Sensory and Microbical Assessment of Fresh-CutJackfruitPulp as Affected by Deseeding, Packaging Methodand Storage Condition

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***Abstract*— This study was conducted to evaluate the effect of deseeding, storage condition and packaging method to the sensory attributes and acceptability as well as the microbial quality of fresh-cut jackfruit. This would specifically benefit the processors as well as local vendors of minimally processed products where the shelf-life is extended, thus increasing the selling period without compromising the quality. The study used two levels of processing method (deseeded & intact pulp), storage condition (chilled & ambient) and packaging method (vacuum & without vacuum). Standard process of fresh-cut jackfruit processing was followed with slight modification in the processing and packaging method. Treatments which have intact pulp (T1-T4) has longer shelf-life than with the deseeded (T5-T8). Total plate count of treatments stored in chilled condition during day 8 is still acceptable with a mean of 1x107 CFU/g compared to the deseeded pulp which reached the allowable limit for the microbial count at day 6 (7x107 CFU/g). Treatments stored at ambient temperatures shows rapid degradation in the sensory acceptability and increase in microbial load of the product. All treatments stored in ambient condition (T2, T4, T6 & T8) have poor appearance with serious defects starting day 1. Treatments stored in chilled conditions are still very acceptable in all the sensory attributes even at day 8. Treatments which are not vacuum packed have high microbial count compared to vacuum packed. Presence of white film and bubbles which are indicators of fermentation were more apparent in not vacuum packed treatments than with vacuum packed.**

***Index Terms*—fresh-cut, jackfruit, shelf-life, microbial quality, sensory properties, deseeding**

I. Introduction

Consumption of fruits and vegetables plays an important role in the promotion of healthy nutrition. It is also one of the priorities of consumers nowadays. However, the primary obstacle of buying ready-to-eat fresh-cut fruits and vegetables is their short shelf-life, leading to quick degeneration and decomposition of the product caused by microbial and enzymatic activity. Thus it is essential to minimize physical damage to fresh produce in order to obtain optimal shelf-life. The use of suitable packaging is vital in this respect [1].

It was found out in a study of Patindol (2016) that the optimum formulation of pre-treatment solution for minimally processed jackfruit was at 0.04374% w/v NaOCl, 0.74% w/v $CaCl_2$ and 0.65% w/v Ascorbic Acid [2]. In general, fresh-cut fruit should be rinsed just after cutting with cold (0 to 1 ℃) chlorinated water at pH 7.0. However with chlorination alone, the product cannot be solely free from contaminants. Proper sanitation procedure during processing is required to ensure product safety. Other factors that influence the quality of fresh cut jackfruit includes the handling conditions (packaging, maintaining optimum ranges of temperature and relative humidity, and the speed of cooling) and the method of preparation (size and surface of the area of the cut pieces, sharpness of cutting tools, removal of surface moisture and washing).

In fresh-cuts, the proliferation of bacteria may be a symptom associated with tissue senescence and may not be a true cause of spoilage except in a few rare exceptions when pectinolytic *Pseudomonas* are present. However, in acidic fresh-cut fruit products, yeasts and molds are typically associated with product spoilage. Reducing initial yeast and mold counts, as well as slowing growth by low temperature storage at <5 ℃ (41 ℉), affects product shelf-life [3] [4].

Well integrated quality assessments that include microbial quality, physiological and sensory quality are significant to determine the shelf-life of fresh-cut fruits and vegetables. To understand the linkage between microbial population dynamics and quality changes in response to pre and post-processing treatments, the microbial quality data need to be correlated with shelf-life outcomes. The role of microbial contaminant-induced deterioration in fresh-cut product`s needs to be determined. Such will enable the development of better approaches for maintaining good quality and ensuring the safety of the products [5].

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Hence, this study was conducted to evaluate the effect of deseeding, storage temperature and method of packaging to the microbial quality as well as the shelf-life of minimally processed jackfruit pulp. Microbial aspect was also studied in relation to the sensory attributes and acceptability of the product during the storage period.

II. Materials and Methods

A. Procurement of Materials

EVIARC Sweet jackfruit was procured from the farm of Job Abuyabor in Mahaplag, Leyte. The chemicals namely, sodium hypochlorite, calcium chloride, and ascorbic acid, acetic acid as well as other materials were acquired from commercial sources.

B. Experimental Design

A 2x2x2 factorial design was employed to compare the different responses of physicochemical properties to the variables. Table below shows the different treatments with their corresponding variables (Table I).

TABLE I. Experimental Combinations of Jackfruit Pulp Preparation, Packaging Method and Storage Condition in Preparation of the Treatments

TREATMENTS	JACKFRUIT PULP PREPARATION	PACKAGING METHOD	STORAGE TEMPERATURE (°C)
T1	With seed	Vacuum	Chilled
T2			Ambient
T3		Without vacuum	Chilled
T4			Ambient
T5	Without seed	Vacuum	Chilled
T6			Ambient
T7		Without vacuum	Chilled
T8			Ambient

*chilled (4-6°C); ambient (30°C)

C. Sensory Evaluation

Sensory evaluation was carried out to determine the quality description and acceptability of fresh-cut jackfruit with seed and without seed as affected by packaging method and storage temperature. Five to ten grams of jackfruit sample for each treatment were used for sensory evaluation. The sensory attributes evaluated were appearance, color, aroma, sweetness, firmness, and general acceptability using a 9-point Hedonic scale and descriptive scale.

