UTILIZATION AND PROCESS OPTIMIZATION OF NATURALLY FERMENTED IMMATURE JACKFRUIT (*Artocarpus heterophyllus* Lam.)

SUBMITTED TO DR. IVY C. EMNACE OF THE DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY, VISAYAS STATE UNIVERSITY, VISCA, BAYBAY CITY, LEYTE AS SUBJECT REQUIREMENT IN FTEC 252-ADVANCED FRUITS AND VEGETABLES PRODUCT PROCESSING

Aguanza, Ma. Aezel M.
Furing, Paul Ian A.
Magallanes, Judife N.
Valdevieso, Leilani M.

May 2017

Table of Contents

ABSTRACT x

INTRODUCTION 1

Nature and Importance of the Study 1

Objectives of the Study 3

Scope and Limitation of the Study 4

Time and Place of the Study 4

REVIEW OF LITERATURE 5

Jackfruit 5

Lactic Acid Bacteria 6

Lactic Acid Fermentation on Fruits and Vegetables 7

Plackett Burman 9

MATERIALS AND METHODS 10

Procurement of Raw Materials 10

Preliminary Experiment 10

Variable Screening 10

Basic Product Preparation 11

Experimental Design 12

Sensory Evaluation 13

Physico-Chemical Analysis 14

Microbial Analysis 15

Physico-Chemical Analysis 16

Sensory Quality Evaluation 16

Relative Cost Analysis 16

RESULTS AND DISCUSSION 17

Sensory Qualities of Fermented young jackfruit 17

Color 20

Aroma 22

Taste 23

Flavor 25

Firmness 26

General Acceptability 28

Attaining the Optimum Formulation 29

Production Cost 30

Physico-chemical properties 31

Microbial Evaluation 40

SUMMARY, CONCLUSION AND RECOMMENDATION 44

Summary and Conclusion 44

Recommendation 46

REFERENCES 47

APPENDICES 53

Appendix A. Variable Screening Acceptability Sheet... 53

Fermented Immature jackfruit 53

Appendix B. Sensory Evaluation Score Sheet.. 54

APPENDIX TABLES.. 55

List of Tables

Table 1. Pluckett Burman Design ____ 9

Table 2.Experimental Combinations of Fermented youg jackfruit. ____ 13

Table 3. Summary of mean acceptability for the sensory attributes of fermented immature jackfruit with varying concentration of spices and brine solution. ____ 17

Table 4.Summary of cross-tabulation for quality on the sensory attributes of fermented jackfruit ____ 18

Table 5 Summary of parametric estimates for the acceptability of all sensory attributes. 19

Table 6.Critical point of acceptability on sensory qualities of fermented jackfruit. ____ 20

Table 7. Summary of analysis of variance for the slurry and jackfruit's TSS, pH and TA of fermented jackfruit at 4 days fermentation as affected by the varying concentration of brine and spices. ____ 32

Table 8.Summary of parameter estimates for the slurry and jackfruit's TSS, pH and TA of the fermented jackfruit at 4 days fermentation as affected by the varying concentration of spice and brine solution. ____ 32

Table 9. Summary of critical values and predicted values at stationary point for the slurry and jackfruits TSS, pH and TA of the fermented jackfruit as affected by varying concentration of spice and brine solution. ____ 33

Table 10. Microbial plate count of fermented jackfruit. ____ 41

Table 11. Analysis of variance between variables. ____ 42

Table 12. Analysis of variance on days of fermentation. ____ 43

List of Figures

Figure 1. Use and Functional Ingredients of Lactic Acid Bacteria (Florou-Paneri P., et al. 2010) 7

Figure 2. Process flow diagram of fermented young jackfruit. 12

Figure 3.Contour plot for color acceptability of fermented jackfruit. 21

Figure 4.Contour plot for aroma acceptability of fermented immature jackfruit. 23

Figure 5.Contour plot for taste acceptability of fermented immature jackfruit. 25

Figure 6. Contour plot for flavor acceptability of fermented immature jackfruit. 26

Figure 7.Contour plot for firmness acceptability of fermented immature jackfruit. 27

Figure 8. Contour plot of general acceptability of fermented jackfruit. 29

Figure 9. Superimposed acceptability plot of color, aroma, taste, flavor, firmness, and general acceptability value >7.17 at Php.144.05 per 500g product cost. 30

Figure 10.Contour plot of fermented jackfruit production codt in laboratory scale. 31

Figure 11.Graphical presentation of (a) pH of slurry, (b) TSS of slurry and (c) TA of slurry. 35

Figure 12.Graphical presentation of (a) pH of jackfruit, (b) TSS of Jackfruit and (c) TA of jackfruit 38

Figure 13.Microbial count of fermented immature jackfruit. 41

List of Appendix Tables

Appendix Table 1. Parameter estiamtes for response surface of color acceptability for fermented jackfruit. 55
Appendix Table 2. Parameter estimates for response surface of aroma acceptability for fermented jackfruit. 55
Appendix Table 3. Parameter estimates for response surface of taste acceptability for fermented jackfruit. 56
Appendix Table 4. Parameter estimates for response surface of flavor acceptability for fermented jackfruit. 56
Appendix Table 5. Parameter estimates for response surface of firmness acceptability of fermented jackfruit. 57
Appendix Table 6. Parameter estimates for response surface of general acceptability for fermented jackfruit. 57
Appendix Table 7. ANOVA of the color acceptability for fermented jackfruit. 58
Appendix Table 8.ANOVA of the aroma acceptability for fermented jackfruit. 58
Appendix Table 9. ANOVA of the taste acceptability for fermented jackfruit. 58
Appendix Table 10. ANOVA of the flavor acceptability for fermented jackfruit. 59
Appendix Table 11. ANOVA of the firmness acceptability for the fermented jackfruit. 59
Appendix Table 12. ANOVA of the general acceptability for the fermented jackfruit. 59
Appendix Table 13. Critical values of color acceptability for fermented jackfruit. 60
Appendix Table 14. Critical values of the aroma acceptability for fermented jackfruit. 60
Appendix Table 15. Critical values of the taste acceptability for fermented jackfruit. 60

Appendix Table 16. Critical values of the flavor acceptability for the fermented jackfruit. ____ 60

Appendix Table 17. Critical values of the firmness for the fermented jackfruit. ____ 60

Appendix Table 18. Critical values of the general acceptability for the fermented jackfruit. ____ 61

Appendix Table 19. ANOVA of the TSS-slurry. ____ 61

Appendix Table 20. ANOVA of the slurry's pH. ____ 61

Appendix Table 21. ANOVA of the slurry's TA. ____ 62

Appendix Table 22. ANOVA of the jackfruit's TSS. ____ 62

Appendix Table 23. ANOVA of the jackfruit's pH. ____ 62

Appendix Table 24. ANOVA of the jackfruit's TA ____ 63

Appendix Table 25. Parameter estimates of slurry's TSS. ____ 63

Appendix Table 26. Parameter estimates of slurry's-pH. ____ 64

Appendix Table 27. Parameter estimates of slurry's TA ____ 64

Appendix Table 28. Parameter estiamtes of jackfruit's TSS ____ 65

Appendix Table 29. Parameter estimates of jackfruit's pH. ____ 65

Appendix Table 30. Parameter estimates of jackfruit's TA ____ 66

Appendix Table 31. Critical values of slurry's TSS ____ 66

Appendix Table 32. Critical values of slurry's pH. ____ 66

Appendix Table 33. Critical values of slurry's TA ____ 66

Appendix Table 34. Critical values of the jackfruit's TSS ____ 67

Appendix Table 35. Critical values of the jackfruit's pH. ____ 67

Appendix Table 36. Critical values of the jackfruit's TA. ____ 67

Appendix Table 37. Raw microbial count ____ 67

Appendix Table 38. Production cost in laboratory scale of fermented jackfruit. ____ 70

Appendix Table 39. Raw data on the acceptability score of Treatment 1. ____ 71

Appendix Table 40. Raw data on the acceptability score of Treatment 2. ____ 72

Appendix Table 41. Raw data on the acceptability of Treatment 3 ____ 73

Appendix Table 42. Raw data on the acceptability of Treatment 4. ____ 74

Appendix Table 43. Raw data on the acceptability of Treatment 5. ____ 75

Appendix Table 44. Raw data on the acceptability of Treatment 6. ____ 76

Appendix Table 45. Raw data on the acceptability of Treatment 7. ____ 77

Appendix Table 46. Raw data on the acceptability of Treatment 8. ____ 78

Appendix Table 47. Raw data on the acceptability of Treatment 9. ____ 79

ABSTRACT

This study was conducted to develop a process that will add value to the so-called nutrient competitor young jackfruit (farm waste). This study aimed to utilize and transform the young jackfruit into a fermented product. Plackett- Burman variable screening and 3x3 Factorial Experiment in Incomplete Block Design with 5%, 10%, 15% spices and 10%, 15%, 20% brine concentration were the independent variables being used. Statistical analysis on the sensory evaluation of the fermented young jackfruit revealed that an increase in brine concentration, salt significantly affects the acceptability of the product in terms of its taste and color. However, parameter estimates tells that the use of spice and brine solution in fermenting the young jackfruit gives a positive result to its sensory parameters, provided that brine solution should only be limited to an amount of 11.67% to expect high acceptability score. Based on the superimposed plots of sensory acceptability of the product, it was pointed out that the acceptability at 7.17 will intersect at 14.2% spice and 11.5% brine solution with a breakeven price of 144.06 per 500g of fermented immature jackfruit. Statistical analysis revealed that the Slurry’s TSS, pH and TA were significantly affected by linear and quadratic interactions of the independent variables. Similarly, statistical analysis on the physicochemical properties of the jackfruit showed that TSS, pH and TA were only significantly affected by the linear interaction of spice and brine. Statistical analysis also showed that there was a significant changes in the products physico-chemical properties during the 4 days of fermentation, greatly influenced by the interaction of the independent variables. Microbial count during fermentation was also monitored, results shows that at 10-15% spice concentration and 10% brine concentration

low microbial count was observed this is due antimicrobial properties of spices; and with 20% brine concentration with lower spice level have also low microbial count. Fermentation therefore could be used as method for the utilization of young jackfruit.

INTRODUCTION

Nature and Importance of the Study

The purposeful application of fermentation in food and beverage preparation, as means to provide palatability, nutritional value, preservative and medicinal properties, is an ancient practice. Fermented foods and beverages continue to make a significant contribution to overall patterns of traditional dietary practices. The human microbiome increases, including its connection to mental health such as anxiety and depression, it become increasingly clear that there are untold connection between human resident microbes and many aspect of physiology. Selhub et al. (2014), found out that fermented foods so often included in traditional dietary practice have the potential to influence brain health by virtue of the microbial action that has been applied to the food or beverage directly influences our own microbiota. This could manifest, behaviorally, via magnified antioxidant and anti-inflammatory activity, reduction intestinal permeability, improve glycemic control, positive influence on nutritional status and direct role in gut-to-brain communication via beneficial shift in intestinal microbiota itself.

Since, today's era focused on beauty and wellness. The trend also goes along with it including food we part take. Fermentation is part of one of the top products in 2016: processing the natural way. Fermented food becomes the "in" product in the food industry specifically the yoghurt, kimchi and pickled fruits and vegetables. Now, in big and established business fermented foods grew by 7% gross income (Anonymous 2017). Hence, it's a good time to take a calculated risk on product development that links to some powerful growth trends. Fermented vegetables are a well-established idea in consumer's mind, they are traditional food format and on offering a fermented vegetable based snack that is ready-to-eat can connect to that idea of traditional use and credible.

It is widely accepted that the beneficial effects of fruits and vegetables for the prevention of certain diseases are due to bioactive compounds they contain (Galaverna G., et.al., 2008). The increased interest in the role of consumer's diet that plays in the prevention and treatment in many illnesses has become widely ratified, these poses a great challenge on the part of researchers and food industries into how food products can help maintain health. A stepping stone in meeting this increased consumers conscious demands is through literature support on the chemical composition of the raw material. Jackfruit's chemical composition for instance contains vitamin A, vitamin C, thiamine, riboflavin, calcium, potassium, iron, sodium, zinc, and niacin among many other nutrients (Shrikant, et.al., 2012). Another benefit of eating jackfruit is that it is a good source of vitamin C. The health benefits of vitamin C are that it is an antioxidant that protects the body against free radicals, strengthens the immune system, and keeps our gums healthy, it is also a rich source of phytochemicals, including phenolic compounds, and offers opportunities for the development of value-added products, such as neutraceutical and food applications to enhance health benefits (Umesh, JB., et.al., 2010). According to Wongsa P and Zamaluddien A., 2005) total phenolic content in jackfruit is 0.36 mg GAE/100 g DW (milligrams of Gallic acid equivalent per gram of dry weight). Phenolic compounds in fruits and vegetables have been suggested to be a major source of bioactive compounds for health benefits (Shrikant,B., et.al., 2012). Natural sources of phenolic compounds and inhibitors of digestive enzymes from food sources have provided an opportunity for low-cost dietary management for cardiovascular diseases (McDougall, GJ., et.al., 2005). Young or immature jackfruit is high in phenolic compounds giving it an astringent character. This young jackfruit can be consumed and can be processed into a functional foods that can provide more than simple nutrition; it can supply additional physiological benefits to the consumer. The concept of changing and utilizing the so called nutrient competitor young jackfruit into a promising fermented food is an example of raising the value of this commodity. Recently, there is an increasing great interest in the scientific community in the functional properties of jackfruit and its product derivatives such as seed flour, utilization of its peel, rags and pith. The jackfruit could be considered a functional food because it has valuable compounds in different parts of the fruit that display functional and medicinal effects (Shrikant,B., et.al., 2012).

The utilization of immature jackfruit as fermented vegetable could be an excellent development. Hence, this study will be conducted.

Objectives of the Study

Generally, this study was conducted to develop a process that adds value to the so called nutrient competitor young jackfruit (farm waste) into a fermented food product.

This study also aims to:

1. Utilize the whole of young jackfruit into a fermented product;
2. Conduct screening of variables that may affect the sensory acceptability of the fermented immature jackfruit.
3. Perform optimization experiment using the significant variables left after the screening;
4. Evaluate the effects of variables on the sensory quality and physico-chemical properties of the fermented young jackfruit.

5. Monitor and determine the changes of the physico-chemical properties (pH, TSS, TA) and microbiological changes during the 4 days of natural fermentation;
6. Determine the optimum combination conditions in processing the lowest cost and acceptable fermented jackfruit;
7. Determine the cost of producing the product for possible commercial production.

Scope and Limitation of the Study

This study was limited on the variable screening, optimization and quality evaluation of fermented immature jackfruit obtained from Uncle Job's Jackfruit Farm in Brgy. San Isidro, Mahaplag, Leyte. It was also limited to the utilization of the 10 – 40 days AES1 jackfruit variety. The fermented young jackfruit will be evaluated on its sensory quality, selected physico-chemical properties such as pH, Total Soluble Solids (TSS) and Titratable Acidity (TA), and microbial quality and cost of production of its optimum combination.

Time and Place of the Study

This study was conducted at the Department of Food Science and Technology (DFST) of Visayas State University (VSU), Baybay City, Leyte on April to May 2017.

REVIEW OF LITERATURE

Jackfruit

In the report of Sidhu (2012), it present jackfruit's multi-purpose species providing food, timber, fuel, fodder, and medicinal and industrial products. The primary economic product of jackfruit is the fruit which is used both when mature and immature. When unripe (green), it is remarkably similar in texture to chicken, making jackfruit an excellent vegetarian substitute for meat. In fact, canned jackfruit (in brine) is sometimes referred to as "vegetable meat". Jackfruit seeds (nuts) can be roasted like chestnuts, or boiled. The fruit pulp is sweet and tasty and used as dessert or preserved in syrup. The fruits and seeds are also processed in a variety of ways for food and other products. Jackfruit value added products include chips, papads, pickles, icecream, jelly, sweets, beverages like squash, nectar, wine and preserved flakes, etc. Additionally, jackfruit leaves, bark, inflorescence, seeds and latex are used in traditional medicines (Sidhu 2012).

Moreover, jackfruit is an extremely versatile and sweet tasting fruit that possesses high nutritional value. From the time immemorial, the whole jackfruit tree is used as traditional medicine. *Artocarpus heterophyllus* has multifaceted medicinal properties. The medicinal properties of Jackfruit as cited by Tejpal and Amrita (2016) include anti-asmatic, antioxidant, antibacterial, antifungal, anticancer, hypoglycemic, antimalarial, anti-diarrheal, anti-arthritic, anti-helmintic, anti-inflammatory, anti-carcinogenic, anti-platelet, antiviral, anti-tubercular, anti-artherosclerotic activities. It has also shown wound healing effect and causes decrease in the sexual arousal, libido, performance and vigor in men (Tejpal 2016).

Lactic Acid Bacteria

Lactic acid bacteria (LAB) are widespread microorganisms which can be found in any environment rich mainly in carbohydrates, such as plants, fermented foods and the mucosal surfaces of humans, terrestrial and marine animals. In the human and animal bodies, LAB are part of the normal microbiota or microflora, the ecosystem that naturally inhabits the gastrointestinal and genitourinary tracts, which is comprised by a large number of different bacterial species with a diverse amount of strains (Barinov A, et.al., 2011, Selhub EM, et.al, 2014). Phylogenetically the LAB belong to the Clostridium branch of Gram positive bacteria. They are non-sporing, aero tolerant anaerobes that lack catalase and respiratory chain, with a DNA base composition of less than 53 mol% G+C (Stiles ME, and WH Holzapfel 1997).

According to their morphology LAB are divided to rods and cocci and according to the mode of glucose fermentation to homofermentative and heterofermentative. The homofermentative LAB convert carbohydrates to lactic acid as the only or major end-product, while the heterofermentative produce lactic acid and additional products such as ethanol, acetic acid and carbon dioxide (Halasz 2009). Thus, the main metabolism of LAB is the degradation of different carbohydrates and related compounds by producing primarily lactic acid and energy. Although, many genera of bacteria produce lactic acid as primary or secondary fermentation products, typical lactic acid bacteria are those of the Lactobacillales order, including the following genera: *Lactobacillus, Carnobacterium, Lactococcus, Streptococcus, Enterococcus, Vagococcus, Leuconostoc, Oenococcus, Pediococcus, Tetragonococcus, Aerococcus* and *Weissella* (Hutkins 2006). Many strains of LAB are among the most important groups of microorganisms used in the food and feed industries, although some of the genus *Pediococcus* cause deterioration of foods, which results in their spoilage (Johnson-Green 2002). LAB have been used in food preservation and for the modification of the organoleptic characteristics of foods, for example flavors and texture (Barinov A., et al. 2011). Various strains of LAB is used as functional ingredient (see Figure 1) and can be found in dairy products (yoghurt, cheese), fermented meats (salami), fermented vegetables (olives, sauerkraut), sourdough bread, etc. (Korhonen 2010).

