# Effects of Organic and Inorganic Fertilizer Application on the Postharvest Quality of Jackfruit (*Artocarpus heterophyllus* Lam.) Var. EVIARC Sweet

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## Abstract

*Jackfruit (Artocarpus heterophyllus Lam.) is one of the most significant trees in tropical home gardens and important genus Artocarpus. The study was conducted to determine the effects of inorganic and organic fertilizer application on the physicochemical and sensory acceptability of jackfruit and identify which nutrient management scheme would give the best postharvest quality. Each replication had four sample trees per treatment. The treatments were designated as follows: T0 – control (no fertilizer application), T1 – inorganic fertilizer (0.830 kg complete fertilizer/tree + 3.329 kg solophos phosphate/tree + 0.726 kg KCl/tree), and T2 – vermicast (75 kg/tree). Analysis of variance and treatment comparison by the least significant difference were performed using the Statistical Tool for Agriculture Research (STAR). Application of organic and inorganic fertilizer significantly influenced the pulp width and circumference and core width of jackfruit. T1 gave bigger pulp circumference (11.38 cm), longest pulp length (7.13 cm) and highest number of pulp per fruit (138.75). The color a (redness/blueness) and b (yellowness) values, pH, total soluble solids (TSS), percent titratable acidity (%TA), vitamin C and juice yield were significantly affected by the application of organic and inorganic fertilizer. The $b^*$ values indicate the yellowness of the fresh-cut jackfruit pulp. It was observed that T1 and T2 had noticeably lower $+b^*$ than those without fertilizer application as indicated by the lower intensity of yellow color. Sensorial analyses of color, aroma, sweetness, firmness, flavor, and juiciness were not significantly influenced by fertilizer application. The two nutrient management schemes revealed comparable general acceptability of jackfruit.*

***Keywords****:* jackfruit, physico-chemical, organic, inorganic, TSS, pH

## 1. Introduction

Physiological maturity is described as "the stage of development when a plant or plant part will continue even if detached" whereas commercial maturity is defined as "the stage of development when a plant or plant part possess the prerequisites for utilization by the consumer for a particular purposes" (Watada *et al*., 1984). Maturity is an integral component of quality, especially in the context of commercial maturity (Will *et al*., 1998). On the other hand, "index" is the sign or indication of the readiness of fruits for harvest according to consumers' choice (Bautista, 1990). An index is of two types-subjective and objective. The former include color, size, changes in appearance, feel, sound, and smell, among others, whereas, the objective indices include chemical constituents, dry matter content, age, weight, length, breadth or diameter, etc. Horticultural maturity is equaled to commercial maturity. In the case of fruits, it is usually referred to as the stage when it possesses the necessary characters preferred by the consumers.

Harvesting of fruits at the proper stage of maturity is very much important both for maintaining quality and marketing. Ripening of fruit may take place either before or after harvest, but it is generally accepted that postharvest ripening of ber only occurs if the fruit is sufficiently mature when picked. Immature fruits do not have satisfactory sweetness and taste. Over mature fruits, on the other hand, lose their attractiveness and crispiness and became slimy in texture within a very short time (Pareek, 2001). Abbas (1997) stated that fruit color, percentage of titratable acids and total soluble solids are the most important maturity indices shown for ber fruits grown in Basrah region, but research in India indicates that the specific gravity of the fruit and fruit color is more suitable indices (Bal, 1980; Bal and Singh, 1978; Bhatia and Gupta, 1985; Bal and Uppal, 1992 as cited by Islam, 2015).

This study aimed to determine the effects of organic and inorganic fertilizer application on the physicochemical and sensory acceptability of jackfruit, and identify which nutrient management scheme would give the best postharvest quality.

## 2. Methodology

### *2.1 Site Description*

A field experiment was conducted on existing jackfruit experimental orchard of Evangelista at Sitio Pundako, Barangay Casilda, Merida, Leyte, Philippines. It is 54 km away from the Visayas State University (VSU), Baybay City, Leyte. Fourteen-year-old trees of EVIARC Sweet variety were used in this study.

### *2.2 Experimental Treatment and Preparation of Fruit Samples*

The experimental treatments were designated as follows:

T0 - control (no fertilizer application)
T1 - inorganic fertilizer (0.830 kg complete fertilizer/tree + 3.329 kg solophos phosphate/tree + 0.726 kg KCl/tree)*
T2 - vermicast (75 kg/tree)
*based on Crop Nutrient Removal (CNR)

Fresh jackfruits of EVIARC Sweet variety were harvested. The total number of jackfruits utilized for the experiment was 12. The fruits were harvested at 140 days from the experimental field and carefully packed and transported to the Postharvest Technology Laboratory, Department of Horticulture at VSU. The fruits were then allowed to ripen at ambient temperature (±27 °C; 70-80% relative humidity) for five days. When the fruits were fully ripe, they were sliced into small pieces for more manageable removal of the core by running a sharp knife along the core line which holds the edible yellow pulps. Different compositions of jackfruit like seeds, rind, rags, testa, pulp and core were weighed separately.