D. Microbial Examination and Shelf-life Study

1) Total plate count

Total Plate Count (TPC) of fresh-cut jackfruit was determined through microbial enumeration. This was conducted every day from 0 to 9th day. Plate Count Agar (PCA) was used as a culture medium and Tryptone Phosphate Peptone was the buffered solution used. The analysis was carried out by serial dilution and pour plating techniques. One gram of pulp sample was added into 9 ml diluent blank and served as dilution 10^{-1}. 8 dilutions were prepared and one ml was pour-plated in duplicate plates. Plates were incubated at 32-35°C for 2 to 3 days in an inverted position. Microbial count was computed using the formula below and reported as CFU/g. inverted position. The microbial count was computed using the formula below and reported as CFU/g.

$$\text{CFU/g} = \frac{\text{average colonies x reciprocal of dilution}}{\text{volume of sample plated}}$$

2) Molds and yeast

All treatment underwent analysis every day until the 9th day of storage. 3M petrifilm were used for the enumeration of molds and yeast. 1 ml of the diluted sample 10^{-1} was pipetted from the test tube. The cover film was slowly lifted and pipet was held perpendicular to the 3M petrifilm plate. The sample was pipetted unto the center of the film for best results. The yeast and mold spreader was used to scatter the liquid. It was placed with the ridge side down over the top film, centered over the inoculum. The inoculum was distributed over a circular area. It is important not to twist or slide the spreader. The spreader was then lifted and allowed to stand for 1 minute for the gel to full. The films were incubated with the clear film side up at 35°C for 5 days (3M™ Petrifilm™ Yeast & Mold Count Plates General Instruction).

E. Statistical Analysis

The quality descriptive scores and acceptability rating of the different treatments were analyzed using frequency distribution. Data from the microbial analysis were subjected to single factor Analysis of Variance (ANOVA). To determine the effect of dependent or response variables on the sensory qualities of fresh-cut jackfruit, interaction plots were used to measure the combined effects of each factor to the parameters. Time series plots in multiple y variables were used employing Minitab Express™ software.

III. Results and Discussions

A. Sensory Analysis

Since the appearance of the treatments stored at room temperature started to deteriorate rapidly even at day 1, sensory attributes taste and off-flavor were compared and reported for day 0 only.

1) Appearance

Appearance is one of the primary guidelines for a product to be considered in good quality. If appearance description is already poor, then as expected all following sensory characteristics will also be non-acceptable to consumers' preference. Table II shows the appearance characteristic of fresh-cut jackfruit during the 9-day storage period. In day 0, all treatments were in good-excellent quality, However in the first day of storage, treatments stored at room temperature (T_2, T_4, T_6 and T_8) were already observed to have poor quality with serious defects in appearance and low acceptability scores (Table II). This may be due to the rapid deterioration of quality brought about by the fast respiration and contamination rate of the product caused by ambient temperature storage. It was observed that vacuumed packed treatments stored in ambient condition started to bloat

which could be an indicator of spoilage due to fermentation (Fig. 1). The appearance of white scum and molds in treatments stored in ambient conditions also indicates that product has already spoiled and is not safe for consumption (Fig. 2). It was also observed that deseeded treatments have more bloated packaging compared to treatment which have intact fruit pulp. Treatments packed with cling wrap were also observed to have more presence of white scum and bubbles compared to vacuum packed products.

TABLE II. SUMMARY DESCRIPTION OF APPEARANCE ON FRESH-CUT JACKFRUIT USING FREQUENCY

DAY	T1	T2	T3	T4	T5	T6	T7	T8
0	excellent	good	excellent	excellent	excellent	good	excellent	good
1	excellent	fair	excellent	poor	good	good	good	poor
2	excellent	fair	excellent	poor	excellent	poor	good	poor
3	good	good	excellent	poor	good	poor	excellent	non-edible
4	excellent	fair	excellent	non-edible	good	fair	excellent	non-edible
5	good	fair	excellent	non-edible	excellent	fair	good	non-edible
6	excellent	fair	excellent	non-edible	good	fair	excellent	non-edible
7	good	fair	good	non-edible	excellent	fair	good	non-edible
8	good	non-edible	excellent	non-edible	good	good	excellent	non-edible
9	good	non-edible	excellent	non-edible	good	fair	good	non-edible

*excellent –field fresh, good-minor defects, fair-moderate defects, poor-serious defects, non-edible- under unusual condition , T1-vacuum and chilled, T2-vacuum and ambient, T3- without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient

