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# PHYSICOCHEMICAL PROPERTIES, PROXIMATE COMPOSITION AND SENSORY EVALUATION OF PINEAPPLE FRUIT (*Ananas comosus*) STORED IN DIFFERENT MEDIA

**[1]O. M. ODEYEMI AND [2]A. E. OJELEYE**

Department of Horticulture, Federal University of Agriculture. Abeokuta. PMB 2240. Ogun State. Nigeria
Department of Agronomy, Osun State University. PMB 4494. Osogbo, Osun State. Nigeria
*__Corresponding Author__: **Tel**: +234

## ABSTRACT

Provision of adequate storage facility enhances the postharvest quality and shelf-life of fruits. An experiment was carried out in the laboratory of the Department of Horticulture, Federal University of Agriculture, Abeokuta (FUNAAB) to determine the postharvest quality and sensory acceptability of pineapple fruits stored in different media. Pineapple fruits from the Directorate of Farms at FUNAAB were harvested at colour break stage and stored in the evaporative cooling structure (ECS) - pots in pot design and ventilated wooden boxes (VWB) while fruits stored in the open shelf served as the control. The experiment was laid out in completely randomised block design, replicated four times. Shell and pulp colour, physiological weight loss (PWL), total soluble solids (TSS), total titratable acidity, pH, proximate contents and sensory acceptability of the fruits were evaluated at pre-storage and after storage at 11 days (DAS). Quality and sensory attributes of pineapple fruits were affected by storage media. Fruits TSS contents increased with storage time while PWL and vitamin C contents reduced with storage time, across the media. Fruits stored in the ECS had comparable vitamin C content with pre stored fruits. Crude protein, crude fibre and carbohydrate contents were comparable in fruits stored in all media. Shell colour change from green to full yellow was reduced in fruits stored in the ECS and had better sensory acceptability when compared with fruits stored in VWB and open shelf. Pineapple fruit stored in the ECS retained fruit quality with better sensory acceptability

**Keywords**: fruits, postharvest handling, quality, sensory attributes, storage

## INTRODUCTION

Pineapple (*Ananas comosus* (L.) Merr) belongs to the Bromeliaceae family and is the third most important tropical fruit in the world after banana and citrus. It is a perennial monocotyledonous plant with a terminal multiple fruit, which is consumed fresh or as pineapple juice (Hassan and Othman, 2011; Wahab and Khairuddin, 2020). Pineapple is regarded as a healthy fruit being a diuretic, aids digestion, boosts the immune system, and shows anti-inflammatory and anthelmintic effects (Paull and Lobo, 2012). The fruit is the only source of bromelain, a proteolytic enzyme complex used in the pharmaceutical market, beer making and as a meat tenderizing agent (Lobo and Siddiq, 2017). In 2019, 17.5% of the world total production of pineapple was from Africa, with Nigeria leading the production. Globally,

Nigeria was rated 7th largest producer, producing 1,126,262.81 MT of pineapple (FAOSTAT, 2021). The major cultivars in cultivation are the 'MD2', 'Sugar Loaf', 'Smooth Cayenne' and 'Queen Victoria' (Aiyelaagbe *et al*., 2012; National Horticultural Research Institute, 2020). In pineapple production, the stage of fruit maturity is critical to quality at harvest (Hossain and Bepary, 2015). Immature fruit do not develop good flavour and sugar content is low while over ripe fruits are highly perishable. For optimum fruit sweetness, pineapple fruit should be harvested when 1/3 to 2/3 or more of the peel colour has turned from green to yellow (Hossain, 2016). However, pineapples have short postharvest shelf life at ambient temperature and deteriorate quickly. Traditionally, the fruits are consumed fresh in Nigeria. The environmental conditions under which pineapple fruits are stored have a significant effect on its shelf life and postharvest quality. Mizra *et al*, (2016) stated that pineapple requires good storage condition to sustain its taste quality and market desirability. However, poor handling and inadequate storage facility are some of the major challenges of pineapple production in Nigeria.