### *2.3 Postharvest Quality Parameters*

Effects of fertilizer applied on fruit weight, circumference, length and diameter; pulp weight, length and width; seed weight; number of seeds and pulp; weight of rags, skin/rind and core; and core length were determined.

### *2.4 Physicochemical Analysis*

Titratable acidity (TA), pH, vitamin C, and TSS (%), juice yield, color, and firmness were determined after five days from the day of fruit harvesting. Acidity of fruit was determined by titrating against standard NaOH solution;

ascorbic acid was determined by iodometric method with volumetric technique and TSS (%) by Brix meter (Rangana, 1986).

### 2.4.1 Titratable Acidity

To find out TA (citric acid), 5 mL of juice extract (aliquot) was placed in a beaker with two drops of phenolphthalein and titrated with 0.1 N NaOH until a faint pink color appeared. It was computed using the Formula 1.

$$\%\ TA\ of\ predominant\ acid = [(V \times N \times M)/W] \times 100 \quad (1)$$

where:

- $V$ = volume of NaOH added (mL)
- $N$ = concentration of NaOH, normality (N)
- $M$ = milliequivalent weight of predominant acid g/meq (citric acid - 0.064; malic acid - 0/067; oxalic acid - 0.045; tartaric acid - 0/075)
- $W$ = weight equivalent of aliquot, g = [weight sample / (weight sample + volume of water added)] × volume aliquot

### 2.4.2 pH and Vitamin C Content

The pH, as a measure of acidity/alkalinity of the juice evaluated from the fruit pulp, was measured using an Orion pH meter model 210 A+.

In determining the vitamin C content, 1 mL aliquot sample was added into 500 mL Erlenmeyer flask together with 50 mL distilled water and three drops of starch indicator solution. The sample was titrated with a standardized iodine solution. The endpoint of the titration was identified as the first trace of a dark blue-black color was permanent. The vitamin C content was calculated using Formula 2.

$$Iodine\ solution\ (mL) \times \frac{vitamin\ C\ (mg)}{1\ mL\ iodine\ solution} = vitamin\ C\ in\ a\ sample\ (mg) \quad (2)$$

2.4.3 Juice Yield and Total Soluble Solids

A total of 50 g of pulp were chopped into small size and placed into a nylon tool used as a strainer and was squeezed. The extracted juice was measured using a graduated cylinder.

The TSS, as an approximate measure of sugar content, was measured using an Atago N1 hand refractometer. Two to three drops of the juice extracted from the fruit pulps were placed into the refractometer prism and the reading was taken against the light. The samples for color measurement were used and the readings were expressed in °Brix. For each sample, six refractometer readings were taken and the average value was computed.

2.4.4 Color and Firmness

The color of the fruit samples was quantitatively measured by taking the $L^*$ or lightness (color intensity) and $a^*$ (redness/blueness color) and $b^*$ (yellowness color) coordinates using a colorimeter application on cellphone at the midpoint of a sample. This was done on fresh-cut fruit pulp using representative samples of the whole lot using replicate per samples per treatment.

Pulp hardness test, which determines pulp firmness, was conducted using a penetrometer where reading was taken in the middle of the sample. Pulp firmness was measured in $kg/cm^2$ and carried out in four replicates.

### *2.5 Proximate Composition Analysis*

A 50 gram samples of pulp from each treatment were submitted to Central Analytical Services Laboratory (CASL) of the PhilRootcrop Research Center, VSU, where the samples were subjected to proximate composition analysis following the standard method set by the Association of Official Analytical Chemists (1990). It included moisture content, ash, protein and sugar.

### *2.6 Sensory Evaluation*

About 5 g samples from each treatment were served in a plate labeled with randomly selected three digit numbers to each of the 64 sensory panelists. Each panelist was provided with water for mouth rinsing before evaluating another sample.

An evaluation was carried out to determine the description and acceptability of different treatments. Samples from different treatments were presented to a group of panelists who evaluated the fresh jackfruit pulp for color, taste, texture, flavor, sweetness, juiciness, firmness and general acceptability. The standard protocol of sensory evaluation was followed using the combination of quality description and a 9-point hedonic scale for acceptability (Mabesa, 1986). They were asked to evaluate the traits by a scoring rate on a 9-point hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely). The different preferences as indicated by scores were evaluated by statistical methods.

Incomplete block design (IBD) was used during sensory evaluation. Type II set plan was followed, set plan of $t = 9$, $k = 6$, $r = 8$, $b = 12$, $E = 0.94$, where t refers to the treatment, k refers to the samples presented to the panelists, r the number of replications based on the planned IBD and b the number of blocks (Cochran and Cox, 1957). The plan was replicated two times to get 64 panelists evaluating each treatment.

### *2.7 Data Analysis*

Analysis of variance (ANOVA) and treatment comparison by the least significant difference (LSD) was performed using the Statistical Tool for Agriculture Research (STAR) program of the International Rice Research Institute.