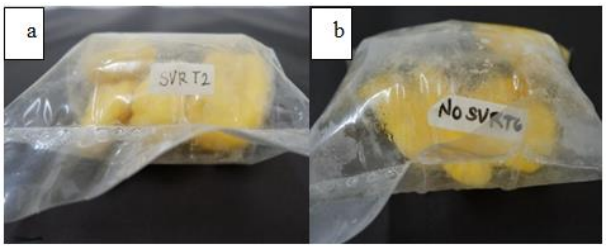


Figure 1. Bloating of vacuum packed fresh-cut jackfruit stored at room temperature (day 1), (a) with seed and (b) without seed

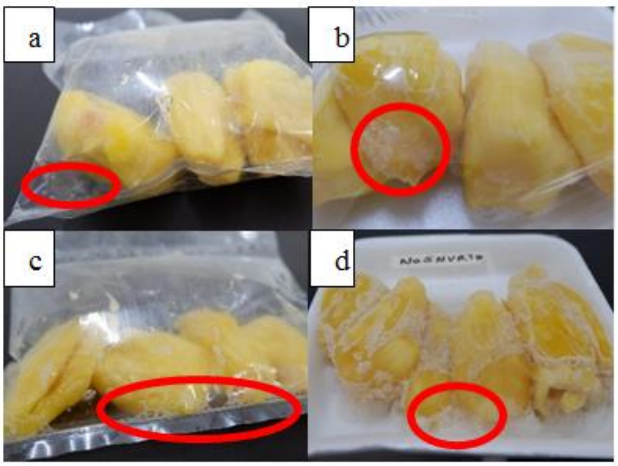


Figure 2. Presence of white scum in treatments stored at ambient condition during day 1 (a and b) with seed (c and d) without seed

It can also be observed that all samples stored in chilled condition (T_1, T_3, T_5 and T_7) have very acceptable description of "excellent (field fresh)" to "good (minor defects)" (Table I) and acceptability rating of 6.75-9.0 which fall in the acceptability description of "like slightly to like extremely" to until the 9th day of storage (Appendix B).

It was observed that acceptability of the product was affected by storage temperature and method of preparation. There is evident decrease on the appearance acceptability of the product for those product stored at room temperature. It was also observed that pulps with intact tissues have more acceptable appearance than those deseeded during the 9- day storage period. This may be a contributor to the degree of browning of the product with respect to time of storage (Appendix A).

Fresh cut products generally have higher respiration rates than the corresponding intact products. Higher respiration rates means a more active metabolism and a faster deterioration rate. According to Cantwell and Suslow (2013), the physical damage or wounding caused by preparation increases respiration and ethylene production within minutes, with associated increases in rates of other biochemical reactions responsible for changes in color (including browning) [6]. Low temperatures decrease variances in respiration and ethylene production rates between the fresh-cut and the intact product. Low temperatures are also vital to retard microbial spoilage on cut surfaces.

2) Color

Color is one attribute that dictates the appearance of a product. In connection to the descriptive and acceptability result of appearance, color sensory attributes were directly related to appearance (Table III). It was shown that samples stored at chilled condition has higher mean acceptability score which range from 6.94 to 7.82 which falls in the acceptability scores "like slightly" to "like very much" compared to treatments stored at ambient condition in which the mean acceptability scores decreased at 24 hours storage. Whereas treatments which are chilled have very acceptable color even at the 9th day of storage (Table IV).

It was observed that acceptability of the color attribute is mainly dictated by the presence of darkening of the tissues as it is also a factor that affects appearance. Enzymatic browning is one of the most limiting factors on the shelf-life of fresh-cut products. During the preparation stages, produce is submit enzymes to bted to operations where cells are broken causinge liberated from tissues and put in contact with their substrates. Enzymatic browning is the discoloration which results from the action of a group of enzymes called polyphenoloxidases (PPO), which have been reported to occur in all plants [7].

As the time of storage increases, the color of the tissues darkens from yellow to brownish yellow in

samples stored in ambient condition (Table III). Chilled treatments maintain their color acceptability even until the last day of storage period. Temperature is the most important environmental factor in the post-harvest life of fresh fruits because of its dramatic effect on the rates of biological reactions, including respiration [8]. It was also observed in Table III that processing method affects the color of the fresh-cut jackfruit. Deseeded treatment at same storage condition exhibit intense color description compared to intact samples. Cutting induces degradative changes associated with plant tissue senescence [9]. And as senescence occur, ripening which causes the enhancement of carotenoid pigments make the pulps' color more intense.

TABLE III. SUMMARY OF COLOR DESCRIPTION OF FRESH-CUT DURING A 9-DAY STORAGE PERIOD

D	T1	T2	T3	T4	T5	T6	T7	T8
0	golden yellow	golden yellow	golden yellow	yellow	golden yellow	golden yellow	golden yellow	golden yellow
1	yellow	yellow	yellow	yellow	yellow	golden yellow	golden yellow	dark yellow
2	yellow	yellow	golden yellow	yellow	yellow	yellow	golden yellow	brownish yellow
3	golden yellow	yellow	golden yellow	light yellow	golden yellow	yellow	golden yellow	brownish yellow
4	golden yellow	golden yellow	yellow	brownish yellow	golden yellow	brownish yellow	yellow	brownish yellow
5	yellow	yellow	yellow	brownish yellow	yellow	yellow	yellow	brownish yellow
6	golden yellow	yellow	yellow	brownish yellow	dark yellow	yellow	golden yellow	brownish yellow
7	golden yellow	dark yellow	yellow	brownish yellow	yellow	yellow	dark yellow	brownish yellow
8	yellow	brownish yellow	yellow	brownish yellow	golden yellow	dark yellow	golden yellow	brownish yellow
9	yellow	brownish yellow	golden yellow	brownish yellow	yellow	yellow	golden yellow	brownish yellow

