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SHELF LIFE AND SENSORY EVALUATION OF CARROT (*Daucus carota* L.) ROOT WITH PACKAGING MATERIALS

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ABSTRACT

Carrot, (*Daucus carota* L.) is an edible orange-yellow coloured root which adds attractiveness to different delicacies. Retailers often pack carrot with polythene bags, which is observed to lose its attractiveness in few days. Three different packaging materials and unpackaged were studied and their effects investigated on the shelf-life and organoleptic properties of carrot roots. The packaging materials were: Polythene bag, *Thaumacoccus danielle* leaf and foil paper. An unpackaged storage served as the control. Prior storage, the carrot samples were washed, cleaned, air dried and sorted. After packaging into different materials, roots were stored in cartoon boxes (CB). The following parameters were measured: physiological weight loss (PWL), shelf-life and organoleptic properties: taste, flavour, mouth fill, sweetness, colour and overall acceptability. Sixty (60) carrot roots of optimum size were arranged randomly into four treatments (packaging materials) including the control (unpackaged), replicated five times and stored for twenty-seven days under average temperature of 32.8^{0}C and RH, 72.8%. Carrot roots were marketable on the 24th day using foil paper. Use of foil paper was effective in extending the shelf-life of carrot for 27 days before showing symptoms of bloating. Visual quality of colour, flavour, taste and sweetness were excellent with carrot packaged in foil paper when compared with other packaging materials and with the unpackaged control in the following order: Foil-paper > leaf > Polythene bag > Control. The type of material used to package carrot roots elongates the shelf-life and delays rotting significantly.

Keywords: Packaging material, carrot root, Foil paper; Polythene bag; *Thaumacoccus danielle*.

INTRODUCTION

Carrot (*Daucus carota* L.) is an important food crop with a low sheflife after harvest (Thorup-Kristensen *et al.,* 2012) which makes it well-suited for both organic and inorganic production. Among 39 fruits and vegetables, it has been discovered that carrots have been ranked 10th in nutritional value (Acharya, *et al*., 2008; Joao and Silva, 2014). Carrot is a good source of dietary fiber and of the trace mineral molybdenum, rarely found in many vegetables. Molybdenum aids in metabolism of fats and carbohydrates and is important for absorption of iron. It is also a good source of magnesium and manganese (Joao and Silva, 2014). Carrots are consumed both raw and cooked or processed into frozen products or juice (Vibe *et al.,* 2015).

Almost all fresh fruits and vegetables such as Carrots, mangoes, pineapples, watermelons and tomatoes grown in Nigeria are consumed locally coupled with seasonal produc-

tions that result in a glut during the season and scarcity at off seasons (Alao, 2000). Due to the soft texture of carrot root, they are easily bruised or wounded as a result of poor harvesting method, and other post-harvest handling operation such as packaging, transportation and storage. In developing countries like Nigeria, despite producing adequate quantities of fruits and vegetables, yet on account of losses in the field as well as in storage, they become inadequate. In addition to this barrier generally, about 30% fruits and vegetables are rendered unfit for consumption due to spoilage after harvesting, inappropriate post-harvesting methods and lack of storage facilities. Consumers measure the quality of carrot fruit primarily by: Physical appearance (color, size, shape, defects, and decay), firmness, and flavor. Carrot quality is significantly affected by pre and post-harvest factors; stage of maturity at harvest; packaging method; number of times handled during marketing, storage temperature and time (Randi, *et al*., 2013). Overall quality and shelf life of carrot is reduced by several factors including water loss, enzymatic browning, texture deterioration, senescence processes and microbial growth, among others. Packaging material adopted in most developing countries (polythene bags) has a huge influence on the rate of postharvest loss of most cut and fresh fruits and vegetables. Consequently, fruit quality is reduced and considerable amount is wasted, from harvesting to final consumption. Research efforts have always focused on varietal development, fertilizer trial and agronomic practices.

In terms of food groups, roots and tubers in which carrot is one record the highest level (over 25%) postharvest loss (FAO, 2019). The high loss has been attributed to several factors among which handling procedures, lack of packaging, storage facilities and poor means of transportation are the major ones.

Consumers prefer to consume their fruits and vegetables fresh due to the high nutritional value. The goal of fresh fruits retailers is to maintain freshness until it gets to the end user and also to extend the shelflife of the produce (Haque *et al*., 2017). Carrot is one of the fresh commodities that is prone to fast decay and therefore requires proper handling after harvest to preserve the quality till it gets to the consumer. Packaging plays a significant role in the market chain of fresh produce in preventing the impact of the storage environment on the produce. Polythene bags of different colour and thickness have been in use to package fresh carrot root in developing countries (Haque, *et al*., 2017).

Therefore, there is need to evaluate the effectiveness of packaging materials like foil paper and leaves that would maintain the organoleptic quality and extend shelf-life of carrot root.

MATERIALS AND METHODS

Source of carrot

Nantes variety of Carrot roots (Plate 1) were purchased at the point of harvest from the fruit market at Lagos in October, 2020. The fruits were free from defects and physical damages such as cuts, pests and diseases. The whole roots were sorted, graded, washed, cleaned and air dried. Sixty (60) carrot roots of average weight between 79.6 and 86.7 g/root were packaged in fifteen (15) into different packaging materials (Polythene bag, leaf and foil paper) and control (Plate 2); stored in ventilated cartoon box (40 cm × 30 cm × 25 cm) while fruits stored in the control were not packaged. The experiment was set up in a Completely Randomized De-

sign (CRD) replicated five times.

Assessment of fruit quality

Data collection commenced from the onset of the storage and continued daily till the 27th day at storage (DAS) on parameters such as the Temperature (^{0}C), Relative humidity (%), Days in storage, Physiological Weight Loss (PWL), which was calculated as the difference between the initial weight (day 0) and the weight at the time of data collection expressed as percentage of the initial fresh weight was carried out at pre-storage and at 27th DAS according to Workneh *et al.,* (2011). Sensory evaluation and decay/rotting were also observed. Sensory evaluation was determined by twenty trained panels that compared coded samples of some specified characteristics such as flavour, taste, colour, sweetness, mouth-feel and overall acceptability on hedonic scale of 1 to 5 with (5= Like a lot, 4=like a little, 3= neither like nor dislike, 2= dislike a little, 1= dislike a lot). The visual appearance of the carrot roots was evaluated using a key (9 = Excellent; 7= Good; 5= Fair; 3 = Poor and 1= Unusable). Level of decay was evaluated using a key (0= Fresh, 3 = Bloat, 5 = Active decay 9 = Advance decay).

Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) and means were separated using least significant difference at 5% level of probability.

Plate 1: Carrot root at harvest

A **B** **C** **D**

Plate 2: Carrot root in Packaging materials used for the experiment (A=*Thaumatococcus daniellii* leaves, B = Polythene nylon, C = Foil paper, D = Control)

RESULTS AND DISCUSSION

Temperature (° C) and Relative humidity (%)

Mean temperature from the packaging materials was 32.8 ° C; relative humidity was 72.8 %. The highest temperature was 37.4 ° C and relative humidity (RH) of 72.8 % was from carrot roots packaged in polythene bags while the least temperature of 30.4 ^{0}C was from foil paper packaging, with least RH of 70.5 % from leaves of *