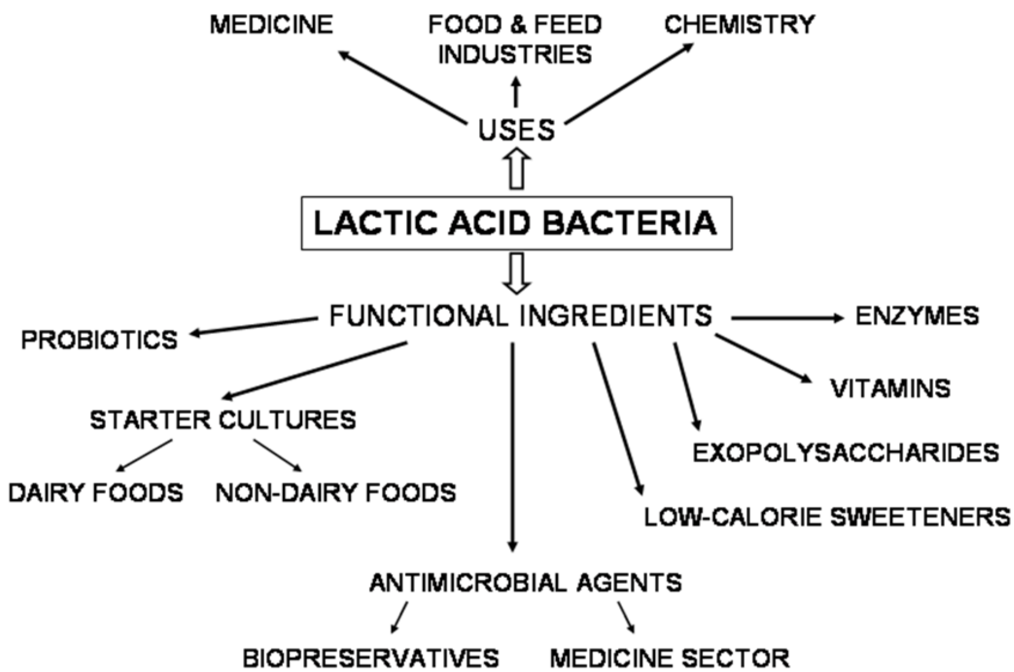


Figure 1. Use and Functional Ingredients of Lactic Acid Bacteria (Florou-Paneri P., et al. 2010)

Lactic Acid Fermentation on Fruits and Vegetables

Lactic acid (LA) fermentation is considered a simple and useful form of biotechnology to keep and/or enhance the safety, nutritional, sensory and shelf life properties of vegetables and fruits (Demir N., et al. 2006). *Lactobacillus* sp. has been used as probiotic organisms. Metchnikoff (1908) described the beneficial effect of lactic acid bacteria on human health century ago. Many literature cited for the last decade have shown the combination of this ancient method off bio-preservation with the current biotechnology tools should allow controlled fermentation processes and the selection of starter cultures to increase the consumption of fresh-like vegetables and fruits (McFeeters 2004 and Di Cagno R., et al. 2013).

Lactic acid bacteria (LAB) convert the carbohydrate contents of the vegetables and fruits into LA, which decreases the pH of the fermented products to around 4.0 ensuring stability. Lower pH value restricts the growth of spoilage flora and pathogenic bacteria. These bacteria improve the human intestinal microbial balance and enhance health by inhibiting the growth of pathogens such as *Escherichia coli, Salmonella* and *Staphylococcus* (Ohmomo S., et al. 2000). They are often considered as probiotic, beneficial for human health and active in lowering the serum cholesterol level (Kaur IP, K Chopra and A Saini 2002). They also stimulate immune responses and prevent tumour formation by inhibiting carcinogenic compounds in the gastro-intestinal tract through reducing fecal bacteria enzyme activity (Nakphaichit M., et al. 2011) or breaking down certain enterotoxins (Bernardeau M., et al. 2006) and influence positive mental health (Selhub EM., et al. 2014).

Fruits are commonly processed for alcoholic fermentation of wine and beer as they are rich in sugars, vitamins, minerals. As juices are slightly acidic, they are therefore a suitable medium for the growth of yeasts, and fruit sugars are rapidly converted into ethanol. Vegetables on the other hand, have low sugar content but are rich in minerals, vitamins, have neutral pH and thus provide a natural medium for fermentation by LAB.

Fermentation of fruits and vegetables can occur ‘spontaneously’ by the natural lactic acid bacterial surface microflora, i.e., *Lactobacillus*, *Leuconostoc* , *Pediococcus*, etc.; however, the use of starter culture such as *Lactobacter plantarum, Lb. rhamnosus, Lb. gasseri* and *Lb. acidophilus* (all probiotic strains) provides consistency and reliability of performance (Di Cagno R., et al. 2013). Pasteurizing or adding preservatives after fermentation, which are commonly done during the industrial production of lactic acid fermented vegetables (e.g., sauerkraut), destroy most of the LAB present, thus cancelling any possible probiotic effects (Montet D., et al. 2006).

Plackett Burman

Developed in 1946 by statisticians Robin L. Plackett and J.P. Burman, it is an efficient screening method to identify the active factors using as few experimental runs as possible. Plackett-Burman experimental design is used to identify the most important factors early in the experimentation phase when complete knowledge about the system is usually unavailable.

Table 1. Pluckett Burman Design

	A	B	C	D	E	F	G
1	+	+	+	-	+	-	-
2	-	+	+	+	-	+	-
3	-	-	+	+	+	-	+
4	+	-	-	+	+	+	-
5	-	+	-	-	+	+	+
6	+	-	+	-	-	+	+
7	+	+	-	+	-	-	+
8	-	-	-	-	-	-	-

Where: High level (+) Low level (-)

MATERIALS AND METHODS

Procurement of Raw Materials

Immature young jackfruits AES1 variety was sourced out from jackfruit plantation in Mahaplag, Leyte and minor ingredients such as garlic, salt, onion, ginger, and mustard was purchased from Baybay City Public Market. Ascorbic Acid that was used in the variable screening was purchased at Cebu City.

Preliminary Experiment

Variable Screening

Preliminary studies were conducted to determine the different variables that significantly affect the sensory acceptability of the fermented immature jackfruit. Input variables were identified to affect the output variables of the product. In order to trim down the variables and eliminate those that do not have significant effect on the final product, screening of the variables was conducted using Plackett-Burman Design (Table 1). The seven input variables identified were: % Ascorbic Acid, Ascorbic Acid soaking time, Alum Concentration, Brine Concentration, Brine soaking time, Spices and Pickling Solution. Table 2 shows the Placket-Burman Design of experiment used in the variable screening. The response variables include color, aroma, taste, firmness and over-all acceptability. The eight runs of the product formulation were subjected to sensory evaluation with 32 semi-trained panelists composed of food technology students. Sensory score sheets used is shown in Appendix A.

Table 2. Minimum and maximum value of variables for 8 run PB screening

Variables	Max Value (+)	Min Value (-)
Ascorbic Acid	5	2
AA Soaking Time	30	10
Alum Concentration	3	1
Brine Concentration	15	5
Brine Soaking Time	18	24
Spices	10%	0
Pickling Solution	with pickling sol.	without pickling sol.

Table 3. Variable screening design for fermented young jackfruit

Run	Variables						
	%AA	AA Soaking t	%Alum Conc	%Brine Conc	Brine Soaking t	Spices	Pickling solution
1	50	30	3	5	8 days	10	2
2	50	30	1	15	4 days	10	1
3	50	10	3	5	4 days	0	1
4	10	30	1	5	8 days	0	1
5	50	10	1	15	8 days	0	2
6	10	10	3	15	8 days	10	1
7	10	30	3	15	4 days	0	2
8	10	10	1	5	4 days	10	2

Basic Product Preparation

The young jackfruit was washed and sanitized with corresponding chlorine concentration for foods (10-20ppm). Then followed the peeling of the fruit and was sliced into strips. The sliced strips was soaked in treated water with ascorbic acid. Then samples was blanched for 1 min. Afterwards it was soaked in different brine solution and corresponding amount of spices for 4 days. After achieving the specified fermentation days, the major ingredients was then drained and washed with purified water. After which, follows the filling of the pickling solution. Figure 2 shows the process flow diagram of the fermented young jackfruit.

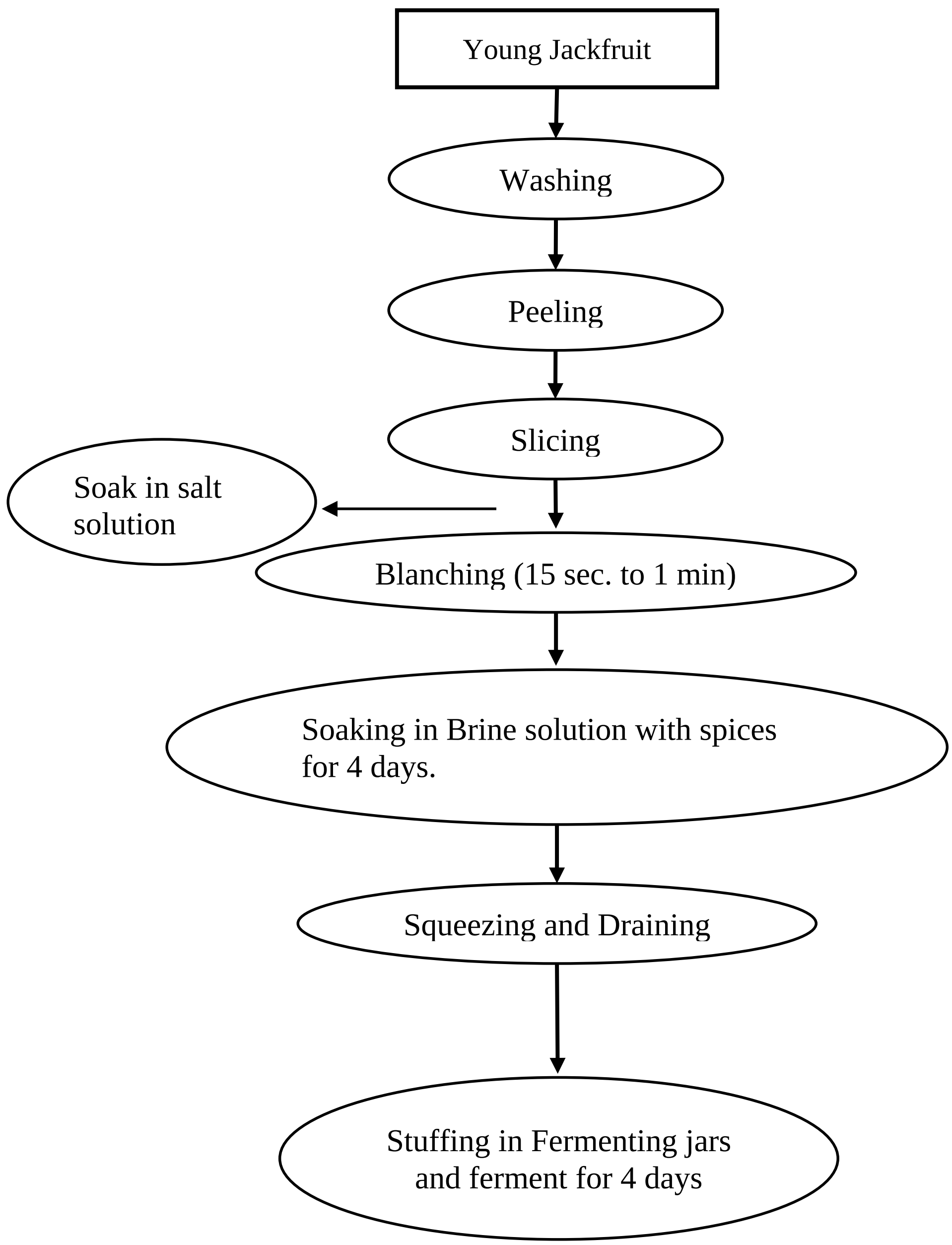


Figure 2. Process flow diagram of fermented young jackfruit.

Experimental Design

In order to optimize the product formulation, a 3x3 Factorial Experiment was employed with 9 treatments. Figure below illustrates experimental design.

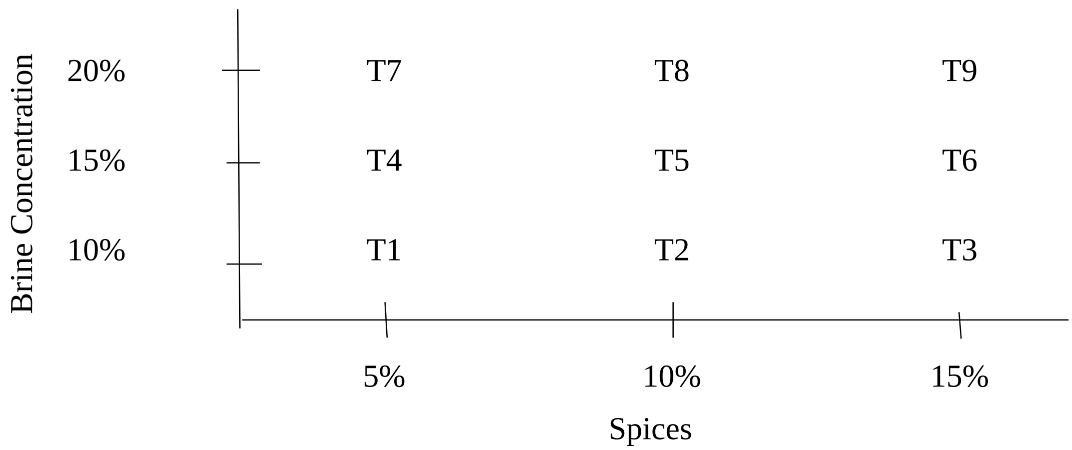


Table 2.Experimental Combinations of Fermented youg jackfruit.

Treatments	Spices%	Brine Concentration%
T1	5	10
T2	10	10
T3	15	10
T4	5	15
T5	10	15
T6	15	15
T7	5	20
T8	10	20
T9	15	20

Sensory Evaluation

The fermented immature jackfruit was subjected to sensory evaluation to determine the acceptability of the naturally fermented immature jackfruit in terms of firmness, color, taste, odor and overall acceptability using the 9- point Hedonic scale. For the variable screening, all the product samples will be evaluated by 35 panelists composed of BSFT students of Visayas State University. The evaluation will be carried out following the acceptability scoresheet shown in Appendix A.

Physico-Chemical Analysis

The screened fermented immature jackfruit will be analyzed daily for selected physico-chemical properties. The properties to be determined are pH, Total Soluble Solids, Titratable Acidity, Colorimetry and pectin. Initial data on the physico-chemical qualities of the fresh young jackfruit will also be gathered.

pH

The pH values on each treatment will be determined using a pH meter (pH-8) HM Digital. The electrode was submerged into the samples and readings was recorded.

Total Soluble Solids

The TSS determination was conducted using a hand held refractometer (ATAGO ATC-1e). The instrument was calibrated first by placing a drop of water on the prism of the instrument. The lid was then closed and the readings were taken by directing the instrument towards the light source. The TSS reading were then expressed in °Brix. The TSS were calculated in the manner described in Food Analysis Laboratory Manual in Food Technology 122 by the equation.

$$\text{TSS} = (\text{dilution factor})\ (°Brix)$$

$$\text{DF} = 1 + \frac{\text{volume of } H_2O \text{ added}}{\text{Weight of sample, (g)}}$$

Total Titratable Acidity (TTA)

The Total Titratable Acidity (expressed as % Lactic Acid) of the fermented young jackfruit was determined following the method by the (AOAC 1980). Approximately 10 grams of finely chopped samples was diluted with 50 mL distilled water and 5 drops of phenolphthalein indicator was added. The solution was titrated with standardized 0.1 N NaOH until pale pink color was achieved. The percent TTA (%LA) was calculated using the following formula

$$\%\mathrm{TTA(LA)} = \frac{\mathrm{V_{NaOH\ used}\ X\ N_{NaOH}\ X\ meq_{acid}\ X\ 100}}{\mathrm{wt.\ of\ sample}}$$

where

$$\text{weight of sample} = \frac{\text{weight of sample(g)x weight of aliquot}}{\text{weight of sample} + \text{weight of water}}$$

Microbial Analysis

Serial dilution and pour plating methods was employed to determine the microbial counts of the sample. PCA (Plate Count Agar) was used as culture medium in determining the number of colony forming unit (CFU) of lactic acid bacteria. Microbial colonies were counted, computed and reported as CFU per mL sample. The calculation for CFU was obtained using the formula:

CFU/mL = (ave.colonies)(reciprocal of dilution factor)(reciprocal of volume plated)

Physico-Chemical Analysis

The fermented immature jackfruit was analysed daily for selected physico-chemical properties. The properties determined were pH, Total Soluble Solids, and Titratable Acidity. The same procedure was followed on the preliminary study.

Sensory Quality Evaluation

Sensory evaluation of fermented immature jackfruit was carried out to determine the most acceptable treatment. Samples of the fermented immature jackfruit from various treatment was evaluated for color, taste, aroma, texture and general acceptability. The samples were coded with three (3) different digit numbers and evaluated by a total of ninety (90) panelist randomly selected from among the Food Technology. Appendix B shows the score sheet used by the panelists The sample were presented to the panelist using Incomplete Block Design (IBD) as laid out by Cochran and Cox (1957). The set plan of t=_, k=_, r=_, b=__, and E=___, type __ will be followed where **t** stands for treatments, **k** refers to the number of units per block and shows the number of replication, **r** refers to the number of application based on IBD, **b** refers to the block, and **E** is the efficiency factor; the table is shown in Appendix _. The set plan will be repeated thrice with total of forty-five (45) panelist with two (2) panelist will be able to evaluate each treatment.

Relative Cost Analysis

Computation of production on different treatments was done using the prevailing market price of ingredient used. The cost of production was analyze using mixture surface regression analysis and plotted as contour plot on ternary graph.

RESULTS AND DISCUSSION

Sensory Qualities of Fermented young jackfruit

The sensory quality attributes analyzed include color, aroma, taste, flavor, firmness and general acceptability. Response Surface Regression Analysis was used to determine the effects of varying concentration of spices and brine solution used unto fermented immature jackfruit to the said attributes, and to determine the optimum formulation of fermented young jackfruit.

The summary of mean acceptability score and cross tabulation for quality description of the sensory attributes of fermented immature jackfruit with varying concentration of spices and brine solution is presented in Table 3 and 4, respectively. Table 3 shows the parameter estimates for the acceptability of all sensory attributes of fermented immature jackfruit. Table 4 shows the critical point of acceptability on sensory qualities of fermented immature jackfruit at varying concentration of spice and brine solution used in fermentation.

Table 3. Summary of mean acceptability for the sensory attributes of fermented immature jackfruit with varying concentration of spices and brine solution.

trt	Variable		Sensory Attributes					
	Spice (%)	Brine (%)	Color	Aroma	Taste	Flavor	Firmness	Gen Acc
1	5	10	7.00	7.09	7.31	7.03	6.93	7.15
2	10	10	7.21	7.43	7.53	7.37	6.93	7.43
3	15	10	7.00	7.31	7.31	7.18	7.28	7.28
4	5	15	6.87	7.28	7.40	7.18	6.87	7.12
5	10	15	7.09	7.34	7.34	7.34	7.12	7.18
6	15	15	6.96	7.06	7.21	6.87	7.03	6.87
7	5	20	6.71	6.87	7.00	7.09	6.78	6.93

8	10	20	6.93	7.18	7.00	7.25	7.03	7.12
9	15	20	6.71	7.06	6.78	7.06	6.84	7.09
Over-all Response Mean			6.9479	7.1840	7.21180	7.15	6.98	7.13

n=32

Table 4.Summary of cross-tabulation for quality on the sensory attributes of fermented jackfruit

trt	Variable		Sensory Attributes				
	Spice (%)	Brine (%)	Color	Aroma	Taste	Flavor	Firmness
1	5	10	Yellowish-white to Yellowish-brown	Perceptible spiced aroma	Just right	Very perceptible spiced-fermented flavor	Moderately firm
2	10	10	Pale yellow to Yellowish-white	Well-blend spiced and pickled aroma	Just right	Moderately to very perceptible spiced fermented flavor	Moderately firm
3	15	10	Yellowish-brown	Well-blend to perceptible pickled aroma	Just right	Very perceptible spiced-fermented flavor	Moderately firm
4	5	15	Yellowish-white to Yellowish-brown	Perceptible pickled aroma	Just right	Moderately perceptible flavor	Slightly firm
5	10	15	Yellowish-white to Yellowish-brown	Perceptible spiced aroma	Just right to Slightly salty	Slightly to moderately perceptible spiced-fermented flavor	Moderately firm
6	15	15	Yellowish-brown	Well-blend spiced and pickled aroma	Just right to Slightly salty	Moderately perceptible spiced-fermented flavor	Moderately firm

7	5	20	Pale yellow	Well-blend to perceptible spiced aroma	Just right to Slightly salty	Very perceptible spiced-fermented flavor	Just right firmness
8	10	20	Yellowish-white to Yellowish-brown	Perceptible spiced aroma	Moderately salty	Very perceptible spiced-fermented flavor	Moderately firm
9	15	20	Yellowish-brown	Perceptible spiced aroma	Moderately salty	Very perceptible spiced-fermented flavor	Moderately firm

Table 5 Summary of parametric estimates for the acceptability of all sensory attributes.