*T1-vacuum and chilled, T2-vacuum and ambient, T3- without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient

TABLE IV. SUMMARY OF MEAN ACCEPTABILITY OF COLOR ON FRESH-CUT JACKFRUIT USING FREQUENCY

PREPARATION	PACKAGING METHOD	STORAGE CONDITION	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8
with seed	vacuum	chilled	7.53	7.46	7.81	7.21	7.75	7.12	7.09	7.43
with seed	vacuum	ambient	7.34	6.78	5.87	6.6	5.87	5.90	6.62	5.53
with seed	without vacuum	chilled	7.43	7.68	7.31	7.72	7.71	7.43	7.34	7.73
with seed	without vacuum	ambient.	7.59	6.56	5.43	5.18	3	3.25	2.96	3.21
without seed	vacuum	chilled	7.34	7.40	7.71	6.84	7.19	7.03	6.84	7.43
without seed	vacuum	ambient	7.53	7.12	6.45	5.75	5.12	5.71	5.65	6.16
without seed	without vacuum	chilled	7.65	6.93	7.03	7.68	7.75	6.87	7.31	7.22
without seed	without vacuum	ambient	7.53	5.84	4.43	3.03	2.37	2.93	2.68	2.19

3) Aroma and sweetness

Fermentation of the product can be an indicator for a spoilage of the product. Deterioration of quality is closely related to the presence of fermented aroma of the jackfruit. Based on the aroma description, it can be clearly observed that treatments stored at room temperature have already undergone fermentation starting day 1. It was also observed that jackfruit pulps which are deseeded establish the same fermented aroma starting day 5. This fermentation in the product may be contributed by the microorganisms responsible for fermentation of the sugars into organic acids as well as the continuation of the respiration process in the living cells of pulps. Results clearly showed that storage temperature as well as preparation plays a significant role in increasing the shelf-life of fresh-cut jackfruit. As cited by Rocha *et al*. (1995), the fresh cut fruit is believed to behave differently to the whole fruit [10]. Due to wounding and damage to the skin cut fruits are usually more perishable than fresh produce [11] [12]. When peeled and cut the outside protective layer is removed, exposing the fresh cells, rich in water, sugars and organic acids [13]. The leakage of nutrients will promote microbial growth and the damaged tissue also provides a portal of entry for establishing a microbial colony [14].One might expect an increase of respiration rate in cut fruit [12]. and the shelf-life of a fruit varies inversely with the respiration rate [15].

The increase in fermented aroma of the jackfruit pulp greatly affects the acceptability of the product. As fermented aroma occurs, acceptability decreases. This can be directly related to the presence of spoilage microorganisms in the product that cause the fermentation of sugars into alcohols and organic acids which are responsible for the occurrence of fermented aroma. It can also be observed in table 4 that there is a slight difference in the aroma acceptability mean of the product throughout the storage period of the treatments stored at chilled environment. The activity of microorganisms can be retarded through low-temperature storage, therefore, decreasing the fermentation time thus preserving the quality of the product.

Table V shows the mean acceptability of the aroma. It was observed that as fermented aroma in the fresh-cut occurs, aroma acceptability decreases. The occurrence of fermented/sour aroma can be an indicator for spoilage of the product.

Sweetness can be closely related to the presence of fermented odor in fresh-cut jackfruit. The samples with poor appearance were not subjected to evaluation for taste. In Table VI, it can be observed that the taste of treatments during the storage period did not significantly

change. Thus chilling conditip extend the shelf-life of the product. As mentioned bon can hely Kader (1987), the temperature is the most important environmental factor in the post-harvest life of fresh fruits because of its dramatic effect on the rates of biological reactions, including respiration [16].

TABLE V. SUMMARY OF AROMA MEAN ACCEPTABILITY

DAY	T1	T2	T3	T4	T5	T6	T7	T8
0	7.06	6.93	7.65	7.25	7.28125	7	7.59	7.34
1	7.15	5.12	7.28	5.2	7.18	6	7.18	4.71
2	7.34	4.345	7	3.96	7.43	4.29	7.3	3.06
3	7.59	3.75	7.25	3.41	6.84	3.46	7.56	2.53
4	7.65	3.6	7.03	2.27	6.67	3.5	7.96	2.18
5	6.90	4.34	7.56	2.78	7.25	4.155	6.90	2.96
6	7.06	5.15	7.71	3.03	6.71	3.68	7.5	2.62
7	7.62	3.968	7.53	2.81	7.09	3.93	7.65	2.06
8	7.5		7.5	2.93	7.25	4.15	7.65	2.56
9	7.65		7.62	3.28	6.03	4.233	7.43	3

