed to the consumption from all ages. Incorporation of non-seasonal fruits endorses the healthy image of yoghurt and it will be a great advantage since it will enhance the versatility of taste, color, and texture for the consumer (Teshome et al., 2017; Warakaulle, Weerathilake, and Abeynayake, 2014).

In the production of yoghurts, Food and Agriculture Organization (FAO) and World Health Organization (WHO) recommended 5-15% of fruit concentration to use in making value-added yoghurt (Roy et al., 2015). This modification will contain both the refreshing flavor of fruit and the beneficial effect of yoghurt. Thus, adopting the study in fruit yoghurt would possibly benefit in producing new product in the market and also in food industry since it will reduce the issue in post-harvest loss in the Philippines due to lack of developing studies in consumption of the fruit.

In the Philippines, one of our major agricultural crops and are leading contributors to economy is the papaya fruit. However, papayas were reported to have as high as 27-40% losses, and one of the causes indicated for this very high percentage is the disease, over ripening, and lack of incorporation to the processed food in which it greatly affects the agricultural viability of the country (Mopera, 2016).

The current study uses the extracts of ripe papaya (*Carica papaya L.*) as an additive to give acceptable flavor, texture, and more nutritional value to yoghurt for the benefit of the consumers. One good source of fiber content is found in papaya (*Carica papaya L.*) fruit, also known as pawpaw fruit (Medina, Gutierrez, and Garcia, 2003), that belongs to the small family of Caricaceae and is one of the non-seasonal fruits (Matter, Mahmoud, and Zidan, 2016). Concluding the consumption of papaya promotes improvement in digestion of protein and reduced health-risk-related issue due to its high amount of vitamins, minerals, antioxidants and other health promoting properties. The production and cultivation of papaya fruit gained the popularity in Brazil, Mexico, Indonesia, China and the Philippines in which it also spread throughout the world (Ortega, 2011).

According to the annual report of Australian Center for International Agricultural Research in 2014, the papaya in the Philippines is an important and continually expanding crop. As a result, the demand of papaya fruits were being adopted in the food industry to incorporate in different types of food products due to its acceptance to the consumer perception and significantly contributed to the consumption of all ages. Numerous studies uses the papaya fruit in producing beverages (Megha and Alka, 2015), dairy products (Olua, Eluwa, and Abuajah, 2016), baked products (Yusufu and Akhigbe, 2014) and even in medicinal use (Charan, Saxena, Goyal, and Yasobant, 2016). The papaya fruit also contains enzyme known as papain, which is used as commercial meat tenderizer that is commonly used in the Philippines (Joseph, 2008). Chemical-rich constituents and valuable properties of papaya are always of an interest due to its varied medicinal properties. In the study of Tompe and Sonone in 2015, papaya fruit consists of nutritional constituents listed in table 1.

Table 1. Nutritional Values of 100 grams of Papaya Fruit

Constituents	**Ripe Papaya**	**Green Papaya**
Protein	0.6 g	0.7 g
Fat	0.1 g	0.3 g
Minerals	0.5 g	0.5 g
Fiber	0.8 g	0.9 g
Carbohydrates	7.2 g	5.7 g
Energy	32 kcal	27 kcal
Total Carotene	2740 µm	0
Beta Carotene	888 µm	0

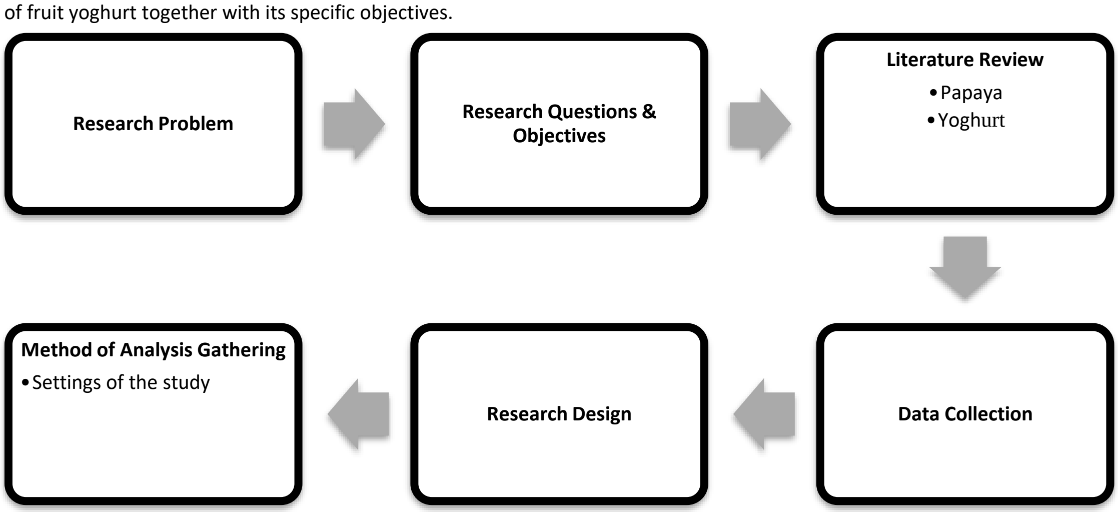
Aside from the high content of fiber and proteolytic enzymes associated with this highly nutritious fruit, the papaya is a nutraceutical plant having a wide range of pharmacological activity and has its own medicinal value (Aravind, Debjit, Duraivel, and Harish, 2013), in which the wide range of enzymes, vitamins, home remedies and other side effects present in papaya makes it a nutraceutical plant.