## 3. Results and Discussion

### *3.1 Fruit Composition of Jackfruit*

Table 1 presents the fruit component of jackfruit such as weight of fruit, seed, pulp, rags, skin and core as influenced by vermicast, inorganic and without fertilizer. Fertilizer application did not significantly influence the fruit weight composition of the ripe whole fruit. It was observed that the edible portion or pulp (4.40 kg) of ripe jackfruit showed heaviest weight of the whole fruit weight composition, which was followed by the rind or skin – the outer covering of the fruit – (3.08 kg) and then the rags or white pulp (2.30 kg), which are the unfertilized ovaries that become fruitlets. The next component was the core (1.41 kg) followed by the seed (1.16 kg), which has the economic importance of jackfruit.

Table 1. Percent fruit composition of jackfruit (*Artocarpus heterophyllus* Lam.) as influenced by inorganic and vermicast fertilizer application

| Treatment | Average weight (kg) per fruit component | | | | | | |
|---|---|---|---|---|---|---|---|
| | Whole fruit$^{ns}$ | Pulp$^{ns}$ | Seed$^{ns}$ | Rind/ skin$^{ns}$ | Testa$^{ns}$ | Rag/ white pulp$^{ns}$ | Core$^{ns}$ |
| T0 – control | 12.65 | 4.32 | 1.20 | 2.95 | 0.63 | 2.35 | 1.20 |
| T1 – inorganic fertilizer | 12.62 | 4.47 | 1.17 | 3.17 | 0.55 | 2.08 | 1.23 |
| T2 – vermicast | 13.50 | 4.42 | 1.10 | 3.12 | 0.53 | 2.47 | 1.81 |
| Overall Mean | 12.92 | 4.40 | 1.16 | 3.08 | 0.57 | 2.30 | 1.41 |
| CV (%) | 17.21 | 13.38 | 23.86 | 11.76 | 38.91 | 14.67 | 22.15 |

ns – not significant; n = 4

The results are the same with the study of Lina (2012), who found out that edible portion (aril or pulp) at ripe stage, rind, and rags made up 34.08, 22.85 and 17.79% of the fruit weight, respectively. According to Bobbio *et al.* (1978) and Kumar *et al.* (1998), seeds, having carbohydrate and protein contents, make up around 10-15% of the total fruit weight. Seeds are normally discarded or steamed and eaten as a snack or used in some local dishes. Seed flour, an alternative product, can be used in some food products. Lastly, the outer covering of the seed called testa had the lowest weight of fruit component (Kumar *et al.*, 1998).

### *3.2 Postharvest Quality*

#### 3.2.1 Physical Fruit Properties

Effects of fertilizer treatment on the number of seeds and pulp; pulp width; core length and width; fruit length, circumference and diameter are presented in Table 2. Statistical analysis showed no significant difference in the number of seeds and pulp, and pulp and core length. However, pulp width and circumference, and core width were significantly influenced by treatment used. Treatment applied with vermicast had shortest pulp (3.74 cm) and core width (7.80 cm), and pulp circumference (10.53 cm) compared with inorganic fertilizer and control treatments. The result might be due to the slow nutrient release of vermicompost compared with inorganic fertilizer in which nutrients are readily available.

Table 2. Number of seeds and pulp, pulp length and width, core length and width and pulp circumference per fruit of jackfruit

| Treatment | Number of seeds[ns] | Number of pulp[ns] | Pulp length (cm)[ns] | Pulp width (cm)** | Pulp circum-ference (cm)* | Core length (cm)[ns] | Core width (cm)** |
|---|---|---|---|---|---|---|---|
| T0 - control | 119.00 | 119.00 | 6.84 | 4.69[a] | 9.62[b] | 30.50 | 8.55[a] |
| T1 - inorganic fertilizer | 139.00 | 139.00 | 7.13 | 4.36[a] | 11.38[a] | 31.50 | 8.57[a] |
| T2 - vermicast | 136.00 | 136.00 | 6.94 | 3.74[b] | 10.53[ab] | 30.50 | 7.80[b] |
| Overall Mean | 131.25 | 131.25 | 6.97 | 4.26 | 10.51 | 30.83 | 8.31 |
| CV (%) | 16.38 | 16.38 | 6.05 | 4.72 | 5.56 | 13.37 | 1.40 |

ns – not significant; * – significant; ** – highly significant; mean in a column followed by the same letter is not statistically different by LSD at 0.05 level; n = 4

In addition, vermicast allows easy plant uptake and improves the moisture holding capacity of soil resulting in better quality of produced crops. Singh (2014) found out that there was a significant increase in growth and yield parameters like leaf area, plant shoot biomass, number of flowers and plant runners, and marketable fruits weight by the applications of vermicomposts compared with inorganic fertilizers. Authors speculated that growth responses stemmed from the ability of humic acids present in vermicompost acting as plant growth regulators or the humates may have absorbed hormonal plant growth regulators. Moreover, the widest pulp was observed in control treatment (4.69 cm) which has comparable performance with inorganic treatment (4.36 cm). While the longest core length and bigger pulp circumference were observed with trees applied with inorganic fertilizer, without fertilizer application had a significant comparable performance with inorganic fertilizer.

### 3.2.2 Physical Property of Fresh Jackfruit

Fresh jackfruits were harvested at 140 days from the experimental field and were then allowed to ripen at an ambient condition for five days. Truc *et al*. (2008) stated that in fruit and vegetable processing, the maturity of raw materials has great effect on the change of their properties, nutritional values and sensory characteristics of the final product.