*T1-vacuum and chilled, T2-vacuum and ambient, T3- without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient

TABLE VI. SWEETNESS DESCRIPTIVE FREQUENCY OF FRESH-CUT JACKFRUIT

DAY	T1	T3	T5	T7
0	moderately sweet	very sweet	slightly sweet	moderately sweet
1	moderately sweet	moderately sweet	moderately sweet	moderately sweet
2	very sweet	moderately sweet	moderately sweet	very sweet
3	moderately sweet	moderately sweet	very sweet	moderately sweet
4	very sweet	moderately sweet	moderately sweet	moderately sweet
5	slightly sweet	moderately sweet	moderately sweet	moderately sweet
6	moderately sweet	moderately sweet	very sweet	moderately sweet
7	moderately sweet	moderately sweet	moderately sweet	very sweet
8	moderately sweet	moderately sweet	moderately sweet	moderately sweet
9	moderately sweet	moderately sweet	slightly sweet	moderately sweet

TABLE VII. FIRMNESS DESCRIPTIVE FREQUENCY OF FRESH-CUT JACKFRUIT

)AY	T1	T2	T3	T4	T5	T6	T7	T8
0	firm	moderately firm	moderately firm	firm	moderately firm	firm	moderately firm	moderately firm
1	moderately firm	firm	moderately firm	firm	firm	moderately firm	moderately firm	
2	moderately firm	firm	moderately firm	very soft	firm	firm	moderately firm	slightly soft
3	moderately firm	firm	firm	firm	firm	very soft	moderately firm	slightly soft
4	moderately firm	slightly soft	moderately firm	moderately firm	moderately firm	slightly soft	moderately firm	very soft
5	firm	firm	moderately firm	very soft	moderately firm	firm	moderately firm	firm
6	firm	firm	very soft	firm	firm	firm	moderately firm	very soft
7	moderately firm	slightly soft	slightly soft	very soft	firm	firm	moderately firm	very soft
8	firm		moderately firm	firm	moderately firm	slightly soft	firm	very soft
9	firm		moderately firm	very soft	moderately firm	firm	firm	very soft

*T1-vacuum and chilled, T2-vacuum and ambient, T3- without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient

4) Firmness

Firmness of jackfruit pulp can be closely related to the degradation of tissues in the pulp caused by biochemical reaction due to ripening and spoilage. Table VII shows the summary of descriptive frequency of each treatment. It was observed that treatments stored in ambient condition have evident degradation on the tissues characterized by softening. Fruit firmness and texture are most closely associated with cell wall structure and composition, and particularly with the cell wall changes that occur during ripening. Brumell (2017) mentioned that many of the changes occurring in fresh-cut fruit are a continuation of the normal ripening events that lead to softening, combined with or influenced by the effects of tissue cutting and wounding [17].

Appendix C shows the interaction of the factors responsible for the firmness acceptability of the product. It was observed that all factors contributed to the mean acceptability of the fresh-cut jackfruit. Samples which are stored in chilled temperature and vacuum packed have higher firmness acceptability throughout the storage period compared to cling wrap packaging and room temperature storage. Treatments with intact fruit pulps were also more acceptable in terms of firmness throughout the storage period. Increase rate of respiration brought by processing method as well as high

storage temperature can cause faster ripening of the fruit. During fruit ripening, cell wall polysaccharides are extensively modified by a variety of ripening-related enzymes secreted from the symplast into the cell wall space. These changes affect the structure and strength of the wall, and ultimately bring about fruit softening and decay. Both pectins and matrix glycans are degraded, although the nature of the changes occurring is species-specific and even cultivar-specific [17].

B. Microbial Analysis

1) Total plate count

To evaluate the product's overall acceptability, it is not only imperative to study the physicochemical and organoleptic properties, but another core guideline that must be taken into consideration is the microbial quality of the product. This is important because it dictates the safety of the product for consumption.

At 0 day, microbial count of fresh-cut jackfruit has the lowest microbial count $5.55x10^2$ (below limit of detection). After 1 day of storage, products at room temperature were not acceptable in appearance due to presence of bubbles and molds (Fig. 3), thus refrigerated samples were only analyzed during the 2nd day of storage.

Figure 3. Indicators of product spoilage during 24 hours storage

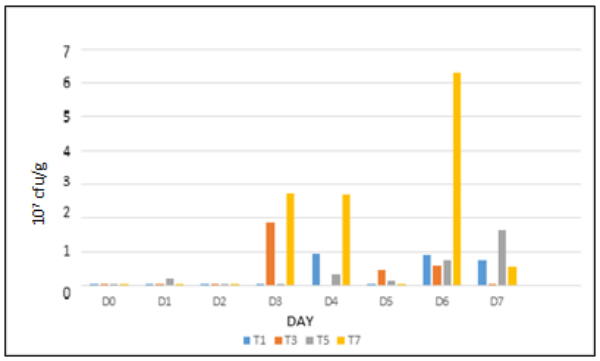


Figure 4. Total Plate Count (107 CFU/g) of fresh-cut jackfruit during 7-day storage period (T1-vacuum and chilled, T2-vacuum and ambient, T3- without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient)