Parameter	**Parameter Estimates**					
	Color	**Aroma**	**Taste**	**Flavor**	**Firmness**	**Gen. Acc.**
Mean/Interc.	6.94**	7.18**	7.21**	7.15**	6.98**	7.13**
(1)Spice (%)(L)	0.03ns	0.06ns	-0.13ns	-0.06ns	0.18ns	0.01ns
Spice (%)(Q)	0.20ns	0.20ns	0.11ns	0.25ns	0.07ns	0.17ns
(2)Brine(%)(L)	-0.28ns	-0.23ns	-0.45**	-0.06ns	-0.16ns	-0.23ns
Brine (%)(Q)	0.046ns	0.06ns	0.16ns	-0.03ns	0.04ns	-0.10ns
1L by 2L	0.00ns	-0.01ns	-0.10ns	-0.09ns	-0.14ns	0.015ns
R-squared	0.01403	0.01622	0.02901	0.01198	0.00875	0.01274

ns = not significant ** = significant at p < 0.01 * = significant at p < 0.05

Table 6.Critical point of acceptability on sensory qualities of fermented jackfruit.

Response	Critical Value		Predicted Acceptability	Type
	Spice (%)	Brine (%)		
Color	10.19ns	7.50**	7.22	Maximum
Aroma	10.45ns	10.55ns	7.24	Maximum
Taste	9.34ns	11.66ns	7.48	Maximum
Flavor	9.48ns	17.11	7.29	Saddlepoint
Firmness	9.19**	19.48**	7.25	Maximum
General	10.13ns	17.73ns	7.14	Saddlepoint

ns = not significant ** = significant at $p < 0.01$ * = significant at $p < 0.05$

Color

Color is the most important of all sensory attributes since it gives the direct judgment of the consumers to the product whether it is pleasing or palatable to consume or not.

The fermented immature jackfruit was perceived as yellowish-white when there's only about 5% spice used during fermentation; and when the amount of spice is tripled to 15%, its color becomes yellowish-brown. In all treatments, it is perceived in array of yellow color – from pale yellow to yellowish-brown, see table 4. The intensity of yellow shade is strengthen by the spice incorporated during the fermentation of immature jackfruit. Hence, at low spice concentration with 10-15% brine solution was generally perceived as yellowish-white to yellowish-brown. Conversely, with spice at 15% concentration, the color of the fermented immature jackfruit was perceived as yellowish-brown at all brine concentration. It is because the spice used are the combination of onion, garlic, white pepper and salabat that has concentrated turmeric and ginger which has bright yellow color.

Color acceptability of the formulations ranged from 6.71 to 7.21 which corresponds to like slightly to like moderately based on 9-point hedonic scale, and has over-all response mean of 6.95 (Table 3). Higher color acceptability scores are found at lowest concentration of brine solution (Fig. 3). An acceptability score of ≥7.17 is found out at 10% brine solution leaving all treatments below 7. Therefore, the panelist preferred yellowish fermented immature jackfruit than a light brown.

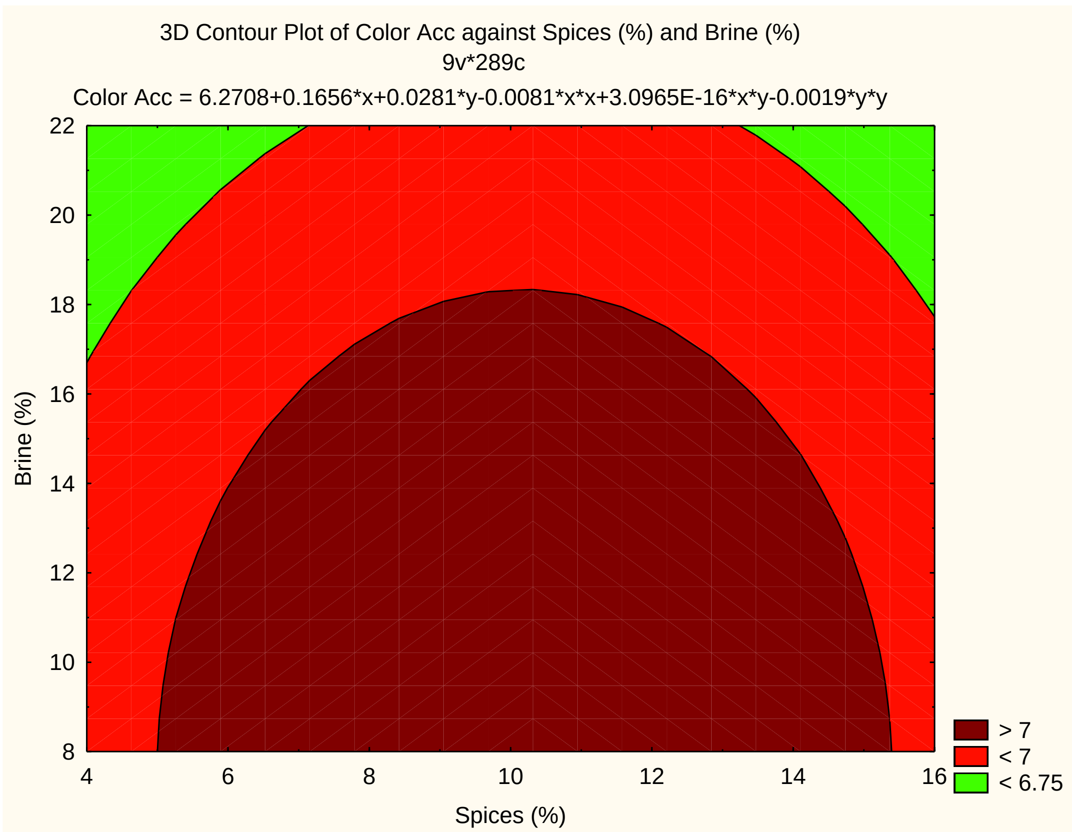


Figure 3.Contour plot for color acceptability of fermented jackfruit.

Response surface regression analysis shows that there is no evident correlation either linear, quadratic or interaction that exist between color acceptability and the varying concentrations of spice and brine solution (Table 5). Although, parameter estimates tell that the use of spice and brine solution in fermenting the immature jackfruit provided positive response to the acceptability of color. Regardless of the concentration of spice, it is predicted that at 7.5% brine solution the color acceptability was maximum. Of these coincide to the statement of Eifert, et.al (2014) that high salt concentration especially the use of iodized salt (common commercial salt in Philippines) will cause browning of vegetables.

Aroma

Another sensory attribute which helps us define the food we eat is aroma. Aroma is also very important since aside from color, it also describes whether the food taste good or not. The use of spice and brine solution effectively enhance the acceptance of fermented immature jackfruit aroma. For instance increasing the concentration of spice at any concentration of brine solution provided an aroma description that ranged from well-blend spiced and pickled aroma to perceptible spiced aroma. On the otherhand, at 20% brine solution with different concentration of spice, the aroma of the product is described as perceptible spiced aroma (Table 4).

Aroma acceptability of the formulations ranged from 6.87 to 7.43 which correspond as “like slightly to like moderately in 9-point hedonic scale with the over-all response mean of 7.18 (Table 3). Higher aroma acceptability scores are found at 10% spice concentration at acceptability score ≥7.17 (Fig. 4).

Response surface regression analysis shows that there is no evident correlation either linear, quadratic or interaction that exist between color acceptability and the varying concentrations of spice and brine solution (Table 5). Although, like color acceptability the parameter estimates tell that the use of spice and brine solution in fermenting the immature jackfruit provided positive response to aroma acceptability.

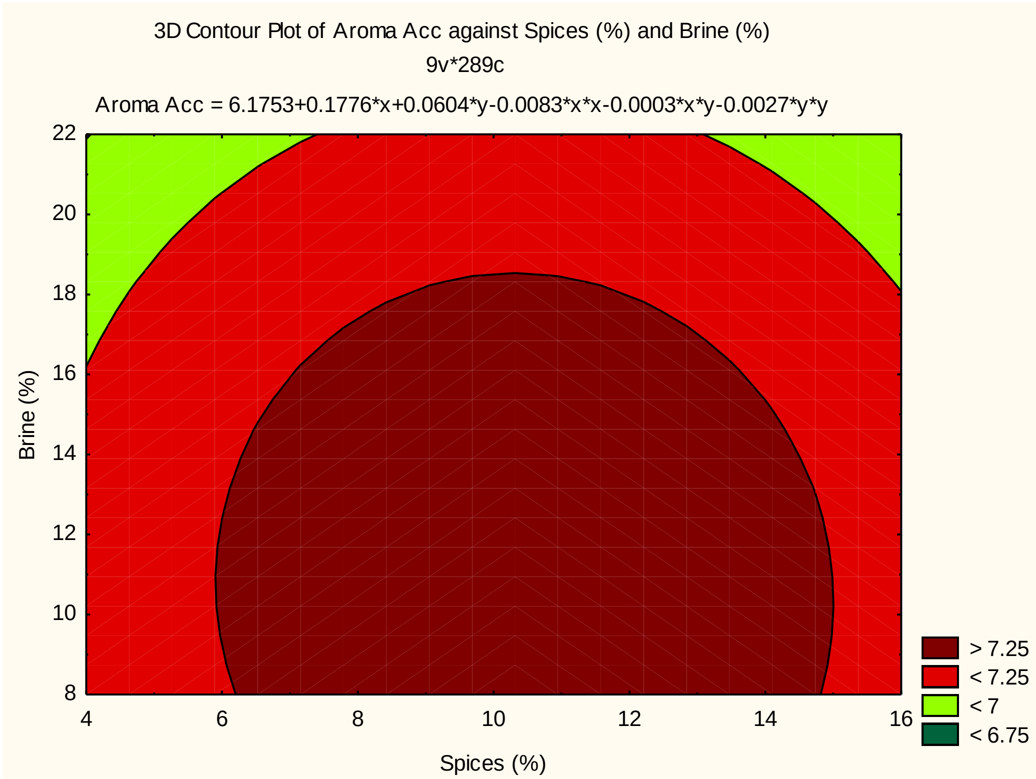


Figure 4.Contour plot for aroma acceptability of fermented immature jackfruit.

Taste

The fermented immature jackfruit was palatable that perceived as "just right taste" at 10% brine solution with varying spice concentration (Table 4). Of these, the product have the just right saltiness, sweetness, pungency and unique fermented taste. It was also complimented to be best serve as appetizers. However, when brine concentration increases it was perceived as slightly salty to moderately salty. This is basically due to osmosis as salt draws out the water and sugar of the immature jackfruit to be used as nutrient by fermenting microorganisms; and conversely the brine enters to the jackfruit cells making it salty. Hence, at higher concentration of brine solution will also increase the saltiness of the product.

Taste acceptability of the formulations ranged from 6.78 to 7.53 which corresponds as like slightly to like very much in 9-point hedonic scale with over-all response mean of 7.21 (Table 3). Higher taste acceptability scores are found at lower brine concentrations (Fig. 5). An acceptability score of ≥7.17 is found out at 10-15% brine concentration leaving all treatments below 7.21. Therefore, the panelist does not preferred a moderate salty fermented immature jackfruit.

Response surface regression analysis shows that the use of brine solution in fermentation gives negative linear effect in the taste acceptability of fermented immature jackfruit (Table 5). Increasing the concentration of brine solution provides significant decrease in the taste acceptability of the product. Parameter estimates tell that the use of spice and brine solution gives positive response to the taste acceptability but in limitation with respect to critical value of the variables, see Table 6. Brine solution should be limited only to an amount of 11.67% to expect high acceptability score. In such, brine solution becomes the limiting factor for the taste acceptability of the product and not the spice concentration.

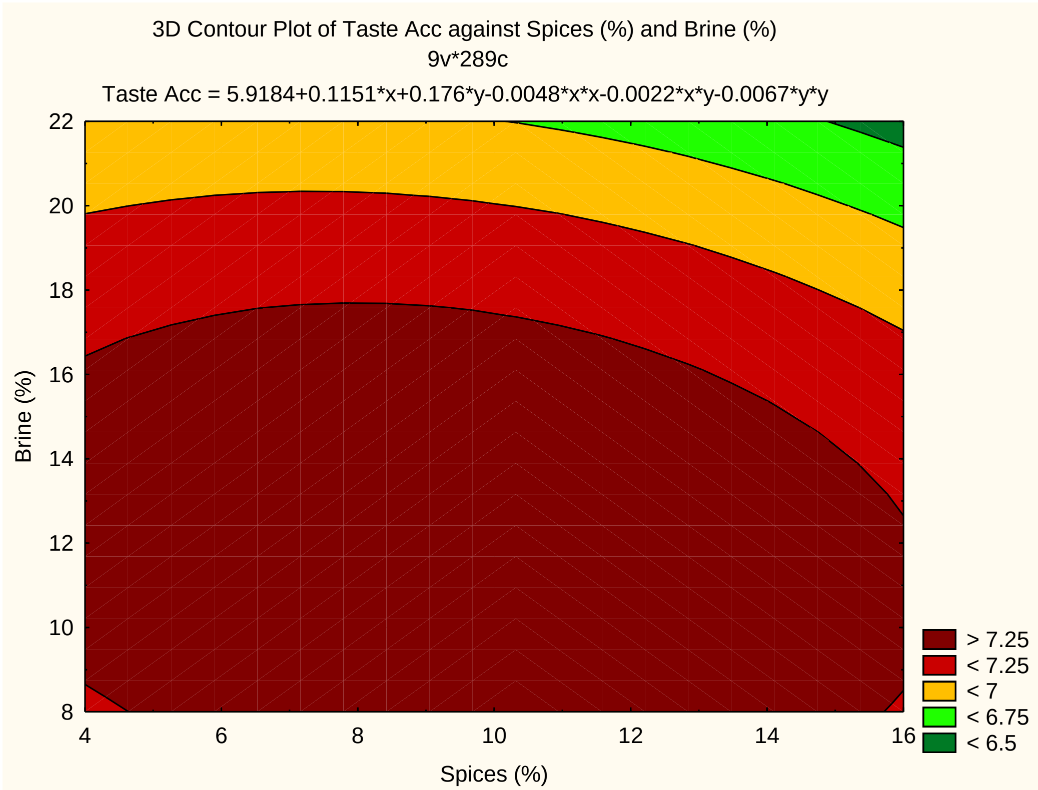


Figure 5.Contour plot for taste acceptability of fermented immature jackfruit.

Flavor

The fermented immature jackfruit was perceived as moderately to very perceptible spiced-fermented jackfruit flavor (Table 4). The spice promotes and engages its flavor to the immature jackfruit during fermentation regardless of its concentration.

Flavor acceptability of the formulations ranged from 6.87 to 7.37 which correspond as like slightly to like moderately in 9-point hedonic scale with an over-all response mean of 6.98 (Table 3). In all treatments, there were no significant difference on it flavor acceptability and have acceptability score of ≥6.8 (Fig. 6.

Response surface regression analysis shows that there were no evident correlation either linear quadratic or interaction that exist between flavor acceptability and the varying concentrations of spice and brine solution (Table 5). Although, like color and aroma acceptability the parameter estimates tell that the use of spice and brine solution in fermenting the immature jackfruit provided positive response to aroma acceptability.

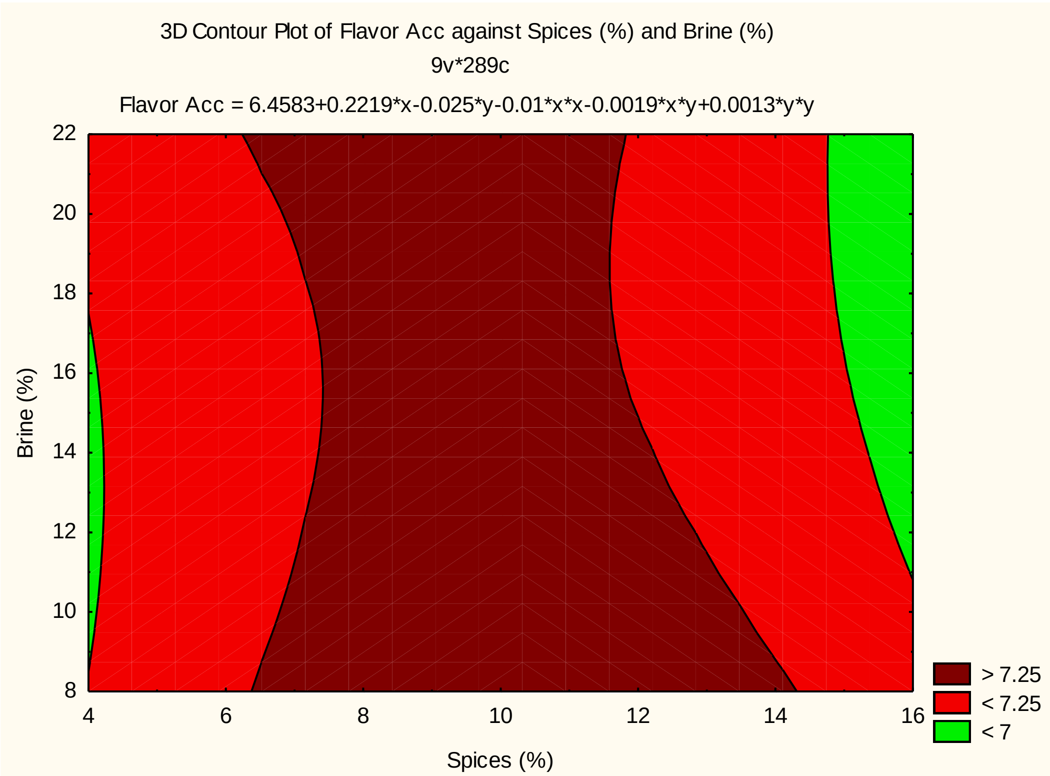


Figure 6. Contour plot for flavor acceptability of fermented immature jackfruit.

Firmness

Another important sensory attribute on which is consumer base their appreciation for fermented vegetable is the character of its firmness. Firmness indicates successful clean-crisp and high quality; getting the right acceptable firmness is a key component of fermented vegetable.

The combination use of spice and brine solution in fermenting the immature jackfruit was perceived as just right firmness to moderately firm (Table 4). Only at treatment 7 with 5% spice and 20% brine solution provides the just right firmness; this is mainly influence by the salt and balance by the lowest concentration of spice (Fig. 7).

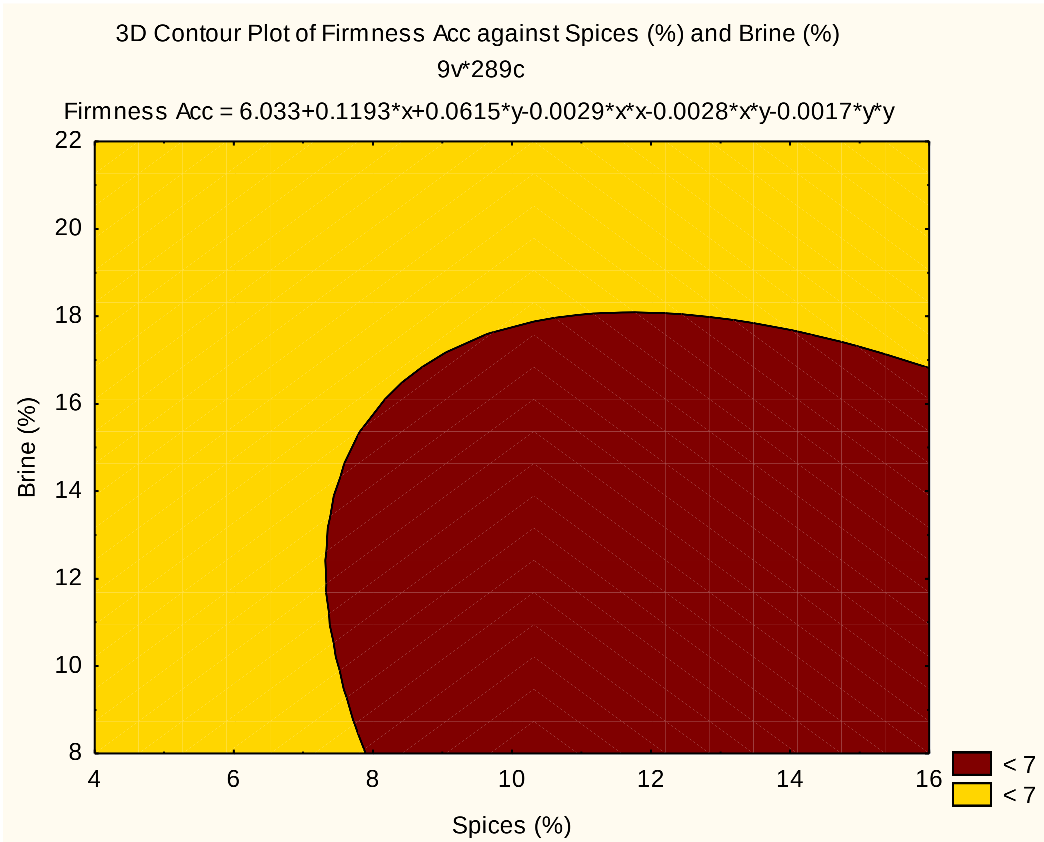


Figure 7.Contour plot for firmness acceptability of fermented immature jackfruit.