Concerning fruits and vegetables, the characteristics that impart distinctive quality may be described by four different attributes, namely color and appearance, flavor (taste and aroma), texture and nutritional value. These four attributes typically affect consumers in the order specified above, for example, consumers evaluate the visual appearance and color first followed by the taste, aroma, and texture (Barrett *et al*., 2010). Kramer (1965) underscored that the appearance of the product usually determines whether a product is accepted or rejected and therefore, this was one of the most critical quality attributes.

Table 3 shows the colorimetric $L^*$ or lightness $a^*$ (greenness-redness) and $b^*$ (blueness-yellowness) values and firmness as influenced by organic and inorganic fertilization. The result revealed that color $a^*$ and $b^*$ values were significantly influenced by inorganic and vermicast fertilizer applications. According to Barrett *et al.* (2010) as cited by Bilalis *et al*. (2018), the $a^*$ value is the most indicative of the intensity of red color with higher $a^*$ values being more desirable in tomatoes. Moreover, this color value has the tendency to increase during tomato ripening since the red color is the result of chlorophyll degradation and synthesis of lycopene and other carotenoids, as chloroplasts converted into chromoplasts (Nour *et al*., 2015 as cited by Bilalis *et al*., 2018). On the other hand, firmness and $L^*$ or lightness value were not significantly affected by treatments used. Fruit firmness has a tendency to increase until the fertilization rate reaches 80 kg N $ha^{-1}$ and beyond this value tends to decrease (Erdal *et al*., 2007 as cited by Bilalis *et al*, 2018). Fruit firmness is negatively associated with the increase of nitrogen content in fruits, since firmness is related to cell turgor and wall characteristics; the major effect of nitrogen is on fruit growth rate with consistency effects on cell properties (Knee, 2002 as cited by Bilalis, 2018).

Table 3. Colorimetric $L^*$ (lightness), $a^*$ (greenness/blueness) and $b^*$ (yellowness) values and firmness of jackfruit

| Treatment | $L^*$ (lightness)$^{ns}$ | $a^*$ (greenness/ redness)$^{**}$ | $b^*$ (blueness/ yellowness)$^{**}$ | Firmness ($kg/cm^2$)$^{ns}$ |
|---|---|---|---|---|
| T0 – control | 41.22 | 15.13$^b$ | 49.87$^a$ | 7.27 |
| T1 – inorganic fertilizer | 36.65 | 15.14$^b$ | 47.16$^b$ | 7.31 |
| T2 – vermicast | 38.31 | 17.41$^a$ | 46.95$^b$ | 7.69 |
| CV (%) | 8.03 | 6.60 | 2.09 | 10.44 |

ns – not significant; * – significant; ** – highly significant; mean in a column followed by the same letter is not statistically different by LSD at 0.05 level

Color changes associated with ripening were determined at each fertilizer applied like inorganic and vermicast fertilizer using colorimeter (Colorimeter smartphone application). Objective $a^*$ and $b^*$ values were significantly affected by the fertilizer applied. The $a^*$ value is a measure of greenness to redness. This value indicates the extent of non-enzymatic oxidation of food which is usually expressed as browning in color (Whitaker and Lee, 1995).

Results showed that $a^*$ values of fresh-cut jackfruit pulp ranged from 15.13 to 17.41 signifying the reddish color product as indicated with the positive sign of the values. Statistical analysis revealed that plants applied with inorganic fertilizer ($a^*$ = 15.14) was not significantly different from plants without fertilizer ($a^*$ = 15.13); vermicast fertilizer ($a^*$ = 17.41) had the highest $a^*$ value.

The $b^*$ values indicate the blue to the yellowness of the fresh-cut jackfruit pulp. It can be observed that inorganic (T1) and vermicast (T2) treatments had observable lower $+b^*$ than those without fertilizer indicating a lower intensity of yellow color; control treatment (T0) has enhanced yellow color. However, T1 and T2 were not significantly different from each other for $b^*$ value. The result implies that the yellowness of the jackfruit pulp was retained in either vermicast or inorganic fertilizer. This color attribute is a very important characteristic that may determine the consumer's acceptability of the fresh-cut produce. Consumers judge the quality of fresh fruits and vegetables based on their appearance and firmness which are external attributes (Civille, 2007).

*3.3 Chemical Property of Fresh Jackfruit*

The application of fertilizer significantly influenced pH, TSS, percent TA (%TA), vitamin C and juice yield of fresh-cut jackfruit (Table 4). Analysis showed that treatment without fertilizer application had the highest TSS (20.38 °Brix) and congruence with % total sugar (44.92%) and vitamin C content with low pH value and TA, respectively. These results might be influenced by some factors or conditions and situation of the sample crop in the area like climate, irrigation, harvest methods and proper pollination. De Lima and Alves (2001) mentioned that the main factors affecting soursop's fruit quality are genetic; environmental (climate, cropping conditions, insolation, irrigation, proper plant nutrition and use of agrochemicals); proper pollination; harvest methods and condition; and physiological age of the fruit at harvest.