The greatest differences among the remaining treatments which passed visual appearance test in both bacterial groups were found after 3 days of storage (Fig. 4). There is an apparent increase in total plate count. According to French regulations, a total plate count (TPC) of $5x10^7$ colony forming units (CFU)/g is the maximum acceptable value at the end of the microbiological shelf-life of numerous fresh-cut fruits and vegetables [17]. Treatment 7 during day 6 has reach the allowable limit for total plate count for fresh cut fruits. According to literatures, deseeded products packed in cling wraps have shelf-life of 7 days. Treatments which have intact pulps have observable lesser microbial count compared to deseeded pulps thus it can safely be said that it has longer shelf-life because during the 9th day storage period it is still within the acceptable limit. It was observed that treatment which are deseeded have higher microbial count compared to intact fruit pulps. When pulps are deseeded, contamination might happen during handling. Limiting the handling time of the product may help reduce microbial count. It can also be observed that treatments which are vacuum packed have lower microbial count compared with those samples which used cling wrap. Packaging materials protect the product from external contamination and limiting the entry points of microorganisms can contribute to lengthening the shelf-life of products.

2) Molds and yeast

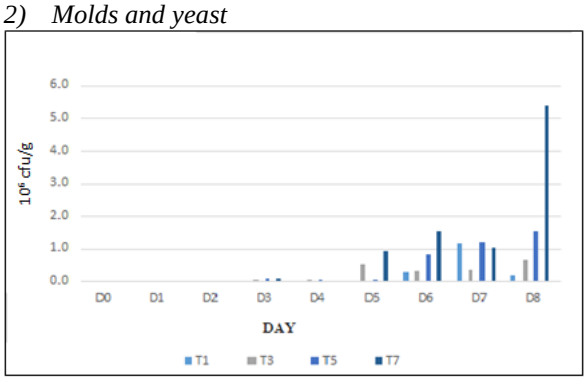


Figure 5. Molds Count (106 CFU/g) of fresh-cut jackfruit during 8-day storage period (T1-vacuum and chilled, T2-vacuum and ambient, T3-without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient)

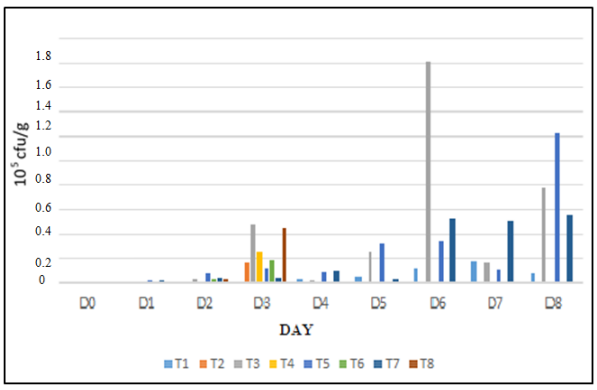


Figure 6. Yeast Count (105 CFU/g) of fresh-cut jackfruit during 8-day storage period (T1-vacuum and chilled, T2-vacuum and ambient, T3-without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient)

The apparent increase in yeast and mold is very evident as storage period increases (Fig. 5 & 6). It was also observed in the study that refrigerated vacuum packed product (T5) has bloated starting day 7, this result can be correlated to the presence of yeast in the product that is responsible for the fermentation of sugars that produce alcohols and carbon dioxides. According to Brackett (1994), microbial decay can be a main source of

spoilage of fresh-cut produce. The microbial decay of fresh-cut fruit may occur much more rapidly than with vegetable products because of the high levels of sugars found in most fruit. The acidity of fruit tissue usually helps suppress bacterial growth but not growth of yeast and molds. There is no evidence to suggest that lower total plate counts (TPC) immediately after processing correlate with increased shelf-life in fresh-cut vegetables. However, for fresh-cut fruit, very low TPC, and especially yeast and mold counts correlate with increased shelf-life.