Previous studies reported on the utilization of different fruits into yoghurt. Teshome et al. (2017) studied on the development of fruit-flavored yoghurt with mango and papaya fruit juices while Debashis et al. (2015) studied yoghurt supplemented with fruit pulp from banana, papaya and watermelon. Thus, incorporation of fruit into yoghurt is possible. However, there are limited studies that focus on the development of papaya yoghurt, particularly in the Philippines.

With consideration of the above points, this research is aimed to develop yoghurt drink from papaya (*Carica papaya L.*). Specifically, it aims to evaluate the papaya yoghurt by its physico-chemical, proximate, microbiological quality, and acceptance through sensory evaluation. The starter cultures that were used are *Lactobacillus bulgaricus* and *Streptococcus thermophilus.* Also, this study includes the packaging and product costing of the finished product. This study can contribute on the utilization of the papaya and promote consumption of the fruit, which can benefit a wide range of consumers. Also, it can contribute to the field of food and nutrition and give advantage to the food industry by adopting studies about fruit yoghurts. This study focuses only on the development of papaya yoghurt and evaluation of its physical, chemical, microbiological and sensory qualities. It doesn't cover shelf life and nutritional value. Only one variety of the papaya was utilized, Red Lady.

RESEARCH DESIGN

The flowchart shown in Figure 1 presented how the researchers came up with the study. Also, it showed the main concept of this study in which papaya was utilized in the development of fruit yoghurt together with its specific objectives.