In view of these challenges, this study was conducted to evaluate the postharvest quality and sensory acceptability of pineapple fruits stored in different media.

## MATERIALS AND METHODS

### *Source of Pineapple*

Sixty- five samples of pineapple fruit (Smooth cayenne variety) were harvested at colour break stage from the Directorate of University Farms at the Federal University of Agriculture, Abeokuta (FUNAAB). The fruits were uniform in size, free from defects, physical damages such as cuts, pests and diseases. The fruits were carefully handled and transported to the laboratory of the Department of Horticulture at FUNAAB. The crowns were carefully removed and the whole fruits cleaned using moistened cloth and air dried.

### *Storage Medium*

Five fruits of similar weight (1.95- 2.46 kg) each were stored in evaporative cooling structure (ECS) pot-in pot design and ventilated wooden box (VWB) (40cm ×30cm × 25cm) while fruits stored in the open shelf served as the control. The experiment was set up in a Completely Randomized Design (CRD) replicated four times. An average temperature and relative humidity of 23.9$^{o}$C and 86.2% RH; 30.1$^{o}$C and 69.1% RH; 29.5$^{o}$C and 67.2% RH were observed in the ECS, ventilated wooden box (VWB) and open shelf respectively (Table 1).

**Table 1: Average temperature and relative humidity observed in the de-greening medium**

| Treatment | Temperature ($^{o}$ C) | Relative humidity (%) |
|---|---|---|
| Evaporative Cooling structure | 23.9 | 86.2 |
| Ventilated Wooden structure | 30.1 | 69.1 |
| Open shelf | 29.5 | 67.2 |

***Assessment of fruit quality***

Data were collected at harvest and 11 days after storage (DAS) on parameters such as the Physiological Weight Loss (PWL) which was calculated as the difference between the initial fresh weight (day 0) and fresh weight at the time of sampling, expressed as a percentage of the initial fresh weight. Shell colour and pulp colour of the fruits were evaluated using a colorimeter (CR-400/410, Konica Minolta, Netherlands) to measure colour space coordinates in hunters L* a* b* units, where L* value corresponds to a dark scale or lightness (0 for black and 100 for white), a* defines the red greenness (negative for green and positive for red) and b* defines the blue yellowness (negative for blue and positive for yellow). Total soluble sugar (TSS) was determined by placing the juice from fresh samples on the reading surface of a hand-held Brix Refractometer (Model Atago 1140, Japan). Percentage TSS was recorded from direct readings on the instrument. Titratable acidity (TA, citric acid) was estimated by titrating 10 mls of freshly-prepared undiluted juice with 0.1N sodium hydroxide in a beaker, using 2-3 drops of phenolphthalein as indicator to a pink colour end point. It was calculated as percent citric acid. pH was determined with the use of a pH meter (Jenway 3310, UK) previously standardized with buffers 4 and 7 at room temperature. Vitamin C was estimated by the standard Indophenol dye method. Proximate composition was determined according to the standard methods of Association of Official Analytical Chemist (AOAC, 2010). This included moisture content, determined using hot air method (AOAC, 2010). Protein, fat, ash and crude fiber were determined by the methods of AOAC (2010). Percentage carbohydrate was determined by subtracting total sum of moisture, protein, fat, ash and crude fibre from 100. Sensory evaluation was determined by twenty trained panels that compared coded samples of some specified characteristics such as appearance, taste, aroma and overall acceptability on hedonic scale of 1 to 9 (Lawless and Heymann, 2013).

***Data Analysis***

Data obtained were subjected to analysis of variance (ANOVA) using Genstat Discovery Statistical package (GenStat, 2011). Means were separated using least significant difference at 5% level of probability.