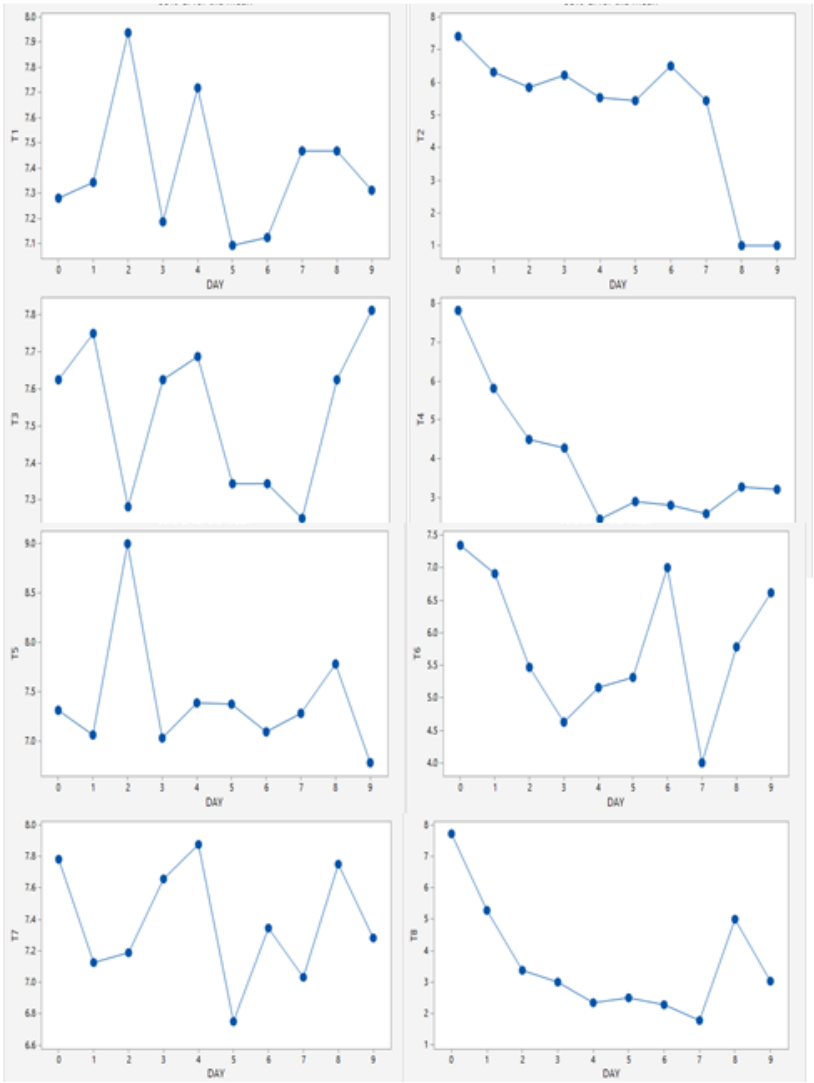
IV. Conclusions

Deseeding of jackfruit during processing plays a significant role in the overall quality of fresh-cut jackfruit. Intact fruit pulp has longer shelf-life than with the deseeded. Tissue rupture during deseeding contributes to the increase in respiration of the pulp which causes browning as well as the increase in microbial contamination. Storage condition greatly affects the organoleptic quality and acceptability as well as shelf-life of fresh-cut jackfruit.

Treatments which have intact pulp (T_1-T_4) has longer shelf-life and higher acceptability (±7.44) than with the deseeded (T5-T8) (±4.18). Total plate count of treatments stored in chilled condition during day 8 is still acceptable with a mean of $1x10^7$ compared to deseeded which reach the allowable limit for microbial count at day 6 (7x107). Storage in chilling condition helps lengthen the product's shelf life and helps retain its natural organoleptic attributes. Packaging materials protect the product from external contamination and limiting the entry points of microorganisms can contribute to prolonging the shelf-life of products as well as minimizing the occurrence of microbial induced off-flavors in the product.

Storage at chilled condition, limiting tissue damage during processing and preventing contamination through rigid packaging can help preserve the sensory quality as well as minimize microbial activity that helps extend the shelf-life of fresh-cut jackfruit.

Appendix A Interval Plot of Appearance Acceptability of Fresh-cut Jackfruit during the 9-day Storage Period

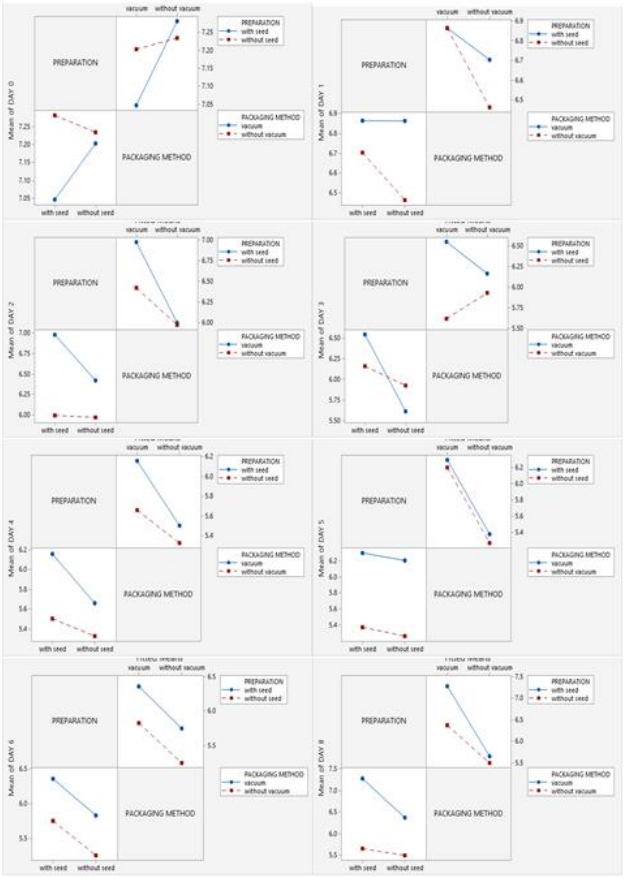


*T1-vacuum and chilled, T2-vacuum and ambient, T3- without vacuum and chilled, T4- without vacuum and ambient, T5-vacuum and chilled, T6-vacuum and ambient, T7- without vacuum and chilled, T8- without vacuum and ambient