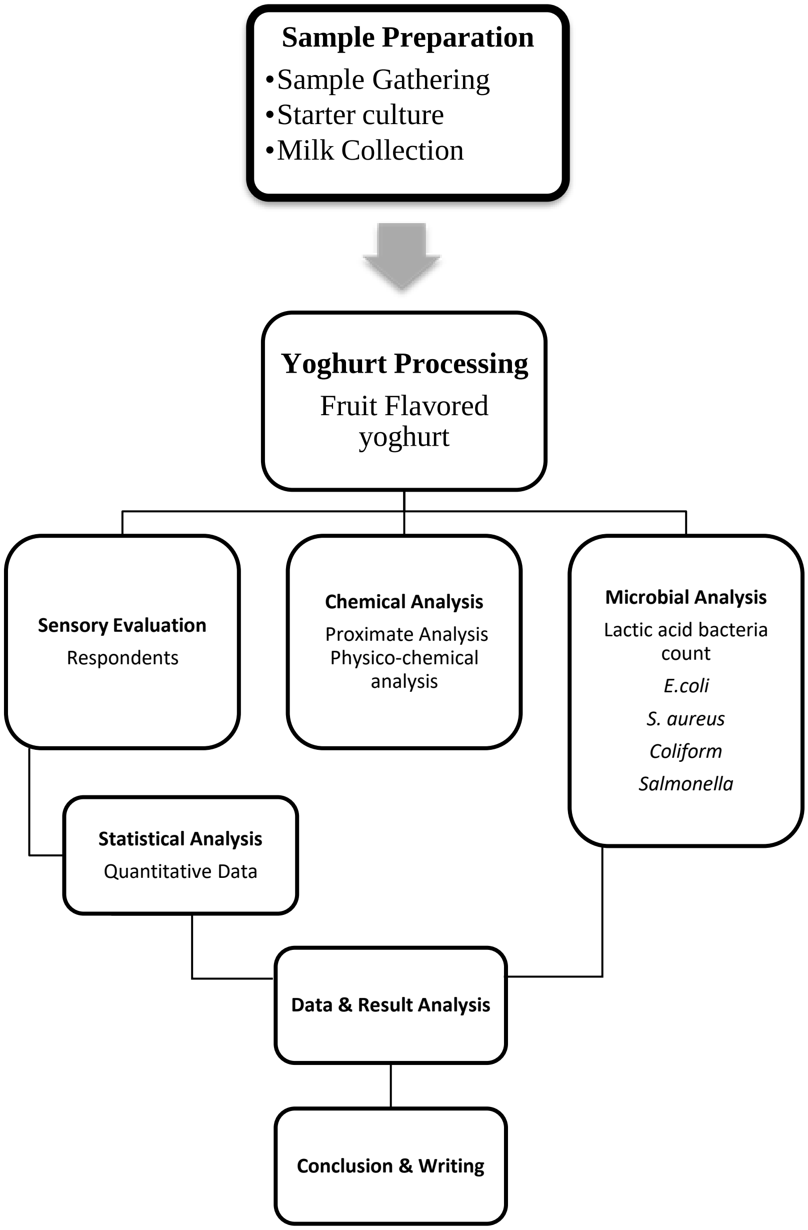


Figure 1. Research Design of the Development of Papaya Yoghurt

MATERIALS AND METHOD

Materials

Collection of Raw Materials

The papaya fruits *(Carica papaya L.,* Red Lady variety) were obtained from a local market in Sampaloc, Manila. Sample of papaya fruit was carried out in Bureau of Plant Industry in Malate, Manila to be verified as *Carica papaya L*. Fresh cow's milk was collected from a dairy farm in Makati, Manila. The skim milk powder and sugar (natural sweetener) were purchased from a local supermarket in Sampaloc, Manila. Frozen dried (Direct Vat Set) cultures containing yoghurt bacteria *Streptococcus thermophilus* and *Lactobacillus bulgaricus* were obtained from IMCD Philippines Corporation in Makati, Manila. The experiment was conducted at Food Laboratory of Colegio de San Juan de Letran.

METHODS

Preparation of Fresh Papaya Extract

Collected papaya fruit (*Carica papaya L.*) were washed with distilled water. The skin and the seed were separated with the help of knife aseptically. The prepared fruits were extracted using extract maker and homogenizer without addition of any water. Immediately, the extract was filtered using a clean cheese cloth to remove foreign matters and was pasteurized for 90˚C for 5 minutes. Pasteurized extract was stored in sterilized bottle, and then cooled immediately at refrigerator temperature of 4˚C (Jayalalitha, Manoharan, Balasundaram, and Elango, 2015).

Preparation of Papaya Yoghurt

For the preparation of yoghurt mix, fresh cow's milk was used and pasteurized at 72°C for 15 minutes. While the starter cultures have a desired growing temperature, the milk was cooled to 42°C. After that, the cultures were inoculated in the cooled milk and the papaya extracts were added in different formulations such as 10%, 15%, and 20%. Then it was incubated at 42°C until it coagulates or the gel structure was formed for 5-6 hours. Lastly, the treatments were cooled after complete coagulation at 4°C to stop the fermentation process. All treatments were stored until sensory evaluation, physico-chemical, and microbial analysis were carried out (Teshome et al., 2017)

Table 2. Formulation Of The Papaya Yoghurt With Their Respective Amount Of Ingredients

Ingredients	**Control**		**10%**		**15%**		**20%**	
	%	**ml**	**%**	**ml**	**%**	**ml**	**%**	**ml**
Papaya extract	0	0	10	25	15	37.5	20	50
Whole milk	97.5968	243.992	87.5968	218.992	82.5968	206.492	77.5968	193.992
Skim milk	2	5	2	5	2	5	2	5
Sugar(Natural Sweetener)	0.4	1	0.4	1	0.4	1	0.4	1
Yoghurt culture	0.0032	0.008	0.0032	0.008	0.0032	0.008	0.0032	0.008
TOTAL	**100**	**250**	**100**	**250**	**100**	**250**	**100**	**250**

