Storability Potentials of Selected Fruits in Evaporative Cooling Structure Using Different Locally Sourced Lagging Materials

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Abstract

The preservation of fresh fruits is a critical aspect of agricultural management, ensuring extended shelf life and maintaining product quality. Evaporative cooling structures (ECSs) have emerged as promising solutions for enhancing fruit storability by providing controlled environmental conditions conducive to prolonging freshness and minimizing post-harvest losses. This paper investigates the storage suitable ofECSs using locally available lagging materials.Jute fibre, stem sponge fibre and sponge gourd fibre were used as lagging materials. The ECSs were loaded with garden egg and sweet orange and were tested using the different lagging materials for a period of 14days.The fruits were loaded in another ECS without lagging which was used as control.The results indicate that the highest weight loss 6.09 and 20.63gwere obtained for sweet orange and garden egg respectively using sponge gourd fibre. Thisshows that the fruits losses weight faster using sponge gourd fibre.It was obtained that the firmness of both fruits were retained using stem sponge fibre and sponge gourd fibre while there was no significant changes in the fruits colour using jute fibre. Furthermore, the bacteria count for sweet orange and garden egg after the storage period was found to range from 2.98 x 10^2cfu/g to 9.18 x 10^2cfu/g respectively for each of the lagging material. Jute fibre was found to be the storability potential of the fruits.

Keywords: *Jute Fibre, Stem Sponge Fibre, Sponge Gourd Fibre, Sweet Orange and Garden Egg*

1. INTRODUCTION

The importance of fruit and vegetables cannot be over emphasized because of its benefit to human and it's generally considered in dietary guidance because of their high concentrations of dietary fibre, vitamins, minerals, especially electrolytes; and more recently phytochemicals, especially antioxidants. They are also an important source of digestible carbohydrates, minerals, and vitamins A and C. Fruit also form an essential part of a balanced diet. (Ejiko *et. al.*, 2022). Phytochemicals having antiviral and antibacterial properties as well as potassium are found in brown/white fruits and vegetables such as banana, garlic, onion and ginger, among others. (Hoejskov, 2014). The higher intake of it is associated with lower risk of cognitive decline hence proved beneficial for mental health (Amao, 2020). Also, fruits and vegetables are nutritionally energy-dense foods containingvitamins, minerals, fibre and other bioactive compounds. (Amao, 2020).

Evaporative cooling systems offer sustainable solutions for temperature control, particularly in arid and semi-arid regions where water is relatively abundant. One crucial component of such systems is the lagging material, which plays a pivotal role in enhancing cooling efficiency by minimizing heat transfer. Over the years, various materials have been employed as lagging materials in evaporative cooling structures such as cellulous – based materials, mineral wools, polyethylene foam, polystyrene foam and jute fibre (Jones and Zaini, 2017: Ejiko *et. al.*, 2022: Rengaraj and Prabhu, 2019). Cellulose-based materials, mineral wool, polyethylene foam, polystyrene foam, and jute fiber are among the most frequently employed materials due to their thermal insulation properties, moisture resistance, durability, and affordability. Liao and Hsieh (2017) and Kundu, (2016) opined that evaporative cooling structures offer an effective solution for vegetable storage by leveraging the principles of evaporative cooling to maintain low temperatures.