## RESULTS AND DISCUSSION

***Physico-chemical properties of pineapple fruits stored in different media***

There was loss in the physiological weight loss (PWL) of the fruits with storage time in all the media evaluated. However, PWL was significantly reduced in fruits stored in the ECS at 11 DAS compared with those stored in ventilated wooden box and open shelf (Figure 1). This may be due to the low temperature and high relative humidity observed in the ECS which would have reduced the rate of water loss into the atmosphere from the fruits (Table 1). The pH and TSS content of the fruits were comparable both at pre-storage and after storing the fruits in the different media (Table 2). TSS is a biochemical component of fruits and its concentration determines fruit quality (Siti Roha *et al*, 2013; Macarena and Erin, 2020). It is also used as an indication of fruit maturity. Pineapple is a non-climacteric fruit in which eating quality is usually determined before harvest (Chen *et al*, 2010). After harvest, the fruit does not continue to ripen or sweeten significantly (Lobo and Paull, 2016). Therefore, it is important to note that pineapple fruits meant for storage should be harvested at colour change from green to yellow from the base.

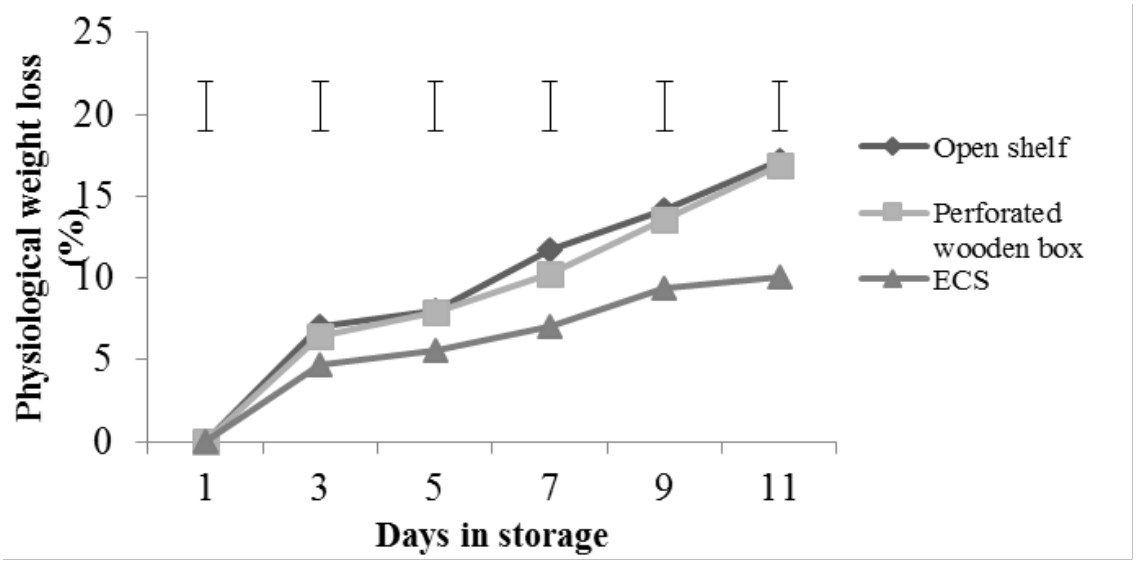


**Figure 1: Physiological weight loss of pineapple fruits stored in different media**

Key: ECS –Evaporative cooling structure, VWB- Ventilated wooden box,

**Table 2: Biochemical properties of pineapple fruits stored in different medium**

| Storage media | pH | TSS (% brix) | Vit. C (mg/100ml) | TTA (%) |
|---|---|---|---|---|
| Pre storage | 3.59 | 14.70 | 15.74 | 0.74 |
| ECS | 3.67 | 16.03 | 13.48 | 0.87 |
| VWB | 3.88 | 16.07 | 12.50 | 0.91 |
| Open shelf | 3.63 | 15.60 | 12.32 | 1.01 |
| LSD <0.05 | Ns | Ns | 2.29 | 0.25 |