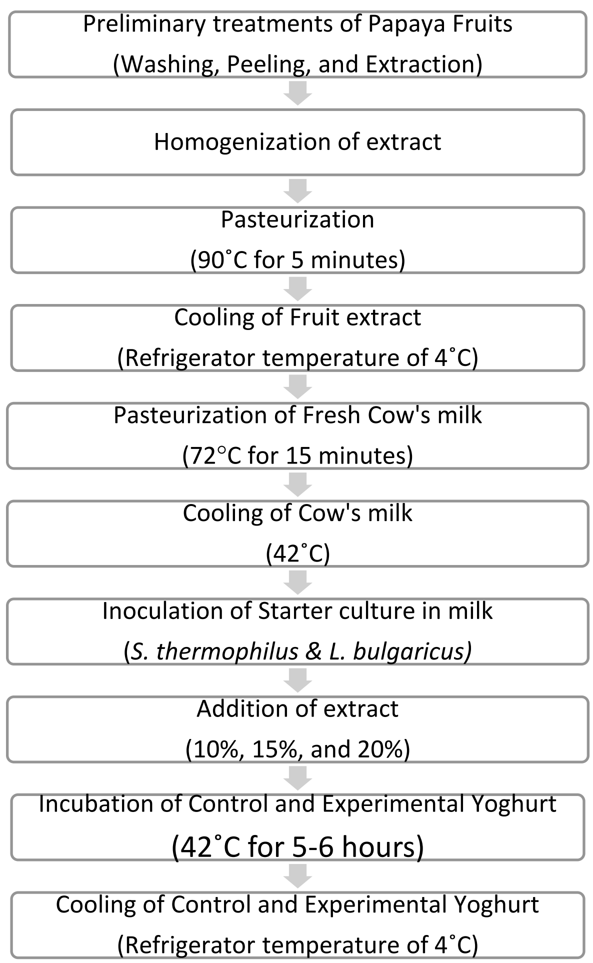


Figure 2. Process Flow in Making Papaya Yoghurt

Sensory Evaluation of Papaya Yoghurt

Sensory evaluation of the yoghurt samples was conducted to determine the acceptability of yoghurt for color, flavor, taste, odor and overall acceptability using a 9-point hedonic scale. The evaluation was conducted to eighty (80) untrained panelists comprised of female and male students, aging 18-24 of Colegio de San Juan de Letran. They were chosen on the basis of their availability, willingness and commitment to partake in the sensory evaluation.

The yoghurt samples (control and different formulations of papaya-flavored yoghurt) were served cold and placed in a white soufflé paper cup. About 30ml of each sample was served to the panelists. Evaluation was done at room temperature at Sensory Laboratory of the Colegio. Fruit yoghurt samples were coded with 3-digit random numbers and each panelist scored and recorded independently on the evaluation sheets provided. Panelists were required to rinse their mouths with warm water before the commencement of tasting. To minimize possible carry over effects, panelists were also required to rinse their mouths thoroughly with warm water after each tasting and wait 90 seconds before tasting the next sample (Teshome et al., 2017).

Chemical Analysis

Proximate Analysis

The Control and the Experimental products were subjected to determine the moisture, ash, protein content, total fat, and total carbohydrates of the papaya fruit yoghurt. 300-500 grams of each sample in specified treatments of papaya fruit were carried out in the test analysis. All the analysis was carried out based on the Official Methods of Analysis of Association of Official Analytical Chemists (AOAC) (1995) and conducted a day after the processing of the yoghurt. Only the 15% of the formulation was subjected to the chemical analysis. This was based on the recommended formulation by the FDA.

Moisture Content

The moisture content of the yoghurt products was determined using the Gravimetric method. Each yoghurt product (10 g) was placed in drying oven at 105°C for 3 hours. Reading was taken at a constant weight using the formula for measuring the weight or moisture loss: initial weights subtract with final weight then divide by the moisture content then multiply by 100 to express the percentage (%) of the dry weight of sample (Olugbuyiro and Oseh, 2011).

$$MC = \frac{(W_i - W_f)}{W_i} \, x \, 100$$

Where: W_i = initial weight
W_f = final weight
MC = moisture content

Ash content

Ash content of the samples was measured gravimetrically by using dried portion of total solid in the muffle furnace. Twenty five grams of the sample were weighed into aluminum dish. About 1 ml 50:50 (ethanol:glycerol) solution was added. It was char over a low Bunsen flame. Ash was at 550°C for 5 hours then weighed (Michael and Frank, 2004).
For the calculation for %Ash:

$$\%Ash = \frac{\textit{weight of residue in crucible after ashing}}{\textit{weight of sample}} \times 100$$

Fat Content

The fat content was determined by the modified Mojonnier ether extraction method (AOAC, 1995). The extracted fat was dried to a constant weight and expressed as percent fat per weight (Olugbuyiro and Oseh, 2011).

Protein

The protein was determined using Kjeldahl method (AOAC, 2000).

Carbohydrates

Carbohydrate content was determined by computation. It was calculated by deducting the sum of values of moisture, protein, fat and ash from 100 (100 - (% moisture + % ash + % Protein + % fat)) (Madruga et al., 2013).

Physico-chemical Analysis of Fruit Yoghurt

pH Value

The pH value was determined using an electrometric pH. The pH values were determined directly from the meter readings (Teshome et al., 2017).

Titratable Acidity as Lactic Acid

Titratable acidity (expressed as % lactic acid) of flavored yoghurt was determined by titration with 0.1N sodium hydroxide solution using phenolpeltalein as indicator (Teshome et al., 2017).

Microbial Analysis

The Control and the Experimental products were subjected to determine the *Staphylococcus aureus, Salmonella, Escherichia coli*, Coliform and Lactic acid bacteria count. About 300-500 grams of each sample were carried out in the test analysis. Microbial analyses were based on the Bacteriological Analytical Manual except for Lactic Acid Bacteria, which was based on Compendium of Methods for the Microbiological Examination of Foods and conducted a day after the processing of the yoghurt. Only the 15% formulation was subjected to the microbial analysis. This was based on the recommended formulation by the FDA.