Lagging materials are essential components of these structures, providing insulation and optimizing the cooling process. Jute fiber, sponge gourd, and stem sponge have gained attention as potential lagging materials due to their unique properties and sustainable characteristics. Their natural, renewable and biodegradable characteristics align with the growing demand for sustainable materials in insulation, packaging, and environmental remediation. Wilson and Wilson, *et al.*, (1995) and Liberty *et al.*, (2013) reported that common lagging materials offer thermal insulation and moisture retention properties, they also pose various challenges and problems. Wilson, *et al.*,(1995) reported that cellulous based materials are prone to degradation when exposed to moisture for extended periods. In evaporative cooling structures, where humidity levels can be high, cellulose-based materials may become breeding grounds for mold, mildew, and bacterial growth. Mineral wool can pose health risks due to the release of airborne fibers during installation and maintenance. Prolonged exposure to airborne fibers can irritate the skin, eyes, and respiratory system, posing risks to workers and potentially contaminating stored vegetables (Prasad and Yang, 2018). Moreover, mineral wool may settle over time, reducing its effectiveness as a lagging material and compromising vegetable preservation. polyethylene foam which contain emit volatile organic compounds (VOCs) can contribute to indoor air pollution and affect the quality and safety of stored vegetables. Furthermore, polyethylene foam is susceptible to degradation when exposed to ultraviolet (UV) radiation and extreme temperatures, reducing its longevity and effectiveness.Improper disposal of polystyrene foam can contribute to plastic pollution, posing environmental hazards. Additionally, polystyrene foam is flammable and releases toxic gases when exposed to fire, potentially endangering stored vegetables and occupants.The problems posed with the common types of lagging materials used in the evaporative cooling structure as stated pose a need for sourcing for a materials which can be environmental friendly as well reduce health risks. Thus, this research investigate the storability potentials of selected fruits in evaporative cooling structure using different locally sourced lagging materials.

2.0. MATERIALS AND METHODS

Three different pad materials were used (Jute, sponge gourd and Stem sponge) as the lagging materials in evaporative cooling structures (ECSs). Also, two different fruits namely eggplant and sweet orange were used for testing the storage effect of each of the lagging material. The fruits were procured from a main market in Akure, Ondo State Southern part of Nigeria. The viable fruits were selected manual using the sensory organs. Figs 1.1 and 1.2 shows the viable fruits for eggplant and sweet organs respectively. Figs 1.3, 1.4 and 1.5 shows the jute, sponge gourd and stem sponge lagging materials respectively.

Fig. 1.1: Egg plant

Fig. 1.2: Sweet oranges

Fig. 1.3: Jute

Fig. 1.4: Sponge gourd

1.5: Stem sponge.

Physiological Property of Fruit during Storage

The physiological properties observed in the research include fruit weight loss, colour change and firmness of the stored fruits. The weight loss of each of the fruit was determined by weighing the sample using a digital weighing balance of 0.01g. The samples were weighed every 6 hours for a period of 14 days. These were done for both the evaporative cooling system without lagging (control) and when lagged with lagging materials. The experiment was replicated five times. The colour of each fruit was determined by using a colour chart. The fruits were stored for a period of 14 days and the coloured were determined every 3 days for both evaporative cooling system without lagging (control) and when lagged with lagging materials. The changes in firmness of the fruits (Sweet orange and eggplant) used were monitored for the samples which were kept in the evaporative cooling system without lagging (control) and when lagged with lagging materials. This was done by Figure 1.1 and 1.2 depicts the fruits samples while figure 1.3 to 1.5 shows the different lagging materials used in the evaporative cooler**.**

Microbial properties

Determination of total microbial load from the sample (Total Viable Count) using standard plate count method. The microbiological contamination for the detection of total coliforms, moulds and yeast. Colony forming units per gram (CFU was determined followed the recommended Standard method of pour plate 9215 (2012).

3.RESULTS AND DISCUSSION

Figure 1.6 and 1.7 shows thevariation in fruit weight loss during storage for sweet orange and eggplant respectively. While figure 1.8 and 1.9 prortary change in colour and firmness of the sweet orange and the eggplant stored in the evaporative cooling system.

Effect of weight loss of the fruits on the storage period using different lagging materials

From figure 1.6, the maximum weight loss of 6.09 g, 4.13 g, 5.66 g, 1.5 g and 4.12 g for sponge gourd, stem sponge, control and jute respectively after 14 days of storage. The effect of the weight loss for sponge gourd stem sponge and control in the first 3 days were highly significant and continued as the day's progresses. Also, the highest weight loss of orange in the jute was very high as the storage period increases. Furthermore, from Figure 1.7there was progressive increase in the weight of the egg plant as the storage increases for each of the lagging material..This result is similar to that obtained by Azene et al (2014) when working on evaporative storage of papya using high and low density polyethylene. The lowest weight loss of 4,12g for the egg plant was obtained when jute wa used as lagging material with the control, having the highest weight loss of 21.04g. This implies that jute is a suitable lagging material for storing eggplant for longer period.