Firmness acceptability of the formulations ranged from 6.78 to 7.28 which corresponds as like slightly to like moderately in 9-point hedonic scale with an over-all response mean of 6.98 (Table 3). There were no significant difference in the mean acceptability in all treatments for firmness.

Response surface regression analysis shows that there were no evident correlation either linear quadratic or interaction that exist between firmness acceptability and the varying concentrations of spice and brine solution (Table 5). Although, like color, aroma and flavor acceptability the parameter estimates tell that the use of spice and brine solution in fermenting the immature jackfruit provided positive response to aroma acceptability. Nevertheless, critical value of both variable have significant influence to the firmness acceptability, it is predicted that at 9.20% spice and 19.48% brine solution the firmness acceptability was already maximum.

General Acceptability

The over-all assessment of the panelist to the formulation is within 6.87 to 7.43 which correspond as "like moderately" with over-all response mean of 6.14 (Table 3). Decreasing the brine solution increases the general acceptability (Fig. 8). When at equal concentrations; treatment 6 with 15% spice and 15% brine yields the lowest acceptability but on treatment 2 with 10% spice and 10% brine gives the highest general acceptability of 7.43.

Response surface regression revealed that there were no evident correlation either linear quadratic or interaction that exist between flavor acceptability and the varying concentrations of spice and brine solution (Table 5). Although, like parameter estimates tell that the use of spice and brine solution in fermenting the immature jackfruit provided positive response to general acceptability of the product.

A positive notion that even at the very little coefficient prediction generated from models of different sensory attributes can be regarded. SAS/IML 9.1 User's Guide (2004) cited that all generated models resulted to R^2-value less than 30%, which is threshold for social science studies.

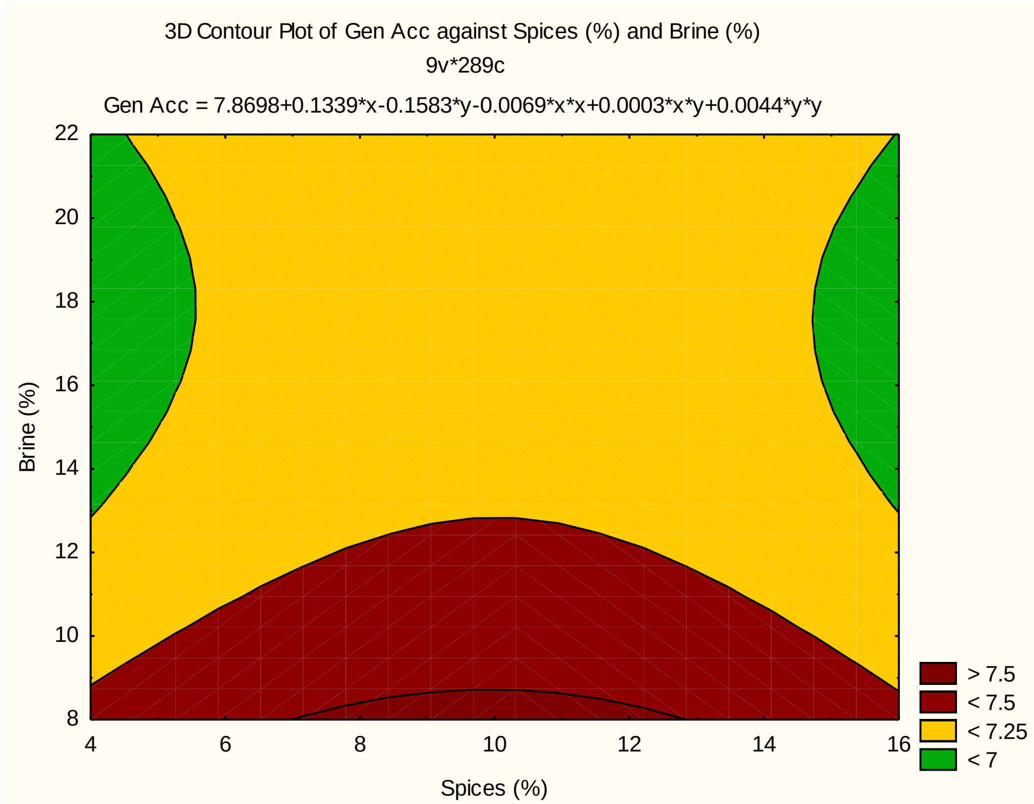


Figure 8. Contour plot of general acceptability of fermented jackfruit.

Attaining the Optimum Formulation

Models of different sensory attributes producing acceptability rating of ≥7.17 are super imposed together with the production cost to determine the least-cost combination or the optimum formulation of ferment immature jackfruit with varying concentration of spice and brine solution used in fermentation. Figure 9 showed that the combined predicted acceptability at 7.17 will intersect at 14.2% spice and 11.5% brine solution with an expected breakeven price (laboratory scale) of Php 144.06 per 500g of fermented immature jackfruit excluding the container.

This optimum formulation is bounded by flavor and firmness acceptability which is the main sensory attribute wherein consumers provides their appreciation of fermented vegetable products.

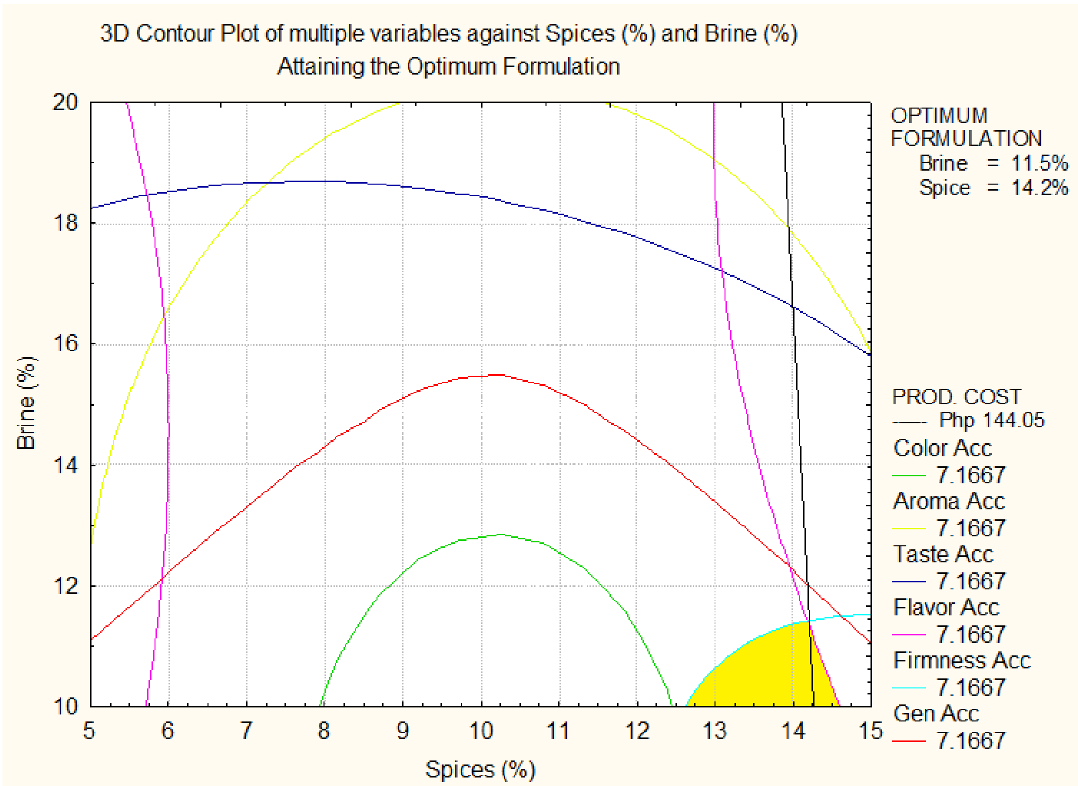


Figure 9. Superimposed acceptability plot of color, aroma, taste, flavor, firmness, and general acceptability value >7.17 at Php.144.05 per 500g product cost.

Production Cost

The expenses incurred in processing the fermented immature jackfruit are based on the prevailing price in the Baybay's market and department store where the raw materials except the jackfruit were procured. Noting that the 30-55 days immature jackfruit used farm waste during pruning and utilizing as raw material to give off higher value. Hence, production cost were affected by the concentration of spice and brine solution used in fermentation which ranged from Php 72.90 to 151.07 per 500g, excluding the packaging cost. In appendix table 19 shows the production cost of the optimum formulation, it is found out to be Php 144.05. The price of spices used played a greater impact that the brine solution on the total cost of product. Thus, production cost of the product generally depends on the amount of spices used (Fig. 10).

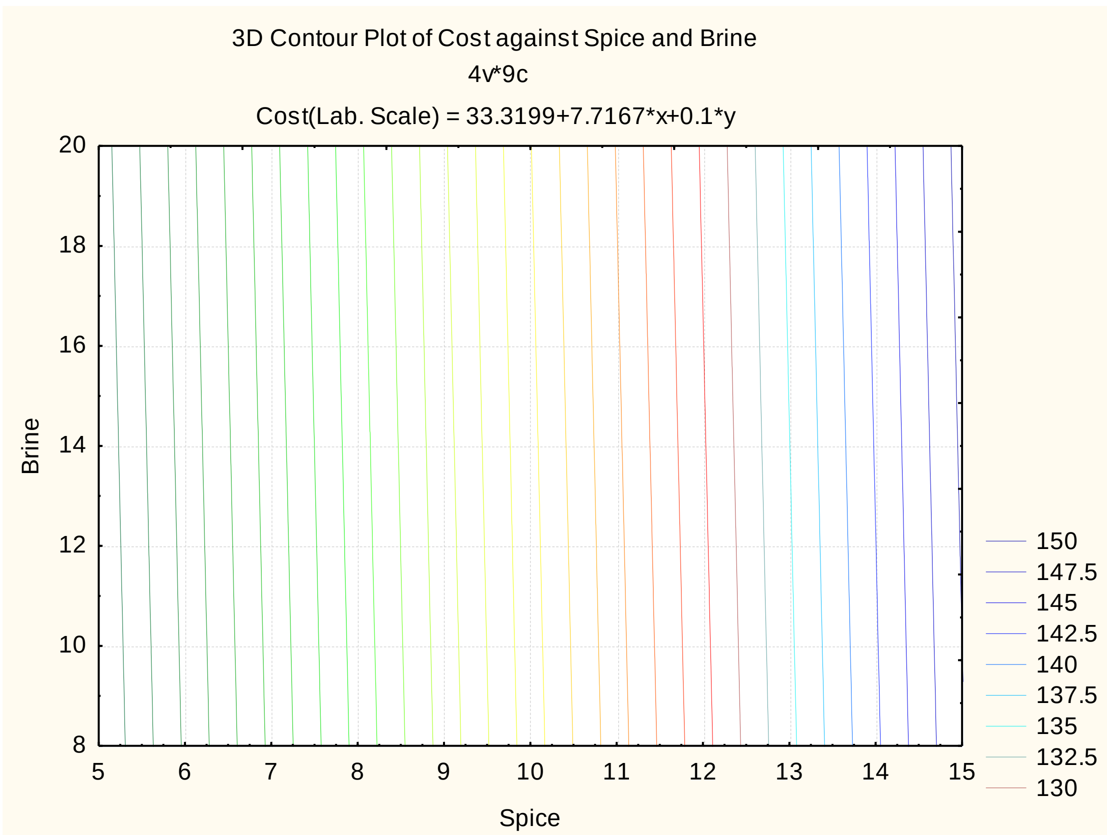


Figure 10.Contour plot of fermented jackfruit production codt in laboratory scale.

Physico-chemical properties

The fermented immature jackfruit's pH, TSS and pH was monitored during the 4 days fermentation process in order to determine the corresponding changes in the products physico-chemical properties as affected by the brine solution and spices.

Table 7. Summary of analysis of variance for the slurry and jackfruit's TSS, pH and TA of fermented jackfruit at 4 days fermentation as affected by the varying concentration of brine and spices.

Regression	**Slurry**			**Jackfruit**		
	TSS	**pH**	**TA**	**TSS**	**pH**	**TA**
Day	35.97**	336.25**	9.99**	33.81**	252.12**	3.32*
(1)Spice%(L)	281.05**	237.13*	312.93**	20.12**	74.82**	5.58*
Spice%(Q)	8.99**	5.51**	47.94**	0.22ns	0.06ns	1.36ns
(2)Brine (L)	2592.00**	47.89**	22.77**	234.33**	0.70ns	4.63*
Brine (Q)	0.63ns	0.02ns	2.84ns	3.05	0.72ns	3.33ns
1L by 2L	6.65*	0.78ns	32.39**	5.41*	1.44ns	19.29**
R – squared	0.96803	0.92924	0.80471	0.78646	0.89391	0.30856

Table 8.Summary of parameter estimates for the slurry and jackfruit's TSS, pH and TA of the fermented jackfruit at 4 days fermentation as affected by the varying concentration of spice and brine solution.

Regression	Slurry			Jackfruit		
	TSS	pH	TA	TSS	pH	TA
Interaction (T*D)	8.045**	3.751**	0.163**	4.538**	3.751**	0.249**
(T)Treatment	0.838**	-0.006ns	0.004**	0.855**	-0.006ns	-0.0028*
(D)Day	0.289**	-0.288**	-0.004ns	1.123**	-0.288**	-0.002ns
Mean/Interc.	12.960**	2.995ns	0.177**	11.624**	3.454	0.229**
(1)Spice %(L	1.658**	0.395**	0.053**	1.522**	0.308	-0.015*
Spice%(Q)	-0.256**	-0.052*	-0.0182**	0.138ns	0.008	0.006ns
(2)Brine (L)	5.036**	-0.177**	0.014**	5.194**	-0.030	-0.013*
Brine (Q)	0.068ns	0.003ns	-0.004ns	0.513ns	0.026	0.010ns
1L by 2L	0.312*	0.027*	0.0211*	0.966**	0.052	-0.0348**
R – squared	0.96803	0.92924	0.81931	0.78646	0.89391	0.30856

Table 9. Summary of critical values and predicted values at stationary point for the slurry and jackfruits TSS, pH and TA of the fermented jackfruit as affected by varying concentration of spice and brine solution.

Response		Critical Values Spice (%)	Critical Values Brine (%)	Predicted Value	Point Type
Slurry	TSS	-16.8284	76.7021	25.42724	Saddlepoint
	pH	9.0115	-48.4490	3.864255	Saddlepoint
	TA	6.17244	15.48231	0.1594591	Minimum
Jack fruit	TSS	6.17244	15.48231	52.40163	Maximum
	pH	250.5479	133.2199	7.490762	Maximum
	TA	15.11111	8.95556	.2373428	Saddlepoint

During fermentation, the major components contained in immature jackfruit and minor ingredients such as onions, garlic, pepper and ginger are degraded or synthesized by various microorganism. The degradation of carbohydrate, a major component of young jackfruit, results in the formation of numerous organic acids which gives unique flavour to fermented products (N.J. Lee, et al., 1981, H.A., Lee et.al, 2013 and Y.S Bang, et. al., 1985 as cited by Su-Yeon, Y. et al., 2017). Figure 11 and 12 showed the graphical presentation of the corresponding changes in the physico-chemical properties of the fermented immature jackfruit. As shown in Figure 11a, the pH value of the product decreased as the fermentation proceeds. The starting pH of the 9 treatments slurry ranges from pH 3- 3. 76 and obtained a final pH that ranges from 2.3- 2.73 for the brine solution. On the other hand, the pH of the immature jackfruit was also obtained, which ranges from 3.73- 4.22 and drops to a final pH that range from 2.76- 3.05 (Figure 12a). This result is in accordance to the result of traditionally fermented maize obtained by Ogbonnaya, N. and Bernice, C.C., 2012, wherein the pH drops to 3.9. Same result was obtained by Wadamori, Y. et al., 2014 in which the initial pH of the kimchi mix was 5.06 and reached to 4.34 after 5 days of brine fermentation. The decrease in pH was due to the formation of lactic acid by the action of the bacteria (Wadamori, Y. et.al., 2014). Tamang, et. al., also states that about 38% of LAB strains could show a strong acidification properties by reducing the pH to less than 5.

Response Surface Regression Analysis revealed that the pH values of the different treatments were significantly affected by the Spices and Brine (Table 7 and Table 8). Analysis of variance (Table 7) also showed that the jackfruits pH is greatly affected by the Spice. The predicted value for the slurry at saddle point was 3.86 and 7.49 for the jackfruit.