Staphylococcus aureus

The *S. aureus* was done by Spread Plate method using Baired Parker Agar. Twenty grams of each sample were added to 80 ml of water blank and homogenized as a primary dilution and represented a dilution factor of 5. 0.5 ml was pipetted on each sample using Baired Parker Agar. The inoculum was spread over surface of agar plate, using sterile bent glass streaking rod. Plates were retained in upright position until inoculum was absorbed by agar (about 10 min. on properly dried plates). Plates were inverted and incubated for 45-48 h at 35-37°C. After incubation, a black, shiny surrounded by clear zones was counted, and then result was recorded and the number of presumptive colonies per gram of sample was calculated (Bennett and Lancet, 2001).

Salmonella

The *Salmonella* was done conventionally using Nutrient Agar (AOAC, 2000).

Escherichia coli and Coliform

E. coli was done by Pour Plate method using Violet Red Bile Agar. Thirty grams of each sample were added to 270 ml of 0.1% peptone water to prepare at 1:10 dilution and were mixed using a stomacher. The 1:10 dilution was serially diluted to 10^{-3}. One ml aliquots of the dilutions were pour-plated in duplicates using Violet Red Bile Agar (VRBA). The plates were incubated at 35°C for 18-24 hours. Purple-red colonies with diameter of 0.5 mm or larger and surrounded by precipitate bile acids were counted under a Quebec Colony counter. One ml each of the 10^{-} dilutions of the samples were likewise subcultured onto 5 tubes of Flourocult Brila Broth (FBB) and incubated at 35°C for 18-24 hours. Presence of gas, fluorescence and indole production in FBB indicates the presence of *E. coli.* Plates with no colony counts were reported as <CFU/g multiplied by the reciprocal of the dilution from where they were counted (Maturin and Peeler, 2001).

Lactic acid bacteria count

Lactic acid bacterial count was done by Pour Plate method using lactobacillus MRS agar. One ml of each yoghurt sample was homogenized using vortex mixer with 9 ml sterile peptone water. Then, one ml of homogenized sample from appropriate serial dilutions was poured-plated on the melted MRS agar in duplicate. It was then incubated in anaerobic jars at 35°C±2 for 48 hours.

Colonies of lactic acid bacteria were counted and expressed as colony forming units per ml (CFU/ml) (Teshome et al., 2017).

Statistical Analysis

The data that was collected from the sensory evaluation of the samples was analyzed using ANOVA tests to measure the specific differences between pairs of means. Results were expressed as means with standard deviations of analysis. One-way analysis of variance was used to establish the significance of differences among mean values at $p < 0.05$ (Ashton, 2015).

RESULTS AND DISCUSSION

Proximate Composition

The table below shows the proximate analysis of the yoghurt samples for ash, proteinmoistue, fat content, and carbohydrates.

Table 3. Proximate composition of the plain yoghurt and fruit yoghurt with 15% papaya extract

Parameters	**Plain Yoghurt (g/100mL) (Control)**	**Papaya Yoghurt (g/100mL) (15%)**
Ash	0.99	0.91
Protein	3.5	3.3
Moisture	87.0	87.1
Fat	3.7	2.8
Carbohydrates	7.9	9.0

According to the results shown in Table 3, the values of the control (plain yoghurt) and the experimental (15% papaya extract) were different. The ash, protein, and fat decreased in experimental, with values of 0.91, 3.3, and 2.8, respectively. While for the control, the values were 0.99, 3.5, and 3.7 for ash, protein, and fat, respectively. The results were influenced by the papaya extract, which has lower ash constituents compared to cow's milk (Teshome et al., 2017). Minerals contributed to ash content and papaya are known to be highly nutritious although the minerals found in ripe papaya are in small amounts (Pinnamaneni, 2017). This was also seen in the lower protein and fat content affected by the addition of papaya extract. Fruits have lesser fat content than milk. But fat gives an important factor in quality of yoghurt (Thomas et al., 2017). For the moisture content, it was nearly the same for the control and the experimental. The experimental has higher moisture content of 87.1 while the control was 87. The cause of the higher moisture content of the experimental was the added fruit extract compared to the control, which was plain yoghurt.

The carbohydrate content was higher in the papaya yoghurt (9.0) than in plain yoghurt (7.9). Addition of extract increased the nutrient content of yoghurt. Similar finding was observed by Hossain et al. (2012): the carbohydrates content of grape yoghurt was increased because grape contains more sugar than milk. Moreover, Debashis et al. (2015) reported that the banana yoghurt carbohydrate content is 17.37%. 17.13% of CHO was found in control sample. The finding of CHO content in banana yoghurt sample was appreciated because of glucose, fructose, and sucrose in banana pulp.

Physico-chemical Composition

The table below shows the physico-chemical properties of control and papaya yoghurt.