Colour changes

The colour of biological produce places a very germane role to determining the ripening rate alongside the deterioration of the produce. The sweet orange and eggplant stored in the evaporative cooling structures with stem sponge, sponge gourd and Jute did not decay for the period of experiment. A similar result was obtained by Babaremu et al (2019) when working on the effects of evaporative cooling system on the storage of sweet orange. Although there was changes in the colour (figure 1.8 – 1.9)of the fruit during storage period but there was a little change in the sweet orange when stem sponge was used as lagging material while there was considerable change in the eggplant when stem sponge is used as the lagging material. This implies that for sweet orange, stem sponge as lagging material gives a better prospect of storability.

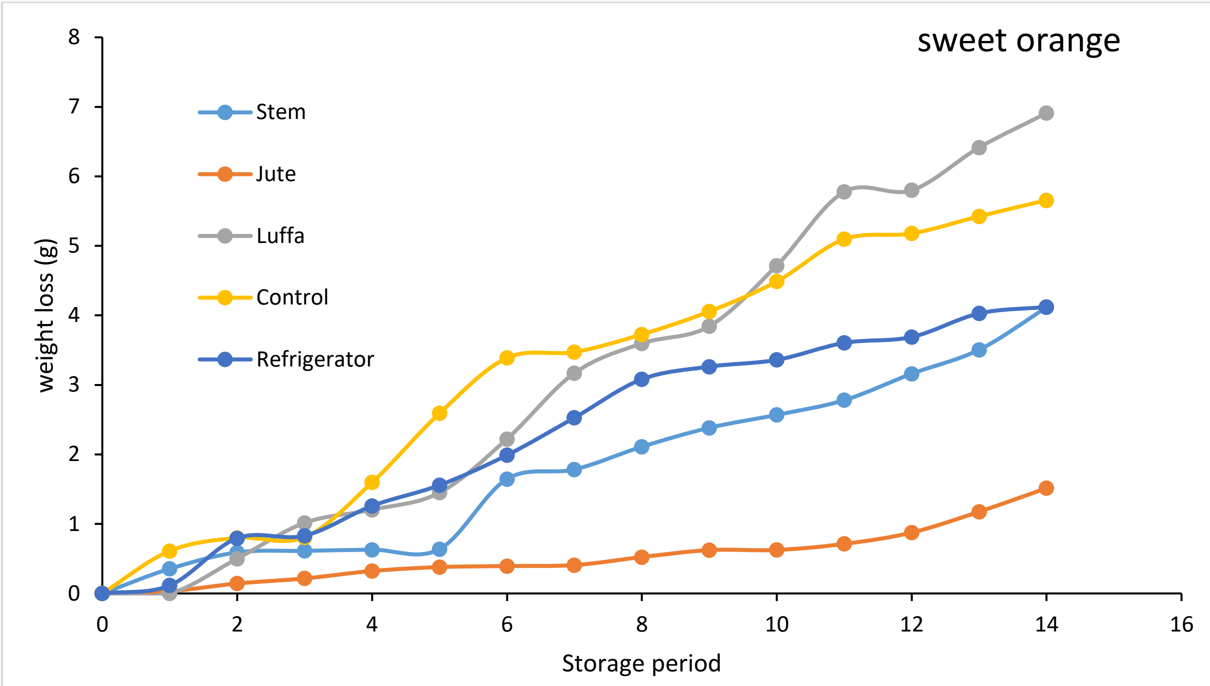

Figure 1.6: Variation in fruit weight loss during storage (Sweet Orange)