(a)

(b)

(c)

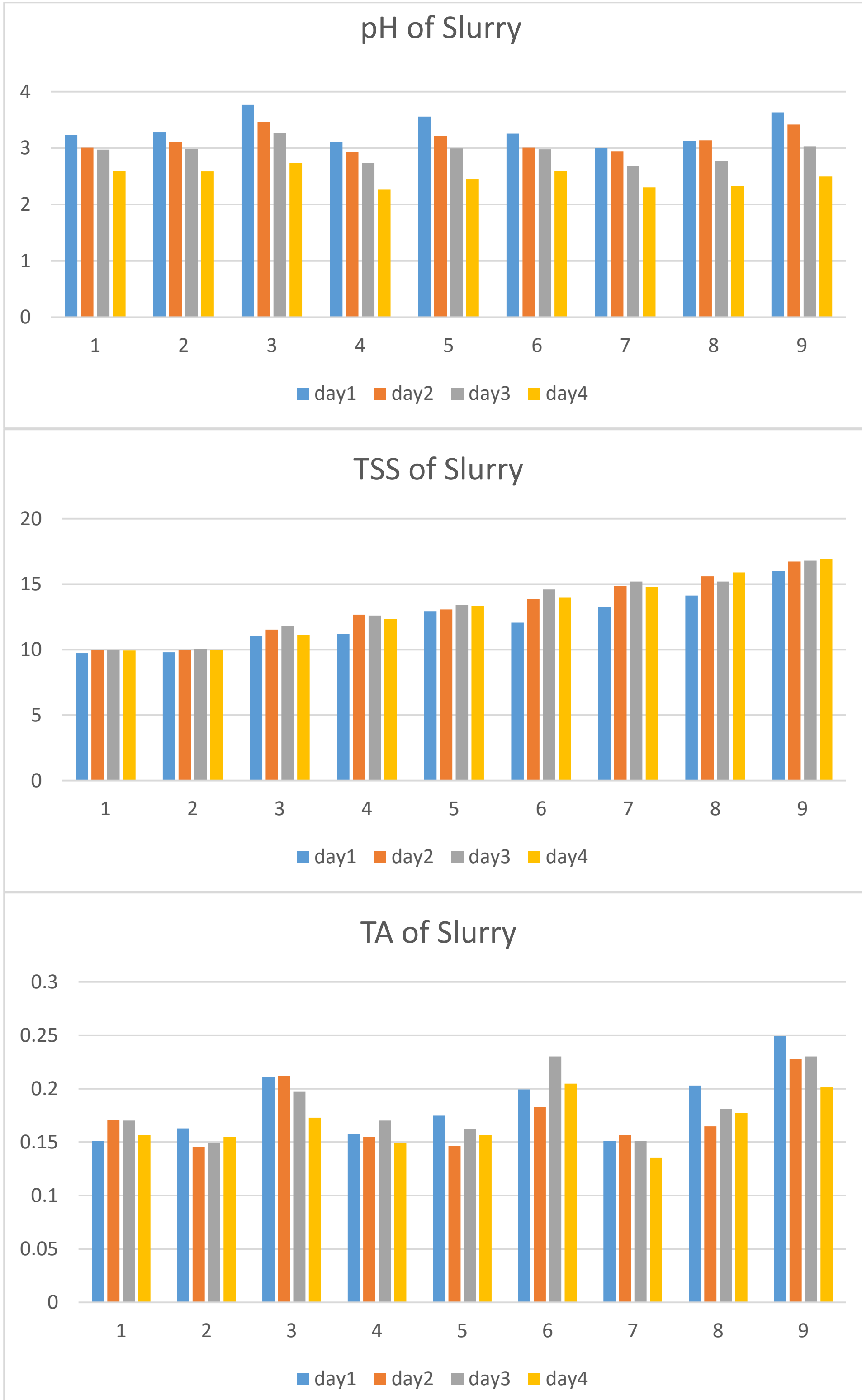
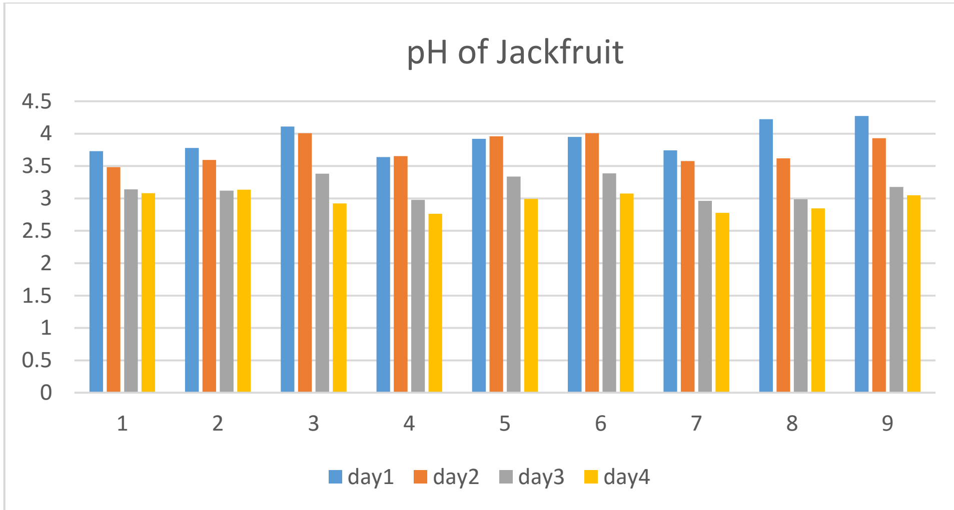


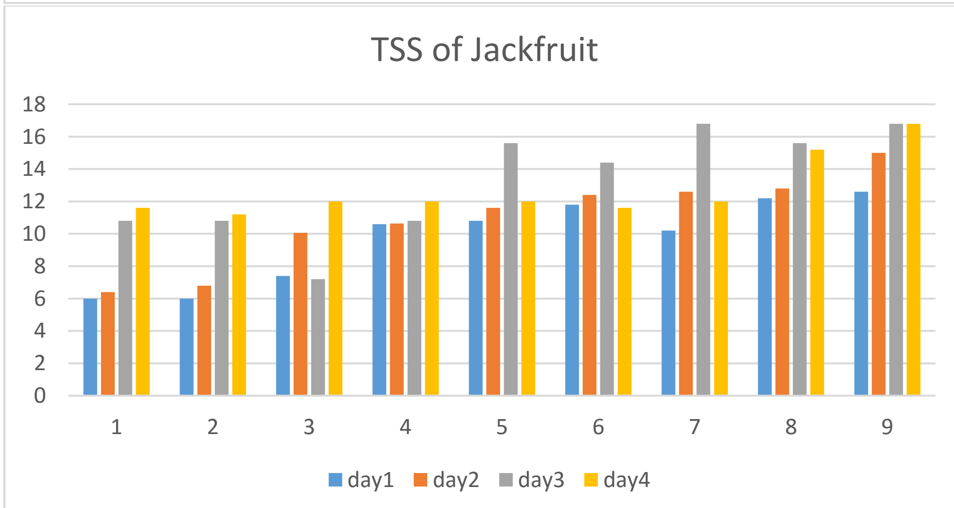
Figure 11.Graphical presentation of (a) pH of slurry, (b) TSS of slurry and (c) TA of slurry.

Young Jackfruit can be accounted as fresh vegetable like commodity, its principal components mostly contains fermentable saccharides because of its immaturity. Fermentable sugars are used by microorganisms to convert sugar to lactic acid. Determination of the Total Soloble Solids during fermentation provides proof of the carbohydrate degradation during fermantation. Figure 11 and 12 shows the graphical presentation of the changes of TSS during the 4 days of fermentation. It can be obserevd that at the first 2-3 days of fermentation the total soluble solids increases. Joshi, V.K., and Sharma, S., 2009 states that the initial increase in TSS is attributed to the process of leaching in which the soluble solids including sugars come into the brine. The use of salt to the sliced young jackfruit, extracts out water and sugars from the sliced young jackfruit into the brine which then according to Pederson, C.S. and Albury, M.N., 1969 might have provided a favorable growth medium for lactic acid bacteria. However, at the 4th day of fermentation shows an unstable result among the 9 treatments, treatments 3,4, 5, 6 and 7 shows a slight decrease. In connection to this, a study of naturally fermented black carrot conducted by Sahota, P.P., et al., 2014, also showed an increase of TSS up to 10 days, and decreased therafter and tends to stabilize up to 15 days during fermentation. Apparently, a study on lactic acid fermentation of radish also showed an increase of TSS up to 8 days of fermentation and decreased therafter and attains stability after 18 days of fermentation, thus the extraction of sugar from the radish shreds initially and then its conversion into lactic acid is responsible for the initial increase and subsequent decrease of TSS (Joshi, V.K., and Sharma, S., 2009). With the findings of the mentioned results that it took up to 18 days before it attains equilibrium, it is then evident that the result obtained on the 4th day of fermentation of the young jackfruit were inconstantly different. Moreover, statistical analysis revealed that the TSS value of the fermented immature jackfruit was significantly affected by the spices and brine (Table 7 and Table 8).

(a)



(b)



(c)

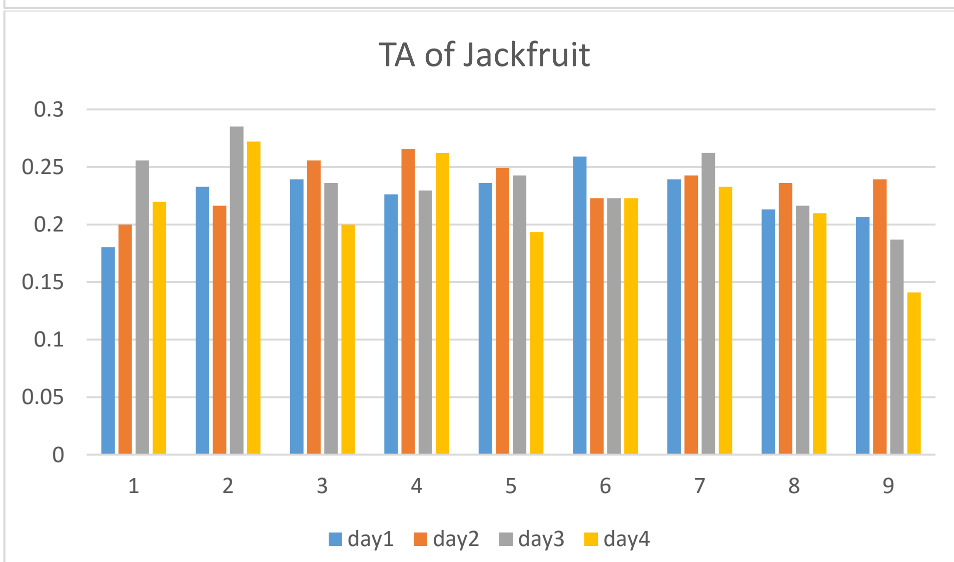


Figure 12.Graphical presentation of (a) pH of jackfruit, (b) TSS of Jackfruit and (c) TA of jackfruit

Any fruit and vegetable when placed in brine, they were subjected to physical and chemical changes that changes its brine solution and modified the fruits and vegetables, as such the development of destinct flavor and odor. The water soluble components are being drawn out from the flesh of the young jackfruit due to diffusion, a process influenced by salt concentration. The sugars that are being diffused in brine are being used by microorganisms and converts it to organic acids. Lactic Acid is the predominating acids produced mostly in fermented products. Differences in the acidification process among treatments were obserevd since the beginning. Figure 11 and 12 shows the changes in %TA of the product within 4 days of fermentation, it can be observed that the 9 treatments shows erratic results. As Titratable Acidity is related to the microbial succession of microorganisms, this results also coincide with the microbial evaluation (Appendix 37) in which microorganisms profile shows an inconsistent pattern..The microbial profile of the 9 treatments shows a few to no microbial load in day 2 and day 3 (Appendix 37) which also shows a slight changes in %TA, however same pattern was observed in day1 and day 4, in which microbial counts are significantly accounted and shows a decline on the %TA. This is due to some environmental conditions that affect the activity of desired (LAB) microorganisms for fermenattion. Yoo, M.J., et.al., 2001, in there study on the physico-chemical and microbiological changes in kimchi states that the acidity does not increase significantly because aerobic microorganisms unassociated with acid production are temporarily active during the early ripening of kimchi, lactobacillus remains inactive and also because water are being released. There was an unstable total acidity and decrease in pH (Figure 11 and 12) obtained in the 4 days of fermentation. In connection, Mheen, T.I., et.al., 1981in his study on the naturally fermented kimchi states that generally the pH decline is a gradual decrease compared with the increase of total acidity, which is assumed to be caused by the buffer reaction of proteins and amino acids. Specifically, treatments 7 (Spice 5%, Brine 20%), treatment 8 (Spice 10%, Brine 20%) and treatment 9 (Spice 15%, Brine 20%) showed a decrease in percent acidity, this is associated to the amount of salts being added. In addition, Gallego, J., et. al., 2010 states that the concentrations of brine were effective in acidity values because NaCl is more prone to solubilisation of organic matters and formation of combined acidity and brines with high combined acidity will show higher pH value, thius the increase of NaCl concentration leads to an increase in pH and a decrease in acidification. Statistical analysis revealed that the %TA of the products slurry and jackfruit was significantly affected by both linear and quadratic interaction of brine and spice.

Hence, changes in chemical components are related to concomitant microbiological growth developed during the spontaneous fermentation.

Microbial Evaluation

Plant harbor a numerous and varied microflora. Certain species of lactic acid bacteria are found consistently on a variety of plants, indication that plants are natural habitat for lactic acid bacteria. Although the numbers of lactic acid bacteria on plant materials are highly variable, most investigation have shown that their number is very low, often in the range of 10-1000 cells per gram (Daeschel, Anderson and Fleming, 1987)which represents approximately 0.01-1% of the total microbial population. However, the low number but widespread presence of lactic acid bacteria on different plants supports the hypothesis that plants are a natural habitat for some species. In such, different levels of spices are applied in the study to know its antimicrobial effect on the fermentation of immature jackfruit.

Table 10. Microbial plate count of fermented jackfruit.

TRT	Variable		Fermentation Days			
	Spices (%)	Brine (%)	Day 1	Day 2	Day 3	Day 4
1	5	10	9,600 cfu/mL	2,500ESPC/mL	200ESPC/mL	35,000 cfu/mL
2	10	10	200ESPC/mL	3,900 cfu/mL	400ESPC/mL	3,500 cfu/mL
3	15	10	200ESPC/mL	17,000 cfu/mL	<100ESPC/mL	140,000 cfu/mL
4	5	15	3,900 cfu/mL	<100ESPC/mL	200ESPC/mL	52,000 cfu/mL
5	10	15	4,400 cfu/mL	400ESPC/mL	100ESPC/mL	100ESPC/mL
6	15	15	5,700 cfu/mL	100ESPC/mL	<100ESPC/mL	1,200ESPC/mL
7	5	20	900ESPC/mL	400ESPC/mL	200ESPC/mL	100,000 cfu/mL
8	10	20	100ESPC/mL	4,100 cfu/mL	400ESPC/mL	22,000 cfu/mL
9	15	20	4,500 cfu/mL	<100ESPC/mL	1,400,000 cfu/mL	320,000 cfu/mL

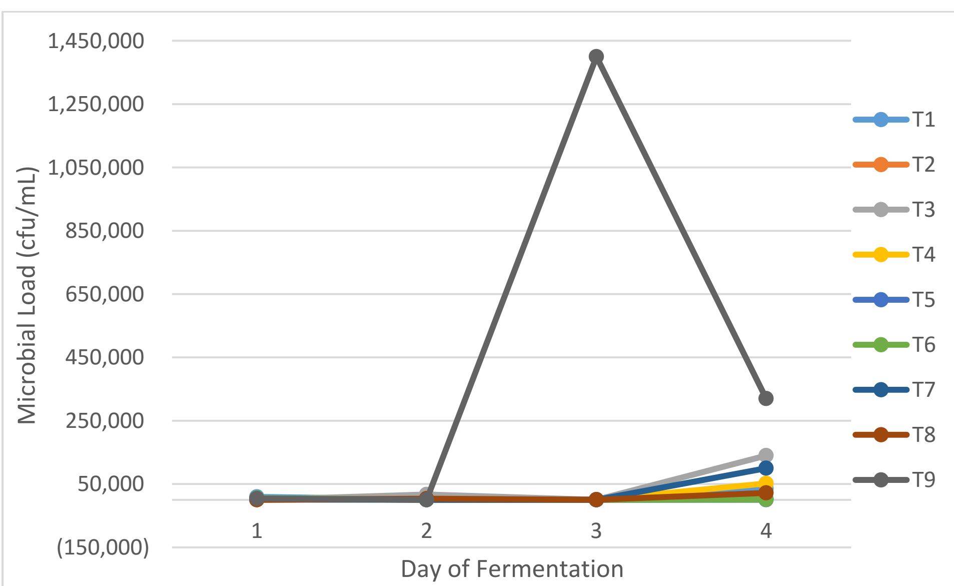


Figure 13.Microbial count of fermented immature jackfruit.

The data presented on table 10 shows at lowest level of spices and brine have higher microbial load at the first day of fermentation. The concentration of spices and brine solution have significant effect on the fermented product (Table 11). The addition of spices is a control procedure necessary in order to prevent spoilage and to provide fermented products of consistent quality; of these in respect to result of pre-experiment and variable screening. The treatment added with spices in immature fermentation have no evident spoilage microorganisms or some indication. At 10-15% spice concentration and 10% brine concentration low microbial count was observed this is due antimicrobial properties of spices; and with 20% brine concentration with lower spice level have also low microbial count this is because as higher salt concentration applied greatly retard and preclude the fermentation, see table 1. In contrast, T9 with 20% brine and 15% spice concentration have the highest microbial succession count on day 3 which is highly significant difference to other treatments (Fig. 13).

It is evident that based on the data gathered that natural succession of fermentative microorganism occurred on the 4 days fermentation of immature jackfruit. It is also found out that day 1 and day 3 have significantly different microbial load between treatments and on the others days of fermentation (Table 12).

Table 11. Analysis of variance between variables.

	Test	Value	F	Effect	Error	p
Intercept	Wilks	0.741121	8.383396	4	96.0000	0.000008
Spice	Wilks	0.727502	4.138063	8	192.0000	0.000140
brine	Wilks	0.716224	4.358735	8	192.0000	0.000075
Spice*brine	Wilks	0.635982	2.933326	16	293.9225	0.000162

Table 12. Analysis of variance on days of fermentation.

		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	22485306.796	8	2810663.350	6.921	.000
day1	Within Groups	40206130.417	99	406122.529		
	Total	62691437.213	107			
	Between Groups	1087634.000	8	135954.250	.975	.460
day2	Within Groups	13808664.917	99	139481.464		
	Total	14896298.917	107			
	Between Groups	4657454.685	8	582181.836	4.789	.000
day3	Within Groups	12034329.833	99	121558.887		
	Total	16691784.519	107			
	Between Groups	7546009.685	8	943251.211	1.606	.133
day4	Within Groups	58148187.833	99	587355.433		
	Total	65694197.519	107			

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary and Conclusion

The study was conducted generally to develop a process that adds value to the so called nutrient competitor young jackfruit (farm waste) into a fermented food product with the aim of utilizing the whole of young jackfruit into a fermented product. Specifically, this study aimed to screen the different variables that may affect the sensory acceptability of the fermented immature jackfruit, to evaluate the effects of variables on the sensory quality and physico-chemical properties of the fermented young jackfruit., monitor and determine the changes of the physico-chemical properties (pH, TSS, TA) and microbiological changes during the 4 days of natural fermentation, determine the optimum combination conditions in processing the lowest cost and acceptable fermented jackfruit, and determine the cost of producing the product for possible commercial production.

Plackett- Burman variable screening design was conducted using 7 variables 8 runs to identify the variables which significantly affect most of the acceptability of the product. Statistical analysis revealed that Brine concentration and the addition of spices during fermentation have affected most of the sensory parameters considered. The levels of brine concentration and amount of spices added were the variables used for optimization.

The identified variables from variable screening were used in optimization experiment following the 3x3 Factorial Experiment in Incomplete Block Design. It was carried out using 5%, 10%, 15% of spices and 10%, 15%, and 20% of Brine Concentration. Microbial evaluation, physico-chemical quality and sensory evaluation of the product was performed. Data for all experimental combinations were analyzed employing response surface regression analysis. Response surface plots were generated for all analyses to illustrate the effects of the independent variables.

Statistical analysis on the sensory evaluation of the fermented young jackfruit revealed that an increase in brine concentration, salt significantly affects the acceptability of the product in terms of its taste and color. However, parameter estimates tells that the use of spice and brine solution in fermenting the young jackfruit gives a positive result to its sensory parameters, provided that brine solution should only be limited to an amount of 11.67% to expect high acceptability score. Contour plots of the different sensory attributes was set at ≥7.17 which corresponds to “like moderately” category of the 9-point hedonic scale. Contour plots were superimposed and overlaid using Statistica 6 software to obtain the optimum formulation. Based on the superimposed plots of sensory acceptability of the product, it was pointed out that the acceptability at 7.17 will intersect at 14.2% spice and 11.5% brine solution with a breakeven price of 144.06 per 500g of fermented immature jackfruit.

Physico-chemical (TSS, pH and %TA) properties and microbial evaluation of the fermented young jackfruit (slurry and the jackfruit) were monitored during the 4 days of fermentation. Statistical analysis revealed that the Slurry’s TSS, pH and TA were significantly affected by linear and quadratic interactions of the independent variables. Similarly, statistical analysis on the physicochemical properties of the jackfruit showed that TSS, pH and TA were only significantly affected by the linear interaction of spice and brine. Statistical analysis also showed that there was a significant changes in the products physico-chemical properties during the 4 days of fermentation, greatly influenced by the interaction of the independent variables. Microbial count during fermentation was monitored, results shows that at 10-15% spice concentration and 10% brine concentration low microbial count was observed this is due antimicrobial properties of spices; and with 20% brine concentration with lower spice level have also low microbial count. During the 4 days fermentation, data on the physico-chemical properties showed an erratic results which can be concluded as greatly affected by the microbial succession.

Recommendation

Based on the results of the experiment, it is strongly recommended to extend the fermentation days until constant physico-chemical changes is attained. Test the pectin degradation of the young jackfruit throughout the fermentation process. Determine the rate of browning of the young jackfruit and evaluate the phenol content of the young jackfruit. It is also recommended to conduct and compare the effect of the different natural fermentation, brining, dry salting, and vinegar fermentation and determine its microbial profile until the last day of fermentation. In relation to microbial profile, it strongly recommended to conduct cultural, morphological and physiological study on the microorganism responsible during the fermentation process. And conduct shelflife study to the finished product with pickling base and without pickling base.