In the experimental area, crop without fertilizer application (T0) was situated at the upper or slightly hilly part of the experimental area while the treatment applied with inorganic fertilizer (T1) was found at the flat part which might influence the insolation or the amount of solar radiation that reached a given area. Moreover, the crop found in the hilly area had a greater exposure to solar radiation than the T1, that is, it had lesser shading effect from a neighboring plant.

Table 4. pH, TSS, %TA, vitamin C and juice yield of jackfruit

| Treatment | pH** | TSS (°Brix)** | % TA** | Vitamin C** (mg/g) | Juice yield (mL/g)** |
|---|---|---|---|---|---|
| T0 - control | 4.56[a] | 20.38[a] | 0.27[b] | 0.34[a] | 17.70[b] |
| T1 - inorganic fertilizer | 4.48[a] | 18.04[b] | 0.51[a] | 0.28[b] | 20.25[a] |
| T2 - vermicast | 4.25[b] | 17.05[b] | 0.35[b] | 0.25[b] | 13.21[c] |
| CV (%) | 1.35 | 4.76 | 11.16 | 8.22 | 9.26 |

ns – not significant; * – significant; ** – highly significant; mean in a column followed by the same letter is not statistically different by LSD at 0.05 level

On the other hand, T1 showed low TSS (18.04 °Brix) obtaining the highest juice yield (20.25 mL/g) and %TA (0.51%). The result was probably influenced with the ecological situation of the sites and nutritional content of the soil. Based on the final analysis of soil, it contains 0.53% total nitrogen (N), 74.06 mg/kg available phosphorus (P), 226.56 mg/kg extractable potassium (K) and 87.50 mg/kg magnesium (Mg). Teisson *et al*. (1979) as cited by Owureku-Asare *et al*. (2015) ascribed the benefit of increasing amounts of K to an increase in ascorbic acid in the fruit pulp that consequently contributes to a reduction of internal fruit darkening. Moreover, increasing levels of nitrogen can result either in a reduction of the Brix value or no significant ($p < 0.05$) changes in fruit sugar content. On the other hand, K, the nutrient that accumulates in the largest amount in plant, also influences productivity and development although to a lesser extent than N (Owureku-Asare *et al*., 2015).

### 3.3.1 Total Soluble Solids

The TSS contents were the lowest on the treatment applied with vermicast (17.05 °Brix) but not significantly different from the treatment applied with inorganic fertilizer (18.04 °Brix); treatment without fertilization had a high amount of TSS (20.36 °Brix) among treatments. The result implies that it might have been affected by the location, nutrients present, soil fertility and exposure of the plant to conditions for its optimum growth and fruit development that may influence and determine its chemical composition. There might also be site-specific influence.

Owureku-Asare *et al*. (2015) stated that ecological sites significantly affected the TSS of pineapples. Lum *et al.* (2011) emphasized that high soluble solid in fruits was a result of the high amount of starch in fruit (jackfruit and apples among others) that was converted into sugar. Malundo *et al.* (1995) reiterated that the decrease in moisture content in the fruits is usually accompanied by an increased percentage of TSS since TSS is the major component of dry matter. Moreover, with proximate analysis, pulp of fresh-cut jackfruit without fertilizer showed high sugar content (44.92%) and low percent moisture content (71.70%) than the treatment with inorganic fertilizer (33.53 and 73.48%) and vermicast (40.05 and 74.84%). The result can be correlated to the soil nutrient analysis of the experimental area in which it had the highest % total N (0.53%), available P (232.38 mg/kg) and extractable K (401.56 mg/kg). Zekri and Obreza (2003) noticed that plants grown at high N or low P concentrations resulted in fruits with high soluble solid content. However, K at high levels reduced fruit TSS.

### 3.3.2 Titratable Acidity

Treatment with inorganic fertilizer had the highest TA content of 0.51% among treatments used. Treatment without fertilizer had the lowest TA (0.27%) but insignificantly different from vermicast treatment (0.35%). The result implies that fresh-cut pulp of jackfruit without fertilizer was moderately sweet compared with pulp applied with inorganic fertilizer. TA and TSS reading had established a relationship. As TSS decreased, TA increased as shown in Table 4. According to Vicente *et al.* (2002), TA is the total concentration of free protons and undissociated acids in a solution that can react with a strong base and be neutralized. The TA of fruit is used along with sugar content as an indicator of maturity; the lower the acid content, there is an increase in sugar content. The amount of organic acids in food directly affects the food flavor, color, stability, and the level of quality. Fandi *et al.* (2010) mentioned that high TA content was observed with low P concentration treatment. These results agree with Abd-Alla *et al.* (2003), Sainju *et al.* (1996) and Zekri and Obreza (2003), who stated that plants grown at low P concentration would produce fruits with high acidity.

### 3.3.3 Vitamin C and pH

Significantly high pH and vitamin C content were noted for pulp without fertilizer application (4.56 and 0.34 mg/g) than the treatment applied with inorganic fertilizer (4.48 and 0.28) and vermicast. Moreover, the lowest pH and vitamin C were observed in treatment applied with vermicast between treatments used.