Table 4 Physico-Chemical Composition of Plain Yoghurt and Papaya Yoghurt

Parameters	**Plain Yoghurt (g/100mL) (Control)**	**Papaya Yoghurt (g/100mL) (15%)**
pH value	4.26 (25.5 °C)	4.16 (25.6°C)
Titratable Acidity as Lactic Acid, %w/v	0.93	1.1

Result showed that papaya yoghurt has a lower pH (4.16) than the plain yoghurt (4.26). The variation of the pH is due to the effect of the fruit extract. Addition of papaya decreased the pH in yoghurt. Similar observation was made by Teshome et al. (2017), that addition of fruit extract to the yoghurt decreased the pH, whereas titratable acidity increased with addition of fruit extract. The papaya yoghurt sample was found to be more acidic (1.1 %) than the plain yoghurt (0.93 %) because of its lower pH (4.16). Fruit extract is more acidic than raw milk that increased acidity in yoghurts. Similar observation was reported by Debashis et al. (2015), who reported that the acidity of yoghurt was increased with addition of banana, papaya and watermelon. This finding also was in agreement with the study of Hossain et al. (2012), where they said the acidity content of fruit yoghurts increased because of high content of these in the fruits (strawberry, orange and grape).

Microbiological Requirements

The table below shows the result of the microbial analysis of the yoghurt samples. The microbiological requirements in this study consist of *Staphylococcus aureus, Escherichia coli, Coliforms, Salmonella* and *Lactic Acid Bacteria*.

Table 5. Microbiological Analysis of Papaya Yoghurt

Parameters	**Plain Yoghurt (g/100mL)**	**Papaya Yoghurt (g/100mL) (15%)**
S. aureus, CFU/mL	<10 est.	<10 est.
E. coli, CFU/mL	Absent	Absent
Coliforms, CFU/mL	<10	<10
Salmonella, in 25 mL	Absent	Absent
Lactic Acid Bacteria, CFU/mL	1.1x10^6	1.5x10^6

Food and Drug Administration of the Philippines', established under the FDA Act of 2009, Bureau Circular No. 01-A s.2004, guidelines for the Assessment of Microbiological Quality of Processed Food are related to food safety and are laying down the standards of food in the Philippines. The microbiological criterion of yoghurt under Philippine regulations is presented in Table 6. The table below presented the microbiological standard of yoghurt in the Philippines.

Table 6. Microbiological Standard of Yoghurt in the Philippines
Source: FDA, 2013

Requirement	**Acceptable Level**
S. aureus, CFU/mL	<100 cfu/ml
E. coli, MPN/mL	0 cfu/ml
Coliforms, CFU/mL	<100 cfu/ml
Salmonella, in 25 mL	0 cfu/25ml
Lactic Acid Bacteria, CFU/mL	≥1x10^6

The microbial load shown in Table 5 of control and papaya yoghurt were <10est. cfu/ml *(S. aureus)* and <10 cfu/ml (Coliform count), and absent in *E.coli* and *Salmonella.* Moreover, the lactic acid bacteria counts of the sample yoghurts were 1.1x10^6 cfu/ml (plain yoghurt) and 1.5x10^6 cfu/ml (papaya yoghurt). The data showed that both yoghurt samples met the prescribed minimum viable count of 10^6 CFU/ml or gram. The values obtained for microbial count are within the standard limt set by Philippine Food and Drug Administration, which is safe for human consumption and not susceptible for microbial growth. Therefore, the developed yoghurt is within satisfactory microbial quality.

The presence of *S. aureus* in yoghurt usually indicates contamination from food handlers through hand or arm lesions caused by *S. aureus* or by coughing and sneezing, which is common during respiratory infections or in symptomatic carriers that come in contact with food (Hussain, 2010). The sample was considered safe when the count did not exceed 100 cfu/ml (FDA, 2013). *Salmonella* species were not detected in any of the yoghurt samples. This could be due to the addition of preservatives to prevent growth of pathogens and to prevent reuse of starter cultures of choice. The sample was considered safe when *Salmonella* was not detected in the food (FAO, 1979). *Escherichia coli,* an indicator organism of fecal contamination, were not detected from the yoghurt samples. It is commonly used as surrogate indicator and must be negative to be safe for consumers based on FDA regulations. Absence of *E-coli* stated that the yoghurt sample is safe for consumption (Shojaei and Yadollahi, 2010). Coliform was observed in both yoghurt samples (<10cfu/ml). Based on FDA standards, the coliform bacteria count must not exceed 100 cfu/ml. The result showed that coliform detected is within the acceptable level. Presence of coliforms might be from poor hygiene or cross contamination from handlers (Birollo, Reinheimer and Vinderolla, 2011). Enumeration of viable LAB counts were done on plain and papaya yoghurt. According to Teshome et al. (2017), lactic acid bacteria count of fruit-flavored yoghurt increased with increase in extract percentage. Moreover, based on the study of Prescott et al. (2005), lactic acid bacteria grow optimally under slightly acidic condition when the pH is between 4.5 and 6.4. In addition to the pH value, concentration of lactose in fruit-flavored yoghurt samples may also influence the growth of lactic acid bacteria.