REFERENCES

Anonymous. *Fermented Foods Market - Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2016-2024.* Transpaency Market Research. In-depth Analysis, Accurate Results. Feb 21, 2017. www.transparencymarketresearch.com/fermented-foods-market.html (accessed April 1, 2017).

Barinov A, A Bolotin, P Langella, E Maguin, M Van De Guchte. *Genomics Of The Genus Lactobacillus. In: Sonomoto K, Yokota A, editors. Lactic Acid Bacteria and Bifidobacteria: Current Progress in Advanced Research.* Portland, USA: Caister Academic Press, 2011.

Bernardeau M, M Guguen and JP Vernoux. "Benefi cial lactobacilli in food and feed: long-term use, biodiversity and proposals for specifi c and realistic safety assessments." *FEMS Microbiology Reviews*, no. 30 (2006): 487–513.

Briones, RM. and IMR Galang. *Assessment of Prospective Impact of Fruits and Vegetables Research at the Industry Level in the Philippines: the Case of the ACIAR-PCAARRD Horticulture Project.* Makati City, Philippines: Philippine Institute for Development Studies, 2012.

Daeschel, M.A., Anderson, R.E. and Fleming, H.P. "Microecology of fermnting plant materials." *FEMS Microbiology Review*, 1987: 46:357-367.

Demir N, KS Bahceci and J Acar. "The effects of differential initial Lactobacillus plantarum concentrations on some properties of fermented carrot juice." *Journal of Food Processing and Preservation* 3, no. 30 (2006): 352-363.

Di Cagno R, R Coda, M De Angelis and M Gobbetti. "Exploitation of vegetables and fruits through lactic acid fermentation." *Food Microbiology*, no. 33 (2013): 1–10.

Eifert, J.A., Boyer, R.R., Williams, R.C., and Summer, S.S. "Vegetable Fermentation." *Virginia Cooperative Exytension*, n.d.

Florou-Paneri P, E Christaki and E Bonos. "Lactic Acid Bacteria as Source of Functional Ingredients." 2010: 1-26.

Galaverna G, Di Silvestro G, Cassano A, Sforza S, Doceana A, Drioli E, Marchelli R. "A new integrated membrane process for the production of concentrated blood orange juice: effect on bioactive compounds and antioxidant activity. Food Chem. ." *Comprehensive Reviews in Food Science and Food Safety. Vol. 11,*, 2008: 106:1021–30.

Gallego, J., Arroyo-López, F. N., Durán-Quintana, M. C. & Garrido-Fernández, A. "Fermentation profiles of Manzanilla- Aloreña cracked green table olives in different chloride salt mixtures." *Food Microbiology* , , 2010: 27, 403-412.

H.-A. Lee, Y.-O. Song, M.-S. Jang, and J.-S. Han. "“Effect of Ecklonia cava on the quality Kimchi during fermentation,." *Journal of the Korean Society of Food Science and Nutrition,, vol. 42, no. 1,*, 2013: 83–88,.

Halasz, A. *Lactic Acid Bacteria. In: Lasztity R, editor. Food Quality and Standards (Vol. 3).* UK: EOLSS Publishers Co Ltd, 2009.

Hutkins, RW. *Microbiology and Technology of Fermented Foods.* USA: Blackwell Publishing, Iowa, 2006.

Johnson-Green. *Introduction To Food Biotechnology.* Boca Raton: CRC Press, 2002.

Joshi, V.K., and Sharma, S. "Lactic acid fermentation of Radish for shelf-stability and pickling." *Natural Product Radiance. Vol 8.*, 2009: (1), 19-24.

Jung, J.Y., S.H. Lee, J.M. Kim, M.S. Park, J.-W. Bae, Y. Hahn, E.L. Madsen and C.O. Jeon. "Metagenomic analysis of kimchi, a traditional Korean fermented food." *Applied and Environmental Microbiology*, 2011: 77: 2264–2274.

Kaur IP, K Chopra and A Saini. "Probiotics: potential pharmaceutical applications." *European Journal of Pharmaceutical Sciences*, no. 15 (2002): 1–9.

Korhonen, A. "Antibiotic Resistance Of Lactic Acid Bacteria." *Dissertations in Forestry and Natural Sciences, University of Eastern Finland*, 2010.

M. J. Yoo, H. R. Kim, and H. J. Chung. "Change in physicochemical and microbiological properties in low-temperature and long-term fermented kimchi during fermentation." *Journal of The Korean Society of Dietary Culture, vol. 16, ,, ,* 2001: pp. 431–441.

McDougall GJ, Shpiro F, Dibosn P, Smith P, Black A, Stewart D. "Different polyphenolic components of soft fruits inhibit alpha-amylase and alpha-glucosidase. J Agri Food Chem." *Comprehensive Reviews in Food Science and Food Safety*, 2005: 53(7):2760–6.

McFeeters, RF. "Fermentation microorganisms and flavor changes in fermented food." *Journal of Food Science* 1, no. 69 (2004): 35–37.

Metchnikoff, E. *The Prolongation of Life.* New York: Putnam and Sons, 1908.

Montet D, G Loiseau and N Zakhia-Rozis. *Microbial Technology of fermented vegetables* . Vol. 1, in *Microbial Biotechnology in Horticulture.* , 309-343. Enfeld, New Hampshire.: R.C. Ray and O.P. Ward . In (eds.) Science Publishers Inc., 2006.

N. J. Lee and J. K. Chun. "Studies on the kimchi pasteurization.Part 1. Method of kimchi pasteurization with Chinese cabbage kimchi and its effect on the storage." *Journal of the Korean Society of Agricultural Chemistry and Biotechnology, , vol. 24, no.4,* , 1981: pp. 213–217.

Nakphaichit M, SC Thanomwongwattana, N Phraephaisarn, S Sakamoto, J Keawsompong, S Nakayama and S Nitisinprasert. "The effect of including Lactobacillus reuteri KUBAC5 during post-hatch feeding on the growth and ileum microbiota of broiler chickens." *Poultry Science* 12, no. 90 (2011): 2753–2765.

Ogbonnaya, N. and Bernice, C.C. "Studies on Akamu, a traditional fermented maize food." *Rev Chil Nutr Vol.39,* , 2012: 1-5.

Ohmomo S, S Murata, N Katayama, S Nitisinprasart, M Kobayashi, T Nakajima, M Yajima and K Nakanishi. "Purifi cation and some characteristics of enterocin ON-157, a bacteriocin produced by Enterococcus faecium NIAI 157." *Journal of Applied Microbiology*, no. 88 (2000): 81–89.

Pederson, C.S. and Albury, M.N. "The sauerkraut fermentation." *Bulletin No. 824. NYSAES,*, 1969: 1-84.

Perez-Diaz,I.M., Breidt, F., Buescher, R.W., Arroyo-Lopez, F.N., Jimenez-Diaz, R., Fernandez, A.G. Gallego, J.B., Yoon, S.S., and Johanningsmeier, S.D.

"Fermenetd and Acidified Vegetables." In *Compendium of Methods for the Microbiological Examination of Foods*. APHA Press, 2013.

Sahota, P.P., Kajal and Dhillon, H.K. "Detection and survival of Cronobacter sakazakii and Klebsiella pneumoniae in naturally fermented black carrot beverage." *International Journal of Advanced Research, Vol.2*, , 2014: 1-12.

Selhub EM, AC Logan, and AC Bested. "Fermented Foods, Microbiota, and Mental Health: Ancient Practice Meets Nutritional Psychiatry." *Journal of Physiological Anthropology*, 2014: 02-12.

Shrikant Baslingappa Swami, N. J. Thakor, P. M. Haldankar, and S. B. Kalse. "Jackfruit and Its Many Functional Components as Related to Human Health: A Review." *Comprehensive Reviews in Food Science and Food Safety. Vol.11*, 2012: 1-12.

Sidhu, AS. *Jackfruit - Improvement in the Asia-Pacific Region.* Hassarghatta Lake Post, Bangaluru - 560 089, Karnataka, India: Asia-Pacific Association of Agricultural Research Institutions c/o FAO Regional Office for Asia and the Pacific Bangkok, Thailand, 2012.

Stiles ME, and WH Holzapfel. "Lactic Acid Bacteria Of Foods And Their Current Taxonomy." *Int. j. Food Microbiology*, no. 36 (1997): 1–29.

T. I. Mheen, T.W. Kwon, and C. H. Lee. "Traditional fermented food products in Korea." *KoreanJournal of AppliedMicrobiology and Biotechnology, vol. 9,,,* 1981: . 253–261, .

Tamang, J. P., Tamang, B., Schillinger, U.,Guigas, C. & Holzapfel, W. H. "Functional properties of lactic acid bacteria isolated from ethnic fermented vegetables of the Himalayas." *International Journal of Food Microbiology , ,* 2009: 135, 28-33.

Tejpal, A. and P. Amrita. "Jackfruit: A Health Boon." *Int. J. Res. Ayurveda Pharm* 7, no. 3 (2016): 59-64.

Umesh JB, Panaskar Shrimant N, Bapat VA. "Evaluation of antioxidant capacity and phenol content in jackfruit (Artocarpus heterophyllus Lam.) fruit pulp. Plant Foods Hum Nutr ." *Comprehensive Reviews in Food Science and Food Safety Vol.11*, 2010: 65:99–104.

Wongsa P, Zamaluddien A. "Total phenolic content, antioxidant actvity and inhibitory potential against α-amylase and α-glucosidase of fifteen tropical fruits. 37th Congress on Science and Technology of Thailand." *Comprehensive Reveiws in Food Science and Food Safety Vol.11,*, 2005: 1-12.

Y. S. Bang, Y. G. Joh, and S. I.Moon. "The change of free amino acid composition during radish kimchi fermentation." *Journal of the Korean Home Economics Association, , vol. 23, .*, 1985: 55–60,.

Yukiko Wadamori, Leo Vanhanen and Geoffrey P. Savage. "Effect of kimchi Fermentation on Oxalate Levels in Silver Beet (Beta vulgaris var.cicla)." *www.mdpi.com/journal/foods, 1-10.*, 2014: 1-10.

APPENDICES

Appendix A. Variable Screening Acceptability Sheet

Fermented Immature jackfruit

Name: ____ Age: _____
Judge no. ____ Date:_____

Instruction: Kindly EVALUATE for color, aroma, firmness, and general acceptability using the scale provided below.

Sample Codes	______	______	______	______	______	______	______	______
Color Acceptability	______	______	______	______	______	______	______	______
Odor Acceptability	______	______	______	______	______	______	______	______
Taste Acceptability	______	______	______	______	______	______	______	______
Firmness Acceptability	______	______	______	______	______	______	______	______
Overall Acceptability	______	______	______	______	______	______	______	______

General Acceptability

9- like extremely
8- like very much
7- like moderately
6- like slightly
5- neither like or dislike
4- dislike slightly
3- dislike moderately
2- dislike very much
1- dislike extremely

Thank you very much!

Appendix B. Sensory Evaluation Score Sheet

Sensory Evaluation Score Sheet
Fermented Young Jackfruit

Name: ____________________ Date: __________

Judge No.: __________ Age: __________

Direction: Kindly evaluate each sample for their color, aroma, taste, flavor, firmness and Gen.Acc using the scale provided below. Please rinse your mouth before testing the next sample.

		SAMPLE					
	CODE	____	____	____	____	____	____
Color							
	Description	____	____	____	____	____	____
	Acceptability	____	____	____	____	____	____
Aroma							
	Description	____	____	____	____	____	____
	Acceptability	____	____	____	____	____	____
Taste							
	Description	____	____	____	____	____	____
	Acceptability	____	____	____	____	____	____
Flavor							
	Description	____	____	____	____	____	____
	Acceptability	____	____	____	____	____	____
Firmness							
	Description	____	____	____	____	____	____
	Acceptability	____	____	____	____	____	____
General Acceptability		____	____	____	____	____	____

COLOR
4-light brown
3-yellowish brown
2-yellowish white
1-pale yellow

AROMA
5-perceptible spiced aroma
4-perceprible pickled aroma
3-well blended spiced and pickled aroma
2-no perceptible spiced aroma
1-no perceptible pickled aroma

TASTE
5- very salty
4- moderately salty
3- slightly salty
2-just right
1-bland

FIRMNESS
5- very firm
4- moderately firm
3- slightly firm
2- just right firmness
1-not firm

Flavor
5- very perceptible spiced fermented Jackfruit
4- moderately perceptible spiced fermented Jackfruit
3- slightly perceptible spiced fermented jackfruit
2- perceptible spiced fermented jackfruit
1- no distinct spiced fermented flavor

GENERAL ACCEPTABILITY
9-like extremely
8-like very much
7-like moderately
6-like slightly
5-neither like nor dislike
4-dislike slightly
3-dislike moderately
2-dislike very much
1-dislike extremely

APPENDIX TABLES

Appendix Table 1. Parameter estiamtes for response surface of color acceptability for fermented jackfruit.

Effect Estimates; Var.:Color Acc; R-sqr=.01403; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.651042 DV: Color Acc										
	Effect	**Std. Err.**	**t(282)**	**p**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**	**Coeff.**	**Std.Err. - Coeff.**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**
Mean/Interc.	6.947917	0.075715	91.76389	0.000000	6.798878	7.096955	6.947917	0.075715	6.798878	7.096955
(1)Spices (%)(L)	0.031250	0.185463	0.16850	0.866313	-0.33381	0.396319	0.015625	0.092732	-0.16690	0.198159
Spices (%)(Q)	0.203125	0.160616	1.26466	0.207037	-0.11303	0.519284	0.101562	0.080308	-0.05651	0.259642
(2)Brine (%)(L)	-0.281250	0.185463	-1.51647	0.130520	-0.64631	0.083819	-0.140625	0.092732	-0.32315	0.041909
Brine (%)(Q)	0.046875	0.160616	0.29184	0.770620	-0.26928	0.363034	0.023437	0.080308	-0.13464	0.181517
1L by 2L	0.000000	0.227145	0.00000	1.000000	-0.44711	0.447116	0.000000	0.113573	-0.22355	0.223558

Appendix Table 2. Parameter estimates for response surface of aroma acceptability for fermented jackfruit.

Effect Estimates; Var.:Aroma Acc; R-sqr=.01622; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.295123 DV: Aroma Acc										
	Effect	**Std. Err.**	**t(282)**	**p**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**	**Coeff.**	**Std.Err. - Coeff.**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**
Mean/Interc.	7.184028	0.067059	107.1294	0.000000	7.052027	7.316028	7.184028	0.067059	7.052027	7.316028
(1)Spices (%)(L)	0.062500	0.164261	0.3805	0.703867	-0.26083	0.385834	0.031250	0.082131	-0.13041	0.192917
Spices (%)(Q)	0.208333	0.142254	1.4645	0.144168	-0.07168	0.488349	0.104167	0.071127	-0.03584	0.244174
(2)Brine (%)(L)	-0.239583	0.164261	-1.4586	0.145802	-0.56291	0.083750	-0.119792	0.082131	-0.28145	0.041875
Brine (%)(Q)	0.067708	0.142254	0.4760	0.634467	-0.21230	0.347724	0.033854	0.071127	-0.10615	0.173862
1L by 2L	-0.015625	0.201178	-0.0777	0.938148	-0.41162	0.380376	-0.007813	0.100589	-0.20581	0.190188

Appendix Table 3. Parameter estimates for response surface of taste acceptability for fermented jackfruit.

Effect Estimates; Var.:Taste Acc; R-sqr=.02901; Adj:.01179 (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.666799 DV: Taste Acc										
	Effect	**Std. Err.**	**t(282)**	**p**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**	**Coeff.**	**Std.Err. - Coeff.**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**
Mean/Interc.	7.211806	0.076076	94.79788	0.000000	7.062057	7.361554	7.211806	0.076076	7.062057	7.361554
(1)Spices (%)(L)	-0.135417	0.186346	-0.72669	0.468017	-0.502223	0.231390	-0.067708	0.093173	-0.251112	0.115695
Spices (%)(Q)	0.119792	0.161381	0.74229	0.458528	-0.197872	0.437455	0.059896	0.080690	-0.098936	0.218728
(2)Brine (%)(L)	-0.458333	0.186346	-2.45958	0.014510	-0.825140	-0.091527	-0.229167	0.093173	-0.412570	-0.045763
Brine (%)(Q)	0.166667	0.161381	1.03275	0.302604	-0.150997	0.484330	0.083333	0.080690	-0.075499	0.242165
1L by 2L	-0.109375	0.228227	-0.47924	0.632141	-0.558619	0.339869	-0.054687	0.114113	-0.279310	0.169935

Appendix Table 4. Parameter estimates for response surface of flavor acceptability for fermented jackfruit.

Effect Estimates; Var.:Flavor Acc; R-sqr=.01198; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.380319 DV: Flavor Acc										
	Effect	**Std. Err.**	**t(282)**	**p**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**	**Coeff.**	**Std.Err. - Coeff.**	**-95.% - Cnf.Limt**	**+95.% - Cnf.Limt**
Mean/Interc.	7.156250	0.069230	103.3694	0.000000	7.019977	7.292523	7.156250	0.069230	7.019977	7.292523
(1)Spices (%)(L)	-0.062500	0.169578	-0.3686	0.712731	-0.396299	0.271299	-0.031250	0.084789	-0.198150	0.135650
Spices (%)(Q)	0.250000	0.146859	1.7023	0.089798	-0.039078	0.539078	0.125000	0.073429	-0.019539	0.269539
(2)Brine (%)(L)	-0.062500	0.169578	-0.3686	0.712731	-0.396299	0.271299	-0.031250	0.084789	-0.198150	0.135650
Brine (%)(Q)	-0.031250	0.146859	-0.2128	0.831645	-0.320328	0.257828	-0.015625	0.073429	-0.160164	0.128914
1L by 2L	-0.093750	0.207690	-0.4514	0.652052	-0.502569	0.315069	-0.046875	0.103845	-0.251284	0.157534

Appendix Table 5. Parameter estimates for response surface of firmness acceptability of fermented jackfruit.

Effect Estimates; Var.:Firmness Acc; R-sqr=.00875; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.648256 DV: Firmness Acc

	Effect	Std. Err.	t(282)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	6.982639	0.075651	92.30038	0.000000	6.833726	7.131552	6.982639	0.075651	6.833726	7.131552
(1)Spices (%)(L)	0.187500	0.185307	1.01183	0.312484	-0.177260	0.552260	0.093750	0.092653	-0.088630	0.276130
Spices (%)(Q)	0.072917	0.160481	0.45436	0.649916	-0.242975	0.388808	0.036458	0.080240	-0.121488	0.194404
(2)Brine (%)(L)	-0.166667	0.185307	-0.89941	0.369202	-0.531427	0.198094	-0.083333	0.092653	-0.265714	0.099047
Brine (%)(Q)	0.041667	0.160481	0.25964	0.795333	-0.274225	0.357558	0.020833	0.080240	-0.137113	0.178779
1L by 2L	-0.140625	0.226954	-0.61962	0.536009	-0.587363	0.306113	-0.070313	0.113477	-0.293682	0.153057

Appendix Table 6. Parameter estimates for response surface of general acceptability for fermented jackfruit.

Effect Estimates; Var.:Gen Acc; R-sqr=.01274; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.490405 DV: Gen Acc

	Effect	Std. Err.	t(282)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	7.135417	0.071938	99.18897	0.000000	6.993814	7.277019	7.135417	0.071938	6.993814	7.277019
(1)Spices (%)(L)	0.010417	0.176210	0.05911	0.952902	-0.336438	0.357271	0.005208	0.088105	-0.168219	0.178636
Spices (%)(Q)	0.171875	0.152603	1.12629	0.261000	-0.128510	0.472260	0.085938	0.076301	-0.064255	0.236130
(2)Brine (%)(L)	-0.239583	0.176210	-1.35964	0.175029	-0.586438	0.107271	-0.119792	0.088105	-0.293219	0.053636
Brine (%)(Q)	-0.109375	0.152603	-0.71673	0.474134	-0.409760	0.191010	-0.054687	0.076301	-0.204880	0.095505
1L by 2L	0.015625	0.215813	0.07240	0.942334	-0.409183	0.440433	0.007812	0.107906	-0.204592	0.220217

Appendix Table 7. ANOVA of the color acceptability for fermented jackfruit.