### 3.4 Proximate Analysis

Proximate composition of pulp on percent moisture content, ash, total N, total protein, and total sugar is shown in Table 5. The result showed that only percentage of total sugar was significantly affected by control treatment, inorganic fertilizer and vermicast. There were no significant differences in fertilizer application on percent ash, total N, total protein and moisture content of the pulp. Treatment with vermicast and without fertilizer had high total sugar content (40.05 and 44.92%) and were comparable from each other while inorganic fertilizer treatment showed the lowest total sugar content (33.53%). The result can be correlated with the result in previous analysis wherein treatment without fertilizer application had the highest total N (0.53%), available P (74.06 mg/kg), extractable K (226.56 mg/kg) and Mg (87.50 mg/kg). Lifang *et al*. (2001) stated that sugar cane yield, sugar content, and total sugar production per hectare can be increased by application of P, K, and Mg. Among these plant nutrients, K has a dominant effect. Furthermore, organic or without fertilizer application would probably enhance the sweetness of the pulp. Increasing N supply can increase fruit acidity and also improve vitamin C content. However, overuse of nitrogen can reduce fruit color and TSS contents (Nava *et al*., 2008).

Table 5. Proximate analysis of jackfruit

| Treatment | % Ash$^{ns}$ | % Moisture$^{ns}$ | % Total N$^{ns}$ | % Total Protein$^{ns}$ | % Total Sugar$^{*}$ |
|---|---|---|---|---|---|
| T0 – control | 3.19 | 71.70 | 0.75 | .99 | 44.92$^{a}$ |
| T1 – inorganic fertilizer | 3.31 | 73.48 | 0.70 | 3.93 | 33.53$^{b}$ |
| T2 – vermicast | 3.71 | 74.84 | 0.63 | 3.56 | 40.05$^{a}$ |
| CV (%) | 8.61 | 11.95 | 33.13 | 43.06 | 9.24 |

ns – not significant; * – significant; mean in a column followed by the same letter is not statistically different by LSD at 0.05 level

### 3.5 Sensory Analysis

The sensory attributes were the basis for the consumer acceptance evaluation of fruit. The different sensory attributes that were considered included color, aroma, sweetness, firmness, flavor, juiciness and general acceptability. The primary quality attributes of a food product include color, texture, flavor and nutritional value. When assessing plant product quality, consumers consider product appearance as a primary criterion, and the color is probably considered the main factor (Kays, 1999). Color description and mean acceptability were not significantly influenced by fertilizer application. The color ranged from “yellow” to “golden yellow” as reflected in Table 6. Color acceptability ranges from 7.91-8.02 with an overall response mean of 7.97 which falls on “like moderately” on the nine-point Hedonic scale.

Table 6. Quality description and mean[1] color acceptability ratings of jackfruit

| Treatment | Description$^{ns}$ | Mean Acceptability$^{ns}$ |
|---|---|---|
| T0 – control | Yellow | 8.00 |
| T1 – inorganic fertilizer | Yellow | 8.02 |
| T2 – vermicast | Golden yellow | 7.91 |
| Overall mean | | 7.97 |
| CV (%) | 32.41 | 10.34 |

[1]N = 64 panelists; ns – not significant

### 3.5.1 Aroma

The unique aroma of jackfruit when fully ripe and mature is one of the distinguishing features. Jackfruit aroma lingers more than any other fruit and is usually very intense at the stage of ripening. The majority of the panelists perceived a “jackfruit aroma” and acceptability ranged from 7.66-7.91 with an overall mean response of 7.74, which falls on the “like moderately” on the nine-point hedonic scale. However, it was not significantly affected by fertilizer application (Table 7).

Table 7. Quality description and mean$_1$ aroma acceptability ratings of jackfruit

| Treatment | Description$^{ns}$ | Mean Acceptability$^{ns}$ |
|---|---|---|
| T0 – control | Moderate jackfruit aroma | 7.91 |
| T1 – inorganic fertilizer | Moderate jackfruit aroma | 7.66 |
| T2 – vermicast | Moderate jackfruit aroma | 7.66 |
| Overall mean | | 7.74 |
| CV (%) | 2.41 | 13.89 |

[1]n = 64 panelists; ns – not significant

### 3.5.2 Sweetness

Sweetness is influenced by the sugar content present in a particular fruit. In many cases, consumers are willing to pay a higher price for fruits that are sweet and juicy. The majority of the panelists perceived “slightly sweet” to “moderately sweet” taste of the fresh-cut jackfruit (Table 8). The observed sweetness acceptability of fresh-cut jackfruit ranges from 7.56-7.78 with an overall response mean of 7.64 which falls on the “like moderately” on the nine-point Hedonic scale.

Table 8. Quality description and mean[1] sweetness acceptability ratings of jackfruit

| Treatment | Description$^{ns}$ | Mean Acceptability$^{ns}$ |
|---|---|---|
| T0 – control | Moderately sweet | 7.78 |
| T1 – inorganic fertilizer | Slightly sweet | 7.56 |
| T2 – vermicast | Slightly sweet | 7.59 |
| Overall Mean | | 7.64 |
| CV (%) | 28.89 | 13.66 |

[1]n = 64 panelists; ns – not significant

### 3.5.3 Firmness

Firmness is one of the textural factors of fruit and vegetable quality. The textural quality of fruits and vegetables is not only important for their eating and cooking quality but also their shipping ability. Soft fruits cannot be shipped long distances without extensive losses due to physical injuries. Tissue softening and associated loss of integrity and leakage of juice from some fresh-cut products can be the primary cause of poor quality and unmarketability (Lamikanra, 2002).