The microbial load shown in Table 5 of control and papaya yoghurt were <10est. cfu/ml *(S. aureus*) and <10 cfu/ml (Coliform count), and absent in *E.coli* and *Salmonella.* Moreover, the lactic acid bacteria counts of the sample yoghurts were 1.1x10^6 cfu/ml (plain yoghurt) and 1.5x10^6 cfu/ml (papaya yoghurt). The data showed that both yoghurt samples met the prescribed minimum viable count of 10^6 CFU/ml or gram. The values obtained for microbial count are within the standard limt set by Philippine Food and Drug Administration, which is safe for human consumption and not susceptible for microbial growth. Therefore, the developed yoghurt is within satisfactory microbial quality.

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Sensory Evaluation

The data obtained was analyzed using ANOVA to measure specific differences between pairs of means. Results were expressed as means with standard deviations of analysis. One-way analysis of variance were used to establish the significance of differences among mean values at p <0.05 (Ashton, 2015).

The table below shows the summarized mean and standard deviation of the yoghurt samples.

Table 7. Significance of different percentage of papaya yoghurt on consumer acceptability

Samples	Color	Flavor	Taste	Odor	Overall Acceptability
C(plain yoghurt)	7.08±1.56a	7.01±1.46a	7.01±1.45a	6.96±1.11a	7.08±1.56a
P1(10% extract)	7.01±1.38a	7.49±1.49ab	7.61±1.26b	7.2±0.97ab	7.05±1.41a
P2(15% extract)	7.25±1.44a	7.38±1.28ab	7.3±1.36ab	7.35±0.98ab	7.19±1.46a
P3(20% extract)	7.59±1.38a	7.6±1.12b	7.3±1.24ab	7.61±1.20b	7.58±1.40a

Mean±Standard deviation values with different superscript in each column show significant difference: C=control, P1=10% papaya, P2=15% papaya, P3=20% papaya

The statistics showed no significant difference in Color and in Overall Acceptability. For the Color, there was no significant difference among the samples at *p-value=0.05.* The P3, which was the yoghurt with 20% papaya, has the highest mean (7.59±1.38), and the P1 (10% papaya) was the lowest (7.01±1.56). The addition of papaya in different percentages didn't significantly affect the color of the yoghurt. This was also seen in the Overall Acceptability, which has no significant difference. The different formulations of papaya in the yoghurt did not make significant changes on the Overall Acceptability of flavored yoghurt. The highest mean was found in the P3 (7.58±1.40) and the lowest was P1 (7.05±1.56).

The computed results showed significant differences in Flavor, Taste, and Odor. The flavor was found statistically different at p-value (<0.05). Using *t-test,* the significant difference between C and P3 was determined. They had a mean of 7.01±1.46 and 7.6±1.12, respectively. It is significantly different because C was the control or no added papaya fruit extract in the yoghurt, while P3 (20%) has the highest percentage of papaya fruit extract among the other samples. The papaya gave sweetness and fruit flavor on the yoghurt, which made it mostly acceptable. This was also observed in the study of Teshome et al. in 2017, where papaya fruit extract improved the sensory properties of yoghurt. The taste was statistically different at p-value (<0.05). Specifically, the samples C and P1 were found significantly different with each other. P1 have 10% papaya fruit extract and it has the highest mean of 7.61±1.26, while C was 7.01±1.45. The change in the taste was observed in P1 because of the added 10% papaya fruit extract. It removed the plain sourness of the C. Also, in the study of Punnagaiarasi et al. in 2016, the extract that was added helped in the consumption of yoghurt. Odor also showed statistical difference at p-value (<0.05), specifically C and P3. The mean of P3 was 7.58±1.40, which was the highest among the samples. The papaya added sweetness in the odor of the flavored yoghurt samples, making it significantly different with plain yoghurt. The results showed that the addition of papaya extract in different formulations improved the sensory qualities of the yoghurt.

The figure below presented the graphical presentation of each coded sample based on the following parameters: color, flavor, taste, odor and overall acceptability.