The vitamin C contents of the pineapple fruits decreased significantly with storage. Vitamin C contents of fruits at pre-storage (15.74 mg/100ml) and ECS (13.48 mg/100ml) were similar but higher than the values obtained for fruits stored in the VWB (12.50 mg/100ml) and open shelf (12.32 mg/100ml). Mohammad *et al*., (2015) stated that fruits and vegetables show a gradual decrease in vitamin C content as the storage temperature or duration increases. However, fruits stored in the ECS had significant higher amount of vitamin C. Odeyemi *et al.,* (2014) had earlier reported that vitamin C content of pawpaw fruits stored in the ECS was retained.

Fruits Titratable acidity contents increased under room storage and VWB with storage days. This increase may be due to the high temperature observed under the storage condition (Tolesa and Workneh, 2017). It has been suggested that fruits utilize organic acids for metabolic activities which results in

decrease in Titratable acidity during storage (Nadya *et al,* 2012). It was also observed that the shell colour values of the fruits increased significantly with storage time. Fruits stored in the VWB had the highest L* value (46.84) when compared with fruits stored in the ECS (43.21), open shelf (45.21) and 39.41 at pre-storage (Table 3). However, the a* values in fruits stored in the ECS, VWB and open shelf were similar but higher than values for fruits at pre-storage. The b* values for fruits stored in the open shelf were comparable but higher than values for fruits stored in the ECS and at pre-storage. This indicates that fruits stored in the VWB and open shelf had deeper yellow colour compared with others. Consumers usually judge the quality of pineapple fruits by the skin colour and aroma. However, high shell colour in pineapple fruits is not always a good measure of sweetness (Lobo and Paull, 2016).

**Table 3: Colour development on pineapple fruits stored in different media**

| | Shell colour | | | Pulp colour | | |
|---|---|---|---|---|---|---|
| Treatments | $L^*$ | $a^*$ | $b^*$ | $L^*$ | $a^*$ | $b^*$ |
| Pre-storage | 39.41 | 6.34 | 19.57 | 76.38 | -2.63 | 35.24 |
| Evaporative cooling structure | 43.21 | 9.47 | 23.09 | 77.18 | -2.56 | 39.17 |
| Ventilated wooden box | 46.84 | 10.85 | 28.60 | 78.88 | -2.52 | 39.17 |
| Open shelf | 45.21 | 11.89 | 28.09 | 77.51 | -2.85 | 35.11 |
| LSD <0.05 | 1.44 | 3.42 | 3.65 | Ns | ns | Ns |

L*=lightness (0=maximum darkness, 100=maximum lightness) a= (+a* redness/ -a* greenness) b= (+b* yellowness/ -b* blueness)

***Proximate composition of pineapple fruits stored in different media***

Fruit moisture contents reduced with storage time while ash and dry matter contents increased with storage time. Fruits at pre-storage had the highest moisture content (87.63 %) followed by fruits stored in the ECS (83.27 %) when compared with fruits stored in other media. This may be due to the relatively high humidity observed in the storage chamber that reduced moisture loss to the atmosphere. Fruits stored in the open shelf had the least moisture content (81.18 %) at 11 DAS (Table 4). This could be due to the exposure of the fruits to direct environmental factors such as high temperature and low relative humidity. The ash content of fruits stored in both the ECS and VWB were comparable but higher than values obtained in fruits at pre-storage and those stored on the open shelf. However, fat, carbohydrates and crude fibre contents of the fruits were similar at pre-storage and at 11 DAS after storage in the different media. Pineapple fruits have no accumulation of starch, therefore, no resolve for major post-harvest quality improvements. The pattern of starch in non-climacteric fruits differs.

Pineapple is a non-climacteric fruit that has no carbon source for promoting postharvest sweetening (Condenunbi *et al*, 2010; Chervin, 2020).