The firmness of fresh-cut jackfruit was not significantly affected by fertilizer application. The majority of the panelists perceived a "firm" texture from fresh-cut jackfruit. The observed firmness ranged from 7.67-7.75 with an overall response mean of 7.71. This falls on the "like moderately" on the nine-point hedonic scale (Table 9).

Table 9. Quality description and mean[1] firmness acceptability ratings of jackfruit

| Treatment | Description$^{ns}$ | Mean Acceptability$^{ns}$ |
|---|---|---|
| T0 – control | Firm | 7.72 |
| T1 – inorganic fertilizer | Firm | 7.75 |
| T2 – vermicast | Firm | 7.67 |
| Overall Mean | | 7.71 |
| CV (%) | 29.64 | 13.24 |

[1]n = 64 panelists; ns – not significant

### 3.5.4 Flavor and Juiciness

The mean flavor of the fresh-cut jackfruit was perceived by the panelists as "slight jackfruit flavor" to "moderate jackfruit flavor". The acceptability ranged from 7.54-7.81 with an overall response mean of 7.70 that falls under "like moderately" of the nine-point hedonic scale. The flavor was not significantly influenced by fertilizer application (Table 10).

Table 10. Quality description and mean[1] flavor acceptability ratings of jackfruit

| Treatment | Description[ns] | Mean Acceptability[ns] |
|---|---|---|
| T0 – control | Moderate jackfruit flavor | 7.81 |
| T1 – inorganic fertilizer | Moderate jackfruit flavor | 7.77 |
| T2 – vermicast | Slight jackfruit flavor | 7.54 |
| Overall Mean | | 7.70 |
| CV (%) | 21.13 | 13.60 |

[1]n = 64 panelists; ns – not significant

The mean juiciness of the fresh-cut jackfruit was perceived by the panelists as "slightly juicy" to "moderately juicy". The observed juiciness ranges from 7.48-7.73 with an overall mean of 7.61. This falls on the "like moderately" on the nine-point hedonic scale (Table 11). Juiciness was not significantly affected by fertilizer application.

Table 11. Quality description and mean[1] juiciness acceptability ratings of jackfruit

| Treatment | Description[ns] | Mean Acceptability[ns] |
|---|---|---|
| T0 – control | Slightly juicy | 7.73 |
| T1 – inorganic fertilizer | Moderately juicy | 7.61 |
| T2 – vermicast | Moderately juicy | 7.48 |
| Overall Mean | | 7.61 |
| CV (%) | 30.00 | 14.68 |

[1]n = 64 panelists; ns – not significant

## 4. Conclusion and Recommendation

The study showed that application of organic and inorganic fertilizers significantly influenced the pulp width and circumference, core width, color on $a^*$ and $b^*$ values, pH, TSS, %TA, vitamin C and juice yield of jackfruit. Either in vermicast or inorganic fertilizer treatment, yellowness of the jackfruit pulp was retained. The jackfruit without fertilizer application (T0) obtained the highest TSS (20.38 °Brix) and vitamin C content followed by treatment with inorganic fertilizer (T1) (18.04 °Brix) which also achieved the highest juice yield (20.25 mL/g). The sensorial attributes (color, aroma, sweetness, firmness, flavor and juiciness) and general acceptability of jackfruit pulp were not influenced by fertilizer application. It is recommended to analyze the microbial count of fresh-cut jackfruit to determine the type of bacteria present. It is also suggested that the same study will be conducted with additional treatment combining organic and inorganic fertilizer.

## 5. References

Abbas, M.F. (1997). Jujube. In Mitra, S.K. (Ed.), Postharvest physiology and storage of tropical and subtropical fruits (pp. 405-415). Wallingford, United Kingdom: CAB International.

Abd-Alla, A.S.M., Adam, S.M., Abou-hadid, A.F., & Iman, S.S.B. (1996). Temperature and fertilizer effects on tomato productivity. Acta Horticulturae, 434, 113-116.

Association of Official Analytical Chemists (AOAC). (1984). Official methods of Analysis (14th Ed.). Washington, DC: AOAC.

Bautista, O.K. (1990). Postharvest technology for South Asian perishable crops: A simplified guide. Makati, Metro Manila, Philippines: Technology and Livelihood Resource Centre.

Barrett, D.M, Beaulieu, J.C. & Shewfelt, R. (2010). Color, flavor, texture, and nutritional quality of fresh-cut fruits and vegetables: Desirable levels, instrumental and sensory measurement, and the effects of processing. Critical Reviews in Food Science and Nutrition, 50(5), 369-389. https://doi.org/10.10.1080/10408391003626322

Bobbio, F.O., El-Dash, A.A., Bobbio, P.A., & Rodrigues, L.R. (1978). Isolation and characterization of the physicochemical properties of the starch of jackfruit seeds (*Artocarpus heterorphyllus* Lam). Cereal Chemistry, 55, 505-11.