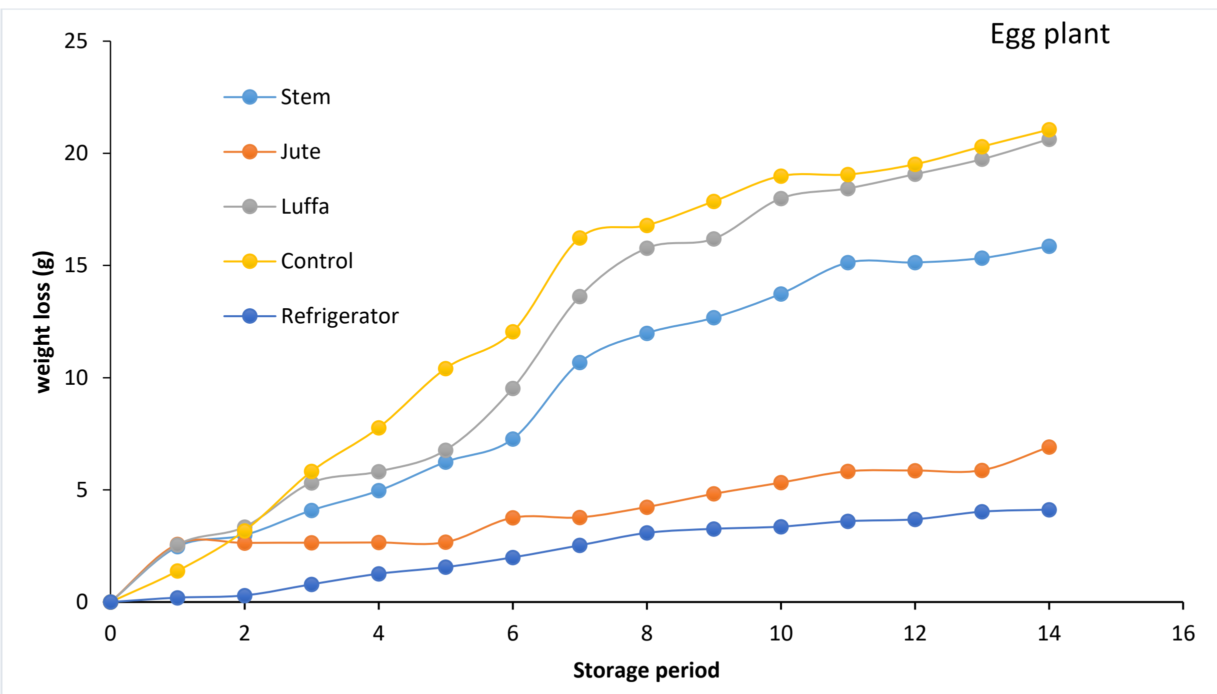

Figure 1.7: Variation in Fruit Weight loss during Storage (Egg plant)

LUFFA CYLINDRINCA

ECSS CONTROL

REFRIGERATOR

STEM SPONGE

JUTE BAG

Fig. 1.8: Sweet Orange Stored in the Evaporative Cooling System

LUFFA CYLINDRICA

ECSS CONTROL

REFRIGERATOR

JUTE

STEM SPONGE

Fig. 1.9: Eggplant Stored in Evaporative Cooling System

Effect of microbial on the stored fruits

The microbial load was determined to ascertain the efficacy of the evaporative cooling structure. Microbial contaminants were found in all the samples analyzed. In this study the samples (sweet orange) were contaminated by Aerobic mesophylic bacteria with a mean value ranged from $1.21x10^2$ to $9.18x10^2$cfu/ml in the storage systems. It was observed that the average microbial load in all the cooling structures were lower than 10^5cfu/ml aerobic mesophilic bacteria. The total fungi/mould range from 4.99X 10^2 to 7.96 X 10^2cfu/ml. All the chemical compositions analyzed were within the standard acceptable range when compared with standard specification of Standard Organization of Nigeria and international commission on microbiology specification for foods. However, the microbial quality Jute (*Corchorus capsularis*)was the best for storing sweet orange based on the microbial and fungi/mould counts.

CONCLUSION

The study on the storability potentials of selected fruits in evaporative cooling structures using different locally sourced lagging materials underscores the importance of innovative, low-cost solutions in preserving perishable produce. Results indicate jute pad has a promising outcomes for extending the shelf life of fruits, offering a sustainable approach to addressing post-harvest losses. Further research and application of these findings hold significant potential for enhancing food security and supporting agricultural economies, particularly in regions with limited access to conventional cooling technologies.

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