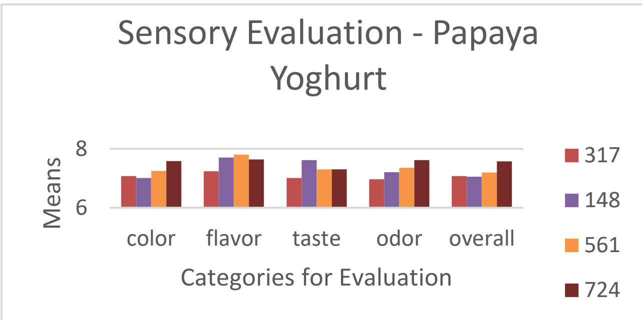

Figure 2. Graphical Presentation of each Coded Sample based on Color, Flavor, Taste, Color and Overall Acceptability

Legend: *317 (Control); 148 (10% papaya); 561 (15% papaya); 724(20% papaya)*
9-point hedonic rating scale (9=like extremely; 8=like very much; 7=like slightly; 6=like; 5=like nor dislike; 4=dislike; 3=dislike slightly; 2=dislike very much; 1=dislike extremely)

Product Costing

In this study, the researchers used cost plus strategy in order to set the price of the product. The computation would be: Purchase Cost + Mark-up + Labor Cost = Selling Cost

Product Costing of Papaya Yoghurt

Purchase Cost = $Php\ 41.72$
Packaging Cost= Php 8.00
Mark-up Price $= Php\ 41.72 \times 0.20$
$= Php\ 8.34$
Labor Cost $= Php\ 41.72\ x\ 0.10$
$= Php\ 4.17$
Selling Cost $= Php\ 41.72 + Php\ 8.00 + Php\ 8.43 + Php\ 4.17$
$= \boldsymbol{Php\ 62.32/Bottle}$ (250ml)

The table below shows the price comparison of the papaya yoghurt to commercial yoghurt. Price was based per 250 ml.

Table 8. Price Comparison of Papaya Yoghurt with Commercial Yoghurt

Product Name	**Brand Name**	**Retail Price**	**Papaya Yoghurt Price**	**Price Difference**	**% Difference**	**Remarks**
Flavored Yoghurt Drink	Mr. Moo	248.75	62.32	186.43	74.95%	Lower
Strawberry Flavored Yoghurt	Nestle	75	62.32	12.68	16.91	Lower
Peach Strawberry Yoghurt	Emborgh	77	62.32	14.68	19.06	Lower
Mixed Berry Yoghurt	Zott	108	62.32	45.68	42.3	Lower

Table 9. Price Breakdown

INGREDIENTS	Weight(ml)	Price (Php)	Amt. needed(m	Total (Php)
Whole Milk	200ml	Php 35.00	206.50	Php 36.45
Skim Milk	250ml	Php 60.00	5.00	Php 1.20
Papaya Extract	1000ml	Php 50.00	37.50	Php 1.87
Sugar	1 ml	Php 2.2	1.00	Php 2.2
Yoghurt Culture	30,000 ml	Php 2680	.008	Php .007
Total				Php 41.72

Based on the price comparison with the commercial yoghurts, the papaya yoghurt has a lower price compared with the commercial yoghurt. Therefore, the papaya yoghurt has a competitive advantage in terms of price based on the price comparison conducted.

Packaging

The label features a transparent background, with peach color corresponding to the product variety. Graphics featured prominently in a handwritten-style font followed by the papaya picture in the upper part. Rectangular paperboard cartons or cups (with or without an aluminum foil layer), PP, blow-molded high-density polyethylene (HDPE), and glass containers are all in common use as packaging for yoghurt drinks (Mohan, 2017). The use of glass maintains through its rigidity of the glass that helps the yoghurt to stabilize without the use of added cornstarch or gelatin. The papaya yoghurt was packed in a 250ml clear glass bottle.

Figure 3. The packaging of the papaya yoghurt.

CONCLUSION

Fruits could be added to yoghurt in order to increase the nutritional quality and improve the sensorial properties of yoghurts. In this research, papaya extract was utilized in the production of yoghurt and it was found nutritionally and organoleptically acceptable. The addition of papaya extract affects the physico-chemical and proximate properties of the yoghurt. It decreased the ash, protein, fat, and pH and increased the moisture, carbohydrates and lactic acid. The microbiological requirement of all the yoghurt samples was within the standard limit. Moreover, the lactic acid bacteria count met the prescribed minimum viable count. The sensory analysis showed statistical difference in flavor, taste and odor but it showed no statistical difference in color and overall acceptability of the yoghurt samples. The 20% papaya yoghurt was most preferred over the other formulations. Therefore, fruit yoghurt, namely papaya yoghurt, could be processed and recommended to the people.

RECOMMENDATION

The important analyses that still need to be determined for the yoghurt samples are the following: shelf life study, nutritional value and microbial analysis on *Listeria monocytogenes and Yeast and Mold count.* Also, the other formulations (10% and 15%) must be analyzed for physical, chemical and microbial qualities. Future works may consider the following factors that affect the quality of the papaya yoghurt: fermentation conditions, formulation of the papaya extract, starter culture, and storage and handling conditions.

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