Civille, G.V. (2007). Food quality: Consumer acceptance and sensory attributes. Journal of Food Quality, 14(1), 1-8. https://doi.org/10.1111/j.1745-4557.1991.tb00044.x

Cochran, W., & Cox, G. (1957). Experimental designs (2nd Ed.). New York: John Wiley and Sons, Incorporated.

De Lima, M.A.C., & Alves, R.E. (2011). Soursop (*Annona muricata* L.). In E. Elhadi (Ed). Postharvest biology and technology of tropical and subtropical fruits: Mangosteen to white sapote (pp. 363-392). United Kingdom: Woodhead Publishing.

Fandi, M., Muhtaseb, J., & Hussein, M. (2010). Effect of N, P, K concentrations on yield and fruit quality of tomato (*Solanum lycopersicum* L.) in Tuff Culture. Journal of Central European Agriculture, 11(2), 179-184.

Islam, M.N., Molla, M.N., Nasrin, T.A.A., Uddin, A.J.M.M. & Kobra, K. (2015). Determination of maturity indices for ber (*Zizyphus mauritiana* Lam.) var. Barikul-2. Bangladesh Journal of Agricultural Research, 40(1), 163-176.

Kays, S. (1999). Preharvest factors affecting appearance. Postharvest Biology and Technology, 15(3), 233-247.

Kumar, S., Singh, A.B., Abidi, A.B., Upadhyay, R.G. & Singh, A. (1988). Proximate composition of jack fruit seeds. Journal of Food Science and Technology, 25,308-309.

Lifang, H., Fan, S., Libo, F., & Zongsheng, Z. (2001). Effects of phosphorus, potassium, sulfur, and magnesium on sugar cane yield and quality in Yunnan. Better Crops International, 15(1), 6-9.

Lina, D.P. (2012). Phenology, reproductive biology and improvement of jackfruit (*Artocarpus heterophyllus* Lam.) production using growth regulators and assisted pollination (Dissertation. University of the Philippines, Laguna, Philippines.

Mabesa, L.B. (1986). Sensory evaluation of foods: Principles and methods. Laguna, Philippines: College of Agriculture, University of the Philippines Los Baños.

Malundo, M.M., Shewfelt, R.L., & Scott, J.W. (1995). Flavor quality of fresh tomato (*Lycopersicon esculentum* Mill.) as affected by sugar and acid levels. Postharvest Biology and Technology, 6,103-110.

Nava, G.I., Dechen, A.R., & Nachtigall, J.R. (2008). Nitrogen and potassium fertilization affect apple fruit quality in Southern Brazil, Communication in Science and Plant Analysis, 39(1-2), 96-107. https://doi.org/10.1080/00103620701759038

Owureku-asare, M.I., Agye-amponsah, J., Agbemavor, S.W.K., Apatey, J., Sarfo, A. K., Okyere, A.A., Twum, L.A., Wum, L.A., & Ddodbi, M.T. (2015). Effect of organic fertilizers on physical and chemical quality of sugar loaf pineapple (*Ananas comosus* L.) grown in two ecological sites in Ghana. African Journal of Food, Agriculture, Nutrition and Development, 15(2), 9982-9995. https://doi.org/10.43 14/AJFAND.

Pareek, O.P. (2001). Ber. Southampton: International Centre for Underutilized Crops.

Rangana, S. (1986). Handbook of analysis and quality control for fruit and vegetable products. New Delhi, India: Tata McGraw-Hill Publishing Co. Ltd.

Sainju, M., Dris, R., & Singh, B. (1996). Mineral nutrition of tomato. Journal of Food, Agriculture and Environment, 1,176-183.

Truc, T.T., Binh, L.N., & Moul, N.V. (2008). Physico-chemical properties of pineapple at different maturity levels. Proceedings of the First International Conference on Food Science and Technology, Mekong River Delta, Vietnam, 130-134.

Vicente, A.R., Martínez, G.A., Civello, P.M. & Chavez, A.R. (2002). Quality of heat-treated strawberry fruit during refrigerated storage. Postharvest Biology and Technology, 25, 59-71. http://doi.org/10.1016/S0925-5214(01)00142-9.

Watada, A.E., Herner, R.C., Kader, A.A., Romani, R.J., & Staby, G.L. (1984). Terminology for the description of developmental stages of horticultural crops. HortScience, 19(1), 20-21.

Whitaker, J.R. & Lee, C.Y. (1995). Enzymatic browning and its prevention. US: American Chemical Society. University of Michigan.

Will, R., Mcglasson, B., Graham, D., & Joyce, D. (1998). Postharvest: An introduction to the physiology and handling of fruits, vegetables and ornamentals (4th Ed.). Wallingford Oxon, United Kingdom: CAB International.

Zekri, M., & Obreza, A. (2003). Plant nutrients for citrus trees. Soil and water science department, Institute of Food and Agricultural Sciences, University of Florida. Retrieved from https://edis.ifas.ufl.edu/ss419