APPENDIX B SUMMARY OF MEAN ACCEPTABILITY FOR APPEARANCE

DAY	T1	T2	T3	T4	T5	T6	T7	T8
0	7.28	7.40	7.62	7.81	7.31	7.34	7.78	7.71
1	7.34	6.31	7.75	5.81	7.06	6.90	7.12	5.2
2	7.93	5.84	7.28	4.5	9	5.46	7.18	3.37
3	7.18	6.21	7.62	4.28	7.03	4.62	7.65	1.00
4	7.71	5.53	7.68	2.45	7.38	5.15	7.87	2.34
5	7.09	5.43	7.34	2.90	7.375	5.31	6.75	2.5
6	7.12	6.5	7.34	2.81	7.09	7.00	7.34	2.28
7	7.46	5.43	7.25	2.59	7.28	4.00	7.03	1.78
8	7.46	2.13	7.62	3.28	7.78	5.78	7.75	5
9	7.31	1.89	7.81	3.21	6.78	6.61	7.28	3.03

APPENDIX C INTERACTION PLOT OF THE DIFFERENT FACTORS THAT AFFECTS MEAN FIRMNESS ACCEPTABILITY OF THE PRODUCT DURING STORAGE



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REFERENCES

[1] M. Scetar, M. Kurek, and K. Galic, "Trends in fruit and vegetable packaging-a review," *Croatian Journal of Food Technology, Biotechnology and Nutrition*, vol. 5, no. 3-4, pp. 69-86, 2010.

[2] M. R. Patindol, "Process optimization of minimally processed fresh-cut jackfruit (*Artocarpus heterophyllus* Lam.)," M.S. Thesis, VSU, 2016

[3] R. E. O' Connor-Shaw, R. Roberts, A. L. Ford, and S. M. Nottingham, "Shelf-life of minimally processed honeydew, kiwifruit, papaya, pineapple, and cantaloupe," *Journal of Food Science*, vol. 59, pp. 1202-1206, 1215, 1994

[4] L. Qi, A. E. Watada, and J. R. Gorny, "Quality changes of fresh cut fruits in CA storage," Fresh-Cut Fruits and Vegetables and MAP, 7th International Controlled Atmosphere Research Conference, University of California, Davis, July 13-18, 1997, vol. 4, pp. 98-117, 1998.

[5] L. Fan and J. Song, "Microbial quality assessment methods for fresh-cut fruits and vegetables," *Stewart Postharvest Review*, vol. 3, p. 10, 2008.

[6] M. Cantwell and T. Suslow, "Fresh-cut fruits and vegetables: Aspects of physiology, preparation, and handling that affect quality," *Technology Horticulture, Products*, Chapter 36, Section 5, pp. 1-8, 2013.

[7] J. R. Whitaker and C. Y. Lee, "Recent advantage in the chemistry of enzymatic browning: an overview," in *Enzymatic Browning and its Prevention, Washington*, C. Y. Lee and J. R. Whitaker, eds., ACS Symp. Ser. 600, 1995, pp. 2-7.

[8] A. A. Kader, "Biochemical and physiological basis for effects of controlled and modified atmospheres on fruits and vegetables," *Journal Food Technology*, vol. 5, pp. 99-104, 1986.

[9] O. Lamikanra, J. C. Chen, D. Banks, P. A. Hunter, "Biochemical and microbial changes during the storage of minimally processed cantaloupe," *Journal of Agricultural and Food Chemistry*, vol. 48, no. 12, 2000.

[10] A. M. C. N. Rocha, R. Brochado, R. Kirby, and A. M. M. B. Morais, "Shelf-life of chilled cut orange determined," *J. Food Control*, vol. 6, pp. 1-6, 1995.

[11] C. C. Huxsoll, H. R. Bolin, and A. King Jr, "Physico-chemical changes and treatments for lightly processed fruits and vegetables," in *Quality of Fruits and Vegetables*, 1989, pp. 203-215.

[12] J. C. Rosen and A. A. Kader, "Postharvest physiology and quality maintenance of sliced pear and strawberry fruits," *J. Food Sci.*, vol. 54, pp. 656-659, 1989.

[13] B. P. Klein, "Nutritional consequences of minimal processing of fruits and vegetables," *J. Food Qual.*, vol. 10, pp. 179-193, 1987.

[14] O. R. Fennema, *Food Chemistry*, 2nd ed., NY: Marcel Dekker, 1985, pp. 857-911.

[15] R. E. Hardenburg, A. E. Watada, and C. Y. Wang, *The Commercial Storage of Fruit*, Vegetables and Florist and Nursery Stocks, USDA, Agriculture Handbook No. 66, 1986, pp. 9-12.

[16] A. A. Kader, "Biochemical and physiological basis for effects of controlled and modified atmospheres on fruits and vegetables," *Journal Food Technology*, vol. 5, pp 99-104, 1986.

[17] D. A. Brummell, "Cell wall disassembly in ripening fruit," *Funct. Plant Biol.*, vol. 33, pp. 103–119, 2006.

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