**Table 4: Proximate composition (%) of pineapple fruits stored in different medium**

| Storage media | Moisture content | Ash | Crude Protein | Crude Fibre | Fat | Carbohydrates | Dry Matter |
|---|---|---|---|---|---|---|---|
| Pre storage | 87.63 | 0.68 | 2.99 | 0.09 | 0.13 | 10.91 | 12.37 |
| ECS | 83.27 | 0.91 | 1.86 | 0.08 | 0.37 | 12.70 | 16.73 |
| VWB | 82.03 | 0.92 | 2.47 | 0.08 | 0.14 | 11.04 | 17.97 |
| Open shelf | 81.18 | 0.72 | 2.84 | 0.10 | 0.15 | 12.03 | 18.82 |
| LSD <0.05 | 2.06 | 0.18 | 0.12 | ns | ns | Ns | 3.54 |

Key: ECS –Evaporative cooling structure, VWB- Ventilated wooden box

***Sensory acceptability of pineapple fruits stored in different media***

The appearance and taste of the pineapple fruits stored in the ECS were liked moderately while the aroma was liked very much by the panel, when compared with pineapple fruits stored in the ventilated wooden box and open shelf at 11 DAS. The appearance of pineapple fruits stored in open shelf were neither liked nor disliked while those stored in the ventilated wooden box were disliked moderately at 11 DAS. However, the taste and aroma of fruits stored on the open shelf and VWD were liked slightly. Overall, pineapple fruits stored in the ECS after 11 DAS were highly acceptable to the panel (Figure 2). Macarena and Erin (2020) reported that sweetness, flavour intensity and flavor were the most important quality factors in determining acceptability of pineapple fruits.

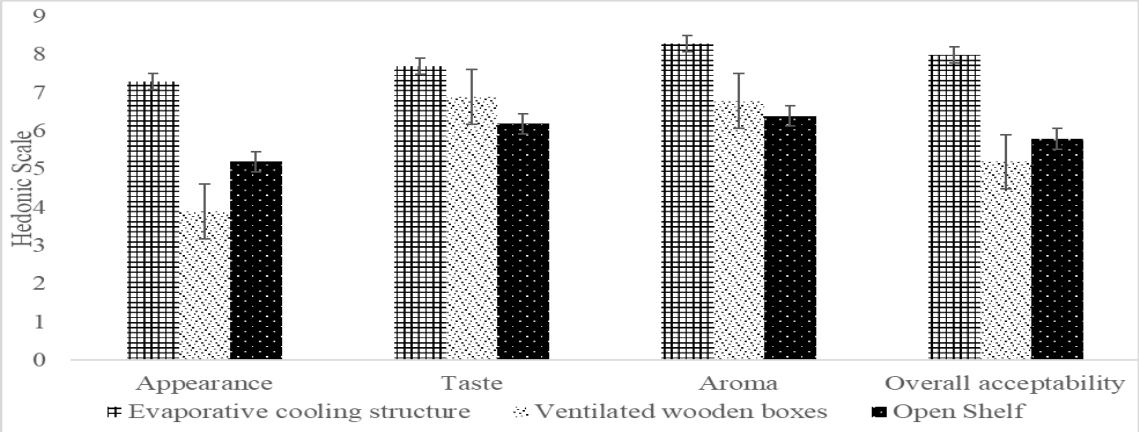


**Figure 2: Sensory evaluation of pineapple fruits stored in different media**

Hedonic scale: 1- dislike extremely, 2-disliked very much, disliked moderately, 4,- disliked mildly, 5-neither disliked nor liked, 6-liked slightly, 7-liked moderately, 8-liked very much, 9 –liked extremely.

## CONCLUSION

The quality and sensory attributes of pineapple fruits were affected by the storage media. Pineapple fruit stored in the ECS retained fruit quality and had better sensory acceptability. The temperature in the storage medium is responsible for the physiological and chemical quality of pineapple fruit at storage. It is important that fruit handlers recognize how to handle pineapple fruits at storage, as this determines the final quality.

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