ANOVA; Var.:Color Acc; R-sqr=.01403; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.651042 DV: Color Acc					
	SS	df	MS	F	p
(1)Spices (%)(L)	0.0469	1	0.046875	0.028391	0.866313
Spices (%)(Q)	2.6406	1	2.640625	1.599369	0.207037
(2)Brine (%)(L)	3.7969	1	3.796875	2.299685	0.130520
Brine (%)(Q)	0.1406	1	0.140625	0.085174	0.770620
1L by 2L	0.0000	1	0.000000	0.000000	1.000000
Error	465.5938	282	1.651042		
Total SS	472.2188	287			

Appendix Table 8.ANOVA of the aroma acceptability for fermented jackfruit.

ANOVA; Var.:Aroma Acc; R-sqr=.01622; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.295123 DV: Aroma Acc					
	SS	df	MS	F	p
(1)Spices (%)(L)	0.1875	1	0.187500	0.144774	0.703867
Spices (%)(Q)	2.7778	1	2.777778	2.144798	0.144168
(2)Brine (%)(L)	2.7552	1	2.755208	2.127371	0.145802
Brine (%)(Q)	0.2934	1	0.293403	0.226544	0.634467
1L by 2L	0.0078	1	0.007813	0.006032	0.938148
Error	365.2248	282	1.295123		
Total SS	371.2465	287			

Appendix Table 9. ANOVA of the taste acceptability for fermented jackfruit.

ANOVA; Var.:Taste Acc; R-sqr=.02901; Adj:.01179 (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.666799 DV: Taste Acc					
	SS	df	MS	F	p
(1)Spices (%)(L)	0.8802	1	0.88021	0.528083	0.468017
Spices (%)(Q)	0.9184	1	0.91840	0.550998	0.458528
(2)Brine (%)(L)	10.0833	1	10.08333	6.049520	0.014510
Brine (%)(Q)	1.7778	1	1.77778	1.066582	0.302604
1L by 2L	0.3828	1	0.38281	0.229669	0.632141
Error	470.0373	282	1.66680		
Total SS	484.0799	287			

Appendix Table 10. ANOVA of the flavor acceptability for fermented jackfruit.

ANOVA; Var.:Flavor Acc; R-sqr=.01198; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.380319 DV: Flavor Acc					
	SS	**df**	**MS**	**F**	**p**
(1)Spices (%)(L)	0.1875	1	0.187500	0.135838	0.712731
Spices (%)(Q)	4.0000	1	4.000000	2.897881	0.089798
(2)Brine (%)(L)	0.1875	1	0.187500	0.135838	0.712731
Brine (%)(Q)	0.0625	1	0.062500	0.045279	0.831645
1L by 2L	0.2812	1	0.281250	0.203757	0.652052
Error	389.2500	282	1.380319		
Total SS	393.9688	287			

Appendix Table 11. ANOVA of the firmness acceptability for the fermented jackfruit.

ANOVA; Var.:Firmness Acc; R-sqr=.00875; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.648256 DV: Firmness Acc					
	SS	**df**	**MS**	**F**	**p**
(1)Spices (%)(L)	1.6875	1	1.687500	1.023809	0.312484
Spices (%)(Q)	0.3403	1	0.340278	0.206447	0.649916
(2)Brine (%)(L)	1.3333	1	1.333333	0.808936	0.369202
Brine (%)(Q)	0.1111	1	0.111111	0.067411	0.795333
1L by 2L	0.6328	1	0.632813	0.383929	0.536009
Error	464.8082	282	1.648256		
Total SS	468.9132	287			

Appendix Table 12. ANOVA of the general acceptability for the fermented jackfruit.

ANOVA; Var.:Gen Acc; R-sqr=.01274; Adj:0. (Sensory_Acceptability_fijf) 2 3-level factors, 1 Blocks, 288 Runs; MS Residual=1.490405 DV: Gen Acc					
	SS	**df**	**MS**	**F**	**p**
(1)Spices (%)(L)	0.0052	1	0.005208	0.003495	0.952902
Spices (%)(Q)	1.8906	1	1.890625	1.268531	0.261000
(2)Brine (%)(L)	2.7552	1	2.755208	1.848630	0.175029
Brine (%)(Q)	0.7656	1	0.765625	0.513703	0.474134
1L by 2L	0.0078	1	0.007812	0.005242	0.942334
Error	420.2943	282	1.490405		
Total SS	425.7187	287			

Appendix Table 13. Critical values of color acceptability for fermented jackfruit.

Critical values; Variable: Color Acc (Sensory_Acceptability_fijf) Solution: maximum Predicted value at solution: 7.220353			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spices (%)	5.00000	10.19231	15.00000
Brine (%)	10.00000	7.50000	20.00000

Appendix Table 14. Critical values of the aroma acceptability for fermented jackfruit.

Critical values; Variable: Aroma Acc (Sensory_Acceptability_fijf) Solution: maximum Predicted value at solution: 7.42279			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spices (%)	5.00000	10.45843	15.00000
Brine (%)	10.00000	10.55048	20.00000

Appendix Table 15. Critical values of the taste acceptability for fermented jackfruit.

Critical values; Variable: Taste Acc (Sensory_Acceptability_fijf) Solution: maximum Predicted value at solution: 7.48352			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spices (%)	5.00000	9.34715	15.00000
Brine (%)	10.00000	11.66961	20.00000

Appendix Table 16. Critical values of the flavor acceptability for the fermented jackfruit.

Critical values; Variable: Flavor Acc (Sensory_Acceptability_fijf) Solution: saddlepoint Predicted value at solution: 7.297065			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spices (%)	5.00000	9.48905	15.00000
Brine (%)	10.00000	17.11679	20.00000

Appendix Table 17. Critical values of the firmness for the fermented jackfruit.

Critical values; Variable: Firmness Acc (Sensory_Acceptability_fijf) Solution: maximum Predicted value at solution: 7.256268			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spices (%)	5.00000	9.199906	15.00000
Brine (%)	10.00000	19.48260	20.00000

Appendix Table 18. Critical values of the general acceptability for the fermented jackfruit.

Critical values; Variable: Gen Acc (Sensory_Acceptability_fijf) Solution: saddlepoint Predicted value at solution: 7.144414			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spices (%)	5.00000	10.13788	15.00000
Brine (%)	10.00000	17.73317	20.00000

Appendix Table 19. ANOVA of the TSS-slurry.

ANOVA; Var.:TSS-Slurry; R-sqr=.96803; Adj:.96544 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.1761277 DV: TSS-Slurry					
	SS	**df**	**MS**	**F**	**p**
Blocks	19.0099	3	6.3366	35.978	0.000000
(1)Spice%(L)	49.5013	1	49.5013	281.053	0.000000
Spice%(Q)	1.5845	1	1.5845	8.996	0.003422
(2)Brine (L)	456.5235	1	456.5235	2592.003	0.000000
Brine (Q)	0.1112	1	0.1112	0.631	0.428846
1L by 2L	1.1719	1	1.1719	6.654	0.011366
Error	17.4366	99	0.1761		
Total SS	545.3388	107			

Appendix Table 20. ANOVA of the slurry's pH.

ANOVA; Var.:pH-Slurry; R-sqr=.92924; Adj:.92352 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0118767 DV: pH-Slurry					
	SS	**df**	**MS**	**F**	**p**
Blocks	11.98065	3	3.993551	336.2506	0.000000
(1)Spice%(L)	2.81636	1	2.816356	237.1327	0.000000
Spice%(Q)	0.06545	1	0.065452	5.5109	0.020888
(2)Brine (L)	0.56889	1	0.568889	47.8995	0.000000
Brine (Q)	0.00031	1	0.000313	0.0264	0.871377
1L by 2L	0.00935	1	0.009352	0.7874	0.377029
Error	1.17579	99	0.011877		
Total SS	16.61681	107			

Appendix Table 21. ANOVA of the slurry's TA.

ANOVA; Var.:TA-Slurry; R-sqr=.81931; Adj:.80471 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0001659 DV: TA-Slurry					
	SS	**df**	**MS**	**F**	**p**
Blocks	0.004975	3	0.001658	9.9951	0.000008
(1)Spice%(L)	0.051920	1	0.051920	312.9379	0.000000
Spice%(Q)	0.007955	1	0.007955	47.9488	0.000000
(2)Brine (L)	0.003779	1	0.003779	22.7767	0.000006
Brine (Q)	0.000473	1	0.000473	2.8483	0.094618
1L by 2L	0.005375	1	0.005375	32.3972	0.000000
Error	0.016425	99	0.000166		
Total SS	0.090902	107			

Appendix Table 22. ANOVA of the jackfruit's TSS.

ANOVA; Var.:TSS-JF; R-sqr=.78646; Adj:.7692 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=2.072585 DV: TSS-Slurry					
	SS	**df**	**MS**	**F**	**p**
Blocks	210.2678	3	70.0893	33.8173	0.000000
(1)Spice%(L)	41.7089	1	41.7089	20.1241	0.000020
Spice%(Q)	0.4630	1	0.4630	0.2234	0.637521
(2)Brine (L)	485.6806	1	485.6806	234.3356	0.000000
Brine (Q)	6.3380	1	6.3380	3.0580	0.083440
1L by 2L	11.2133	1	11.2133	5.4103	0.022058
Error	205.1859	99	2.0726		
Total SS	960.8574	107			

Appendix Table 23. ANOVA of the jackfruit's pH.

ANOVA; Var.:pH-JF; R-sqr=.89391; Adj:.88534 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0229512 DV: pH-JF					
	SS	**df**	**MS**	**F**	**p**
Blocks	17.35991	3	5.786638	252.1274	0.000000
(1)Spice%(L)	1.71742	1	1.717422	74.8292	0.000000
Spice%(Q)	0.00156	1	0.001557	0.0679	0.795024
(2)Brine (L)	0.01620	1	0.016200	0.7058	0.402851
Brine (Q)	0.01671	1	0.016713	0.7282	0.395529
1L by 2L	0.03307	1	0.033075	1.4411	0.232826
Error	2.27217	99	0.022951		
Total SS	21.41705	107			

Appendix Table 24. ANOVA of the jackfruit's TA

ANOVA; Var.:TA-JF; R-sqr=.30856; Adj:.25269 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0007545 DV: TA-JF					
	SS	df	MS	F	p
Blocks	0.007519	3	0.002506	3.32153	0.022891
(1)Spice%(L)	0.004213	1	0.004213	5.58350	0.020085
Spice%(Q)	0.001032	1	0.001032	1.36739	0.245069
(2)Brine (L)	0.003494	1	0.003494	4.63096	0.033832
Brine (Q)	0.002519	1	0.002519	3.33835	0.070695
1L by 2L	0.014559	1	0.014559	19.29566	0.000028
Error	0.074700	99	0.000755		
Total SS	0.108036	107			

Appendix Table 25. Parameter estimates of slurry's TSS.

Effect Estimates; Var.:TSS-Slurry; R-sqr=.96803; Adj:.96544 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.1761277 DV: TSS-Slurry									
	Effect	Std. Err.	t(99)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	12.96019	0.040383	320.9292	0.000000	12.88006	13.04031	12.96019	0.040383	12.88006	13.04031
(1)Spice%(L)	1.65833	0.098919	16.7646	0.000000	1.46206	1.85461	0.82917	0.049459	0.73103	0.92730
Spice% (Q)	-0.25694	0.085666	-2.9994	0.003422	-0.42692	-0.08696	-0.12847	0.042833	-0.21346	-0.04348
(2)Brine (L)	5.03611	0.098919	50.9117	0.000000	4.83984	5.23239	2.51806	0.049459	2.41992	2.61619
Brine (Q)	0.06806	0.085666	0.7944	0.428846	-0.10192	0.23804	0.03403	0.042833	-0.05096	0.11902
1L by 2L	0.31250	0.121150	2.5794	0.011366	0.07211	0.55289	0.15625	0.060575	0.03606	0.27644

Appendix Table 26. Parameter estimates of slurry's-pH.

Effect Estimates; Var.:pH-Slurry; R-sqr=.92924; Adj:.92352 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0118767 DV: pH-Slurry

	Effect	Std. Err.	t(99)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	2.99593	0.010487	285.6899	0.000000	2.97512	3.016734	2.995926	0.010487	2.975118	3.016734
(1)Spice%(L)	0.39556	0.025687	15.3991	0.000000	0.34459	0.446524	0.197778	0.012843	0.172294	0.223262
Spice% (Q)	-0.05222	0.022246	-2.3475	0.020888	-0.09636	-0.008082	-0.026111	0.011123	-0.048181	-0.004041
(2)Brine (L)	-0.17778	0.025687	-6.9209	0.000000	-0.22875	-0.126809	-0.088889	0.012843	-0.114373	-0.063405
Brine (Q)	0.00361	0.022246	0.1623	0.871377	-0.04053	0.047751	0.001806	0.011123	-0.020264	0.023876
1L by 2L	0.02792	0.031460	0.8874	0.377029	-0.03451	0.090340	0.013958	0.015730	-0.017253	0.045170

Appendix Table 27. Parameter estimates of slurry's TA

Effect Estimates; Var.:TA-Slurry; R-sqr=.81931; Adj:.80471 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0001659 DV: TA-Slurry

	Effect	Std. Err.	t(99)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	0.177050	0.001239	142.8466	0.000000	0.174590	0.179509	0.177050	0.001239	0.174590	0.179509
(1)Spice%(L)	0.053707	0.003036	17.6900	0.000000	0.047683	0.059731	0.026853	0.001518	0.023841	0.029865
Spice% (Q)	-0.018206	0.002629	-6.9245	0.000000	-0.023423	-0.012989	-0.009103	0.001315	-0.011712	-0.006495
(2)Brine (L)	0.014489	0.003036	4.7725	0.000006	0.008465	0.020513	0.007245	0.001518	0.004233	0.010257
Brine (Q)	-0.004437	0.002629	-1.6877	0.094618	-0.009654	0.000780	-0.002219	0.001315	-0.004827	0.000390
1L by 2L	0.021164	0.003718	5.6919	0.000000	0.013786	0.028542	0.010582	0.001859	0.006893	0.014271

Appendix Table 28. Parameter estiamtes of jackfruit's TSS

Effect Estimates; Var.:TSS-JF; R-sqr=.78646; Adj:.7692 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=2.072585 DV: TSS-JF

	Effect	Std. Err.	t(99)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	11.62407	0.138530	83.91007	0.000000	11.34920	11.89895	11.62407	0.138530	11.34920	11.89895
(1)Spice%(L)	1.52222	0.339328	4.48599	0.000020	0.84892	2.19552	0.76111	0.169664	0.42446	1.09776
Spice% (Q)	0.13889	0.293867	0.47263	0.637521	-0.44421	0.72198	0.06944	0.146933	-0.22210	0.36099
(2)Brine (L)	5.19444	0.339328	15.30803	0.000000	4.52114	5.86775	2.59722	0.169664	2.26057	2.93387
Brine (Q)	0.51389	0.293867	1.74871	0.083440	-0.06921	1.09698	0.25694	0.146933	-0.03460	0.54849
1L by 2L	0.96667	0.415590	2.32601	0.022058	0.14205	1.79129	0.48333	0.207795	0.07102	0.89564

Appendix Table 29. Parameter estimates of jackfruit's pH.

Effect Estimates; Var.:pH-JF; R-sqr=.89391; Adj:.88534 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0229512 DV: pH-JF

	Effect	Std. Err.	t(99)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	3.454352	0.014578	236.9602	0.000000	3.42543	3.483277	3.454352	0.014578	3.425426	3.483277
(1)Spice%(L)	0.308889	0.035708	8.6504	0.000000	0.23804	0.379742	0.154444	0.017854	0.119018	0.189871
Spice% (Q)	0.008056	0.030924	0.2605	0.795024	-0.05330	0.069416	0.004028	0.015462	-0.026652	0.034708
(2)Brine (L)	-0.030000	0.035708	-0.8401	0.402851	-0.10085	0.040853	-0.015000	0.017854	-0.050426	0.020426
Brine (Q)	0.026389	0.030924	0.8533	0.395529	-0.03497	0.087749	0.013194	0.015462	-0.017486	0.043875
1L by 2L	0.052500	0.043733	1.2005	0.232826	-0.03428	0.139276	0.026250	0.021867	-0.017138	0.069638

Appendix Table 30. Parameter estimates of jackfruit's TA

Effect Estimates; Var.:TA-JF; R-sqr=.30856; Adj:.25269 (Spreadsheet7) 2 3-level factors, 4 Blocks, 108 Runs; MS Residual=.0007545 DV: TA-JF

	Effect	Std. Err.	t(99)	p	-95.% - Cnf.Limt	+95.% - Cnf.Limt	Coeff.	Std.Err. - Coeff.	-95.% - Cnf.Limt	+95.% - Cnf.Limt
Mean/Interc.	0.229210	0.002643	86.71671	0.000000	0.223965	0.234455	0.229210	0.002643	0.223965	0.234455
(1)Spice%(L)	-0.015299	0.006475	-2.36294	0.020085	-0.028146	-0.002452	-0.007649	0.003237	-0.014073	-0.001226
Spice% (Q)	0.006557	0.005607	1.16935	0.245069	-0.004569	0.017682	0.003278	0.002804	-0.002285	0.008841
(2)Brine (L)	-0.013933	0.006475	-2.15197	0.033832	-0.026780	-0.001086	-0.006966	0.003237	-0.013390	-0.000543
Brine (Q)	0.010245	0.005607	1.82711	0.070695	-0.000881	0.021370	0.005122	0.002804	-0.000440	0.010685
1L by 2L	-0.034832	0.007930	-4.39268	0.000028	-0.050566	-0.019098	-0.017416	0.003965	-0.025283	-0.009549

Appendix Table 31. Critical values of slurry's TSS

Critical values; Variable: TSS-Slurry (Spreadsheet7) Solution: saddlepoint Predicted value at solution: 25.42724

	Observed - Minimum	Critical - Values	Observed - Maximum
Spice%	5.00000	-16.8284	15.00000
Brine%	10.00000	76.7021	20.00000

Appendix Table 32. Critical values of slurry's pH.

Critical values; Variable: pH-Slurry (Spreadsheet7) Solution: saddlepoint Predicted value at solution: 3.864255

	Observed - Minimum	Critical - Values	Observed - Maximum
Spice%	5.00000	9.0115	15.00000
Brine	10.00000	-48.4490	20.00000

Appendix Table 33. Critical values of slurry's TA

Critical values; Variable: TA-Slurry (Spreadsheet7) Solution: minimum Predicted value at solution: .1594591

	Observed - Minimum	Critical - Values	Observed - Maximum
Spice%	5.00000	6.17244	15.00000
Brine	10.00000	15.48231	20.00000

Appendix Table 34. Critical values of the jackfruit's TSS

Critical values; Variable: TSS-JF (Spreadsheet7) Solution: maximum Predicted value at solution: 52.40163			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spice%	5.00000	6.17244	15.00000
Brine	10.00000	15.48231	20.00000

Appendix Table 35. Critical values of the jackfruit's pH.

Critical values; Variable: pH-JF (Spreadsheet7) Solution: maximum Predicted value at solution: 7.490762			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spice%	5.00000	250.5479	15.00000
Brine	10.00000	133.2199	20.00000

Appendix Table 36. Critical values of the jackfruit's TA.

Critical values; Variable: TA-JF (Spreadsheet7) Solution: saddlepoint Predicted value at solution: .2373428			
	Observed - Minimum	**Critical - Values**	**Observed - Maximum**
Spice%	5.00000	15.11111	15.00000
Brine	10.00000	8.95556	20.00000

Appendix Table 37. Raw microbial count

TRT	Dilution	Replicate	Count			
			Day 1	Day 2	Day 3	Day 4
1	100	1	77	25	2	156
1	100	2	116	1	0	25
1	1000	1	8	7	0	54
1	1000	2	5	1	0	16
1	10000	1	1	21	5	96
1	10000	2	0	4	1	89
1	100000	1	60	0	2	4228
1	100000	2	45	0	0	66
1	1000000	1	12	4	1	5222
1	1000000	2	8	0	0	93
1	10000000	1	30	14	0	250
1	10000000	2	13	7	0	88
2	100	1	2	39	4	2800
2	100	2	2	6	0	35

2	1000	1	3	48	0	665
2	1000	2	4	18	0	150
2	10000	1	60	72	1	616
2	10000	2	18	7	0	586
2	100000	1	3	120	2	728
2	100000	2	0	5	0	276
2	1000000	1	25	188	0	25
2	1000000	2	8	0	0	0
2	10000000	1	13	0	0	0
2	10000000	2	2	0	0	0
3	100	1	2	386	670	670
3	100	2	1	9	0	504
3	1000	1	3	38	0	223
3	1000	2	2	18	0	63
3	10000	1	5	31	0	1008
3	10000	2	4	20	0	543
3	100000	1	0	4	0	268
3	100000	2	2	1	0	196
3	1000000	1	6	2	0	616
3	1000000	2	2	2	0	13
3	10000000	1	4	2296	0	42
3	10000000	2	50	0	0	21
4	100	1	39	0	2	81
4	100	2	21	0	0	24
4	1000	1	1	0	4	658
4	1000	2	0	0	1	96
4	10000	1	41	0	0	1750
4	10000	2	15	0	0	1512
4	100000	1	5824	3136	2	96
4	100000	2	3248	4	0	21
4	1000000	1	3640	5	0	2170
4	1000000	2	2184	0	0	324
4	10000000	1	1512	14	0	1005
4	10000000	2	1120	10	0	26
5	100	1	312	4	1	1
5	100	2	44	0	0	0
5	1000	1	13	5	1	0
5	1000	2	3	0	0	0
5	10000	1	2	35	30	1
5	10000	2	2	27	4	0
5	100000	1	3	4	31	2
5	100000	2	3	1	3	0
5	1000000	1	5	5	0	0

5	1000000	2	2	5	0	0
5	10000000	1	1	2	0	0
5	10000000	2	3	0	0	0
6	100	1	33	1	0	12
6	100	2	82	0	0	0
6	1000	1	13	1	0	8
6	1000	2	14	0	0	0
6	10000	1	93	1	0	1462
6	10000	2	30	0	0	26
6	100000	1	32	1	0	186
6	100000	2	58	0	0	106
6	1000000	1	24	2	3	40
6	1000000	2	29	0	0	50
6	10000000	1	16	0	90	0
6	10000000	2	19	0	10	0
7	100	1	9	4	2	2254
7	100	2	9	2	1	12
7	1000	1	12	2	1	161
7	1000	2	10	2	0	40
7	10000	1	15	6	12	12
7	10000	2	1	3	2	2
7	100000	1	3	42	1	1
7	100000	2	3	5	0	0
7	1000000	1	6	1	0	1
7	1000000	2	9	0	0	1
7	10000000	1	21	20	0	7
7	10000000	2	50	0	0	1
8	100	1	1	41	4	224
8	100	2	0	3	1	411
8	1000	1	2	1	1	1
8	1000	2	2	0	0	0
8	10000	1	22	3	2	4
8	10000	2	1	0	0	0
8	100000	1	2	0	4	195
8	100000	2	2	0	11	175
8	1000000	1	8	0	2	450
8	1000000	2	2	0	0	165
8	10000000	1	12	2	0	4
8	10000000	2	3	1	0	0
9	100	1	49	0	1024	313
9	100	2	41	0	3584	277
9	1000	1	17	1	730	544
9	1000	2	22	0	223	82

9	10000	1	14	4	1456	686
9	10000	2	12	1	252	86
9	100000	1	4	2	42	27
9	100000	2	3	1	34	4
9	1000000	1	7	1	0	24
9	1000000	2	9	1	0	14
9	10000000	1	4	1	539	0
9	10000000	2	1	0	134	0

Appendix Table 38. Production cost in laboratory scale of fermented jackfruit.

Trt	Water	Fuel	JF	Sugar	Vinegar	Salt	Garlic	Onion	Pepper	Salabat	labor	TOTAL
1	3.75	0.06991	0.5	12.5	6.5	1	6	3	23.33333	6.25	10	72.90324
2	3.75	0.06991	0.5	12.5	6.5	1	12	6	46.66667	12.5	10	111.4866
3	3.75	0.06991	0.5	12.5	6.5	1	18	9	70	18.75	10	150.0699
4	3.75	0.06991	0.5	12.5	6.5	1.5	6	3	23.33333	6.25	10	73.40324
5	3.75	0.06991	0.5	12.5	6.5	1.5	12	6	46.66667	12.5	10	111.9866
6	3.75	0.06991	0.5	12.5	6.5	1.5	18	9	70	18.75	10	150.5699
7	3.75	0.06991	0.5	12.5	6.5	2	6	3	23.33333	6.25	10	73.90324
8	3.75	0.06991	0.5	12.5	6.5	2	12	6	46.66667	12.5	10	112.4866
9	3.75	0.06991	0.5	12.5	6.5	2	18	9	70	18.75	10	151.0699
of	3.75	0.06991	0.5	12.5	6.5	1.15	17.04	8.52	66.26667	17.75	10	144.0466

Appendix Table 39. Raw data on the acceptability score of Treatment 1.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	1	5	10	9	8	9	8	8	8
2	1	5	10	7	7	8	8	8	8
3	1	5	10	7	8	7	8	8	8
4	1	5	10	7	7	7	8	7	8
5	1	5	10	7	8	8	8	8	7
6	1	5	10	8	9	9	9	9	9
7	1	5	10	8	8	8	7	8	8
8	1	5	10	7	6	8	7	8	7
9	1	5	10	8	7	8	7	7	7
10	1	5	10	7	7	7	7	7	7
11	1	5	10	8	8	9	8	8	9
12	1	5	10	7	7	7	7	6	7
13	1	5	10	7	9	9	8	6	8
14	1	5	10	6	5	5	5	6	5
15	1	5	10	8	8	8	8	8	8
16	1	5	10	7	7	6	6	5	6
17	1	5	10	4	6	4	4	6	4
18	1	5	10	7	7	8	8	8	8
19	1	5	10	4	7	3	5	4	4
20	1	5	10	6	6	7	6	5	6
21	1	5	10	7	6	8	7	8	7
22	1	5	10	7	6	8	6	6	7
23	1	5	10	8	7	7	8	6	8
24	1	5	10	8	8	9	8	8	9
25	1	5	10	7	7	7	7	7	7
26	1	5	10	8	8	8	8	8	8
27	1	5	10	6	6	6	6	6	6
28	1	5	10	6	6	8	6	8	8
29	1	5	10	6	6	6	6	6	6
30	1	5	10	9	9	9	9	9	9
31	1	5	10	6	6	7	6	5	6
32	1	5	10	7	7	6	6	5	6

Appendix Table 40. Raw data on the acceptability score of Treatment 2.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	2	10	10	9	8	9	8	8	8
2	2	10	10	7	7	8	8	8	8
3	2	10	10	7	8	8	7	7	8
4	2	10	10	6	7	8	8	7	7
5	2	10	10	8	8	8	8	8	8
6	2	10	10	7	7	7	7	8	7
7	2	10	10	8	8	7	8	7	7
8	2	10	10	8	8	9	8	7	8
9	2	10	10	7	7	7	7	7	7
10	2	10	10	6	7	7	7	6	7
11	2	10	10	7	8	8	8	7	8
12	2	10	10	6	9	9	8	6	7
13	2	10	10	5	5	5	5	5	5
14	2	10	10	8	8	8	7	7	8
15	2	10	10	7	8	7	7	7	7
16	2	10	10	9	7	7	5	6	6
17	2	10	10	6	7	8	8	8	8
18	2	10	10	8	8	8	8	4	7
19	2	10	10	5	7	6	7	6	7
20	2	10	10	8	7	8	7	7	9
21	2	10	10	7	8	7	8	8	8
22	2	10	10	8	8	8	8	4	7
23	2	10	10	8	8	7	7	8	9
24	2	10	10	7	7	7	7	7	7
25	2	10	10	9	9	9	9	9	9
26	2	10	10	9	9	9	9	9	9
27	2	10	10	6	6	6	6	6	6
28	2	10	10	8	8	8	8	8	8
29	2	10	10	9	7	9	9	9	9
30	2	10	10	7	7	7	7	7	7
31	2	10	10	6	7	7	7	6	7
32	2	10	10	5	5	5	5	5	5

Appendix Table 41. Raw data on the acceptability of Treatment 3

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	3	15	10	7	7	8	8	7	8
2	3	15	10	7	7	8	8	7	7
3	3	15	10	9	8	8	8	8	8
4	3	15	10	7	6	7	8	7	7
5	3	15	10	7	8	8	8	8	8
6	3	15	10	7	8	6	7	7	6
7	3	15	10	9	8	7	8	9	8
8	3	15	10	7	9	8	9	8	8
9	3	15	10	8	7	8	8	8	8
10	3	15	10	7	7	8	7	8	8
11	3	15	10	7	8	7	7	8	8
12	3	15	10	8	8	7	7	8	9
13	3	15	10	7	7	7	7	7	7
14	3	15	10	6	6	6	4	6	5
15	3	15	10	8	8	8	7	8	8
16	3	15	10	8	8	7	8	7	8
17	3	15	10	7	7	7	4	6	5
18	3	15	10	6	6	5	5	6	4
19	3	15	10	6	7	8	8	8	8
20	3	15	10	4	7	6	7	4	6
21	3	15	10	4	6	7	5	5	5
22	3	15	10	7	7	8	7	8	8
23	3	15	10	8	8	8	8	8	9
24	3	15	10	4	4	6	6	6	6
25	3	15	10	4	7	6	7	4	6
26	3	15	10	8	8	9	7	8	8
27	3	15	10	6	6	6	6	8	6
28	3	15	10	8	8	8	8	8	8
29	3	15	10	9	9	9	9	9	9
30	3	15	10	9	9	8	9	9	9
31	3	15	10	6	6	6	6	6	6
32	3	15	10	9	9	9	9	9	9

Appendix Table 42. Raw data on the acceptability of Treatment 4.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	4	5	15	9	8	9	9	9	9
2	4	5	15	7	7	7	7	7	7
3	4	5	15	7	7	7	8	7	7
4	4	5	15	9	8	8	8	8	8
5	4	5	15	6	6	8	8	7	8
6	4	5	15	6	7	7	7	8	7
7	4	5	15	8	8	7	8	8	7
8	4	5	15	8	9	8	7	6	7
9	4	5	15	8	9	9	8	8	7
10	4	5	15	6	6	8	7	7	7
11	4	5	15	7	7	7	6	6	6
12	4	5	15	7	9	9	9	6	7
13	4	5	15	8	8	8	8	8	8
14	4	5	15	7	7	8	7	9	8
15	4	5	15	7	7	6	6	5	6
16	4	5	15	6	8	7	7	7	7
17	4	5	15	4	7	7	7	4	7
18	4	5	15	4	6	4	3	6	4
19	4	5	15	6	6	8	7	7	7
20	4	5	15	8	7	7	7	5	7
21	4	5	15	8	8	9	8	8	9
22	4	5	15	4	7	7	7	4	7
23	4	5	15	8	7	7	7	6	7
24	4	5	15	7	8	9	8	8	8
25	4	5	15	8	8	8	8	8	8
26	4	5	15	6	6	6	6	6	6
27	4	5	15	8	8	8	8	8	8
28	4	5	15	6	8	8	8	8	8
29	4	5	15	6	6	6	6	6	6
30	4	5	15	6	6	6	6	6	6
31	4	5	15	6	6	6	6	6	6
32	4	5	15	9	8	8	8	8	8

Appendix Table 43. Raw data on the acceptability of Treatment 5.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	5	10	15	9	8	9	9	8	8
2	5	10	15	9	8	9	8	9	9
3	5	10	15	7	7	8	7	7	7
4	5	10	15	6	7	6	7	7	8
5	5	10	15	6	8	7	8	7	7
6	5	10	15	7	8	7	7	7	6
7	5	10	15	8	8	7	7	7	7
8	5	10	15	6	8	6	8	8	8
9	5	10	15	7	9	8	8	8	8
10	5	10	15	6	7	7	7	7	7
11	5	10	15	7	7	7	7	7	7
12	5	10	15	8	8	9	7	8	8
13	5	10	15	7	7	7	7	7	7
14	5	10	15	5	5	5	5	5	4
15	5	10	15	8	8	7	7	7	7
16	5	10	15	7	7	8	7	7	7
17	5	10	15	7	9	7	8	7	7
18	5	10	15	6	6	5	5	6	4
19	5	10	15	7	7	8	8	6	7
20	5	10	15	5	5	6	6	6	6
21	5	10	15	7	9	8	8	8	8
22	5	10	15	4	5	9	9	7	8
23	5	10	15	7	7	8	8	6	7
24	5	10	15	9	7	7	7	7	7
25	5	10	15	7	7	7	7	7	8
26	5	10	15	7	7	7	7	7	7
27	5	10	15	9	9	9	9	8	9
28	5	10	15	9	9	9	9	9	9
29	5	10	15	8	8	8	8	8	8
30	5	10	15	8	6	6	6	6	6
31	5	10	15	9	9	9	9	9	9
32	5	10	15	5	5	5	5	5	5

Appendix Table 44. Raw data on the acceptability of Treatment 6.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	6	15	15	9	8	9	9	8	9
2	6	15	15	9	8	9	8	9	9
3	6	15	15	6	8	8	7	7	7
4	6	15	15	7	8	8	8	6	6
5	6	15	15	5	8	6	6	4	6
6	6	15	15	5	7	7	7	7	7
7	6	15	15	9	8	8	8	7	7
8	6	15	15	7	7	8	7	8	8
9	6	15	15	7	8	9	8	8	8
10	6	15	15	6	7	6	6	6	7
11	6	15	15	8	8	8	8	7	7
12	6	15	15	5	5	5	5	5	4
13	6	15	15	7	8	7	7	7	7
14	6	15	15	7	7	8	7	8	7
15	6	15	15	8	7	9	8	9	8
16	6	15	15	6	6	8	5	7	7
17	6	15	15	7	7	8	8	7	7
18	6	15	15	6	6	5	5	6	5
19	6	15	15	5	6	6	6	6	6
20	6	15	15	7	7	7	6	7	7
21	6	15	15	8	8	8	8	8	6
22	6	15	15	8	2	1	2	7	3
23	6	15	15	7	8	7	7	8	8
24	6	15	15	9	7	7	7	7	8
25	6	15	15	7	8	9	8	8	8
26	6	15	15	6	6	6	6	6	6
27	6	15	15	6	6	6	6	6	6
28	6	15	15	7	7	7	7	7	7
29	6	15	15	8	8	8	8	8	8
30	6	15	15	6	6	6	6	6	6
31	6	15	15	7	8	9	8	8	8
32	6	15	15	8	8	8	8	7	7

Appendix Table 45. Raw data on the acceptability of Treatment 7.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	7	5	20	9	8	8	9	9	9
2	7	5	20	9	8	9	8	9	9
3	7	5	20	7	8	7	7	8	8
4	7	5	20	7	7	7	8	7	8
5	7	5	20	7	7	7	6	5	5
6	7	5	20	9	8	7	8	3	8
7	7	5	20	6	8	5	8	8	8
8	7	5	20	8	7	8	8	8	8
9	7	5	20	7	6	6	7	7	8
10	7	5	20	7	8	8	8	8	8
11	7	5	20	7	7	7	7	7	7
12	7	5	20	6	9	9	6	7	6
13	7	5	20	5	5	5	5	4	4
14	7	5	20	7	7	8	8	7	7
15	7	5	20	6	7	8	7	7	7
16	7	5	20	8	7	9	8	9	8
17	7	5	20	5	7	7	7	7	7
18	7	5	20	6	6	5	6	6	5
19	7	5	20	6	7	8	8	9	8
20	7	5	20	7	7	7	8	4	6
21	7	5	20	4	6	3	5	4	4
22	7	5	20	4	3	5	5	5	5
23	7	5	20	8	7	8	7	8	6
24	7	5	20	2	2	5	4	6	6
25	7	5	20	7	7	7	8	4	6
26	7	5	20	8	7	7	7	7	7
27	7	5	20	7	8	8	8	8	8
28	7	5	20	8	8	8	8	8	8
29	7	5	20	6	6	6	6	6	6
30	7	5	20	7	7	7	7	7	7
31	7	5	20	8	8	8	8	8	8
32	7	5	20	7	7	7	7	7	7

Appendix Table 46. Raw data on the acceptability of Treatment 8.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	8	10	20	9	8	9	9	9	9
2	8	10	20	6	7	7	8	7	8
3	8	10	20	7	8	7	7	7	7
4	8	10	20	8	8	7	7	7	7
5	8	10	20	8	8	8	8	6	7
6	8	10	20	7	8	8	8	8	8
7	8	10	20	6	7	7	6	6	7
8	8	10	20	7	7	7	7	7	7
9	8	10	20	7	8	9	8	8	8
10	8	10	20	7	7	7	6	6	7
11	8	10	20	7	7	7	7	8	7
12	8	10	20	8	9	8	9	9	8
13	8	10	20	7	7	7	7	7	7
14	8	10	20	8	7	9	8	7	8
15	8	10	20	7	7	7	8	7	7
16	8	10	20	6	6	5	6	6	5
17	8	10	20	6	8	8	8	9	8
18	8	10	20	7	8	8	8	8	8
19	8	10	20	8	8	3	8	5	6
20	8	10	20	3	3	6	5	4	4
21	8	10	20	7	7	7	7	8	8
22	8	10	20	8	9	7	7	7	7
23	8	10	20	7	7	7	7	7	7
24	8	10	20	8	8	6	8	8	8
25	8	10	20	6	6	6	6	6	6
26	8	10	20	7	7	6	7	7	7
27	8	10	20	7	7	7	7	7	7
28	8	10	20	6	6	6	6	6	6
29	8	10	20	6	6	6	6	6	6
30	8	10	20	6	6	6	6	6	6
31	8	10	20	9	8	9	9	9	9
32	8	10	20	6	7	7	8	7	8

Appendix Table 47. Raw data on the acceptability of Treatment 9.

Panel	TRT	Spices (%)	Brine (%)	Color Acc	Aroma Acc	Taste Acc	Flavor Acc	Firmness Acc	Gen Acc
1	9	15	20	9	8	8	9	9	9
2	9	15	20	9	8	9	9	9	9
3	9	15	20	7	8	8	8	8	8
4	9	15	20	7	8	7	7	7	7
5	9	15	20	7	5	7	6	5	5
6	9	15	20	5	7	6	8	4	7
7	9	15	20	8	9	8	8	7	8
8	9	15	20	6	7	8	8	8	8
9	9	15	20	6	7	7	7	8	8
10	9	15	20	7	7	7	7	7	7
11	9	15	20	6	7	7	7	6	7
12	9	15	20	8	8	8	7	7	8
13	9	15	20	5	5	5	5	5	5
14	9	15	20	7	7	8	7	7	8
15	9	15	20	7	7	8	9	9	8
16	9	15	20	6	6	5	5	6	5
17	9	15	20	7	7	7	8	7	8
18	9	15	20	7	7	4	7	7	7
19	9	15	20	4	6	3	6	5	5
20	9	15	20	7	8	6	7	6	8
21	9	15	20	6	7	7	7	8	7
22	9	15	20	8	8	8	8	8	9
23	9	15	20	7	7	7	7	7	7
24	9	15	20	8	9	7	7	7	7
25	9	15	20	7	7	7	7	7	7
26	9	15	20	6	6	6	6	6	6
27	9	15	20	7	7	7	7	7	7
28	9	15	20	7	7	7	7	7	7
29	9	15	20	6	6	6	6	6	6
30	9	15	20	4	4	4	4	4	4
31	9	15	20	7	8	8	8	8	8
32	9	15	20	7	8	7	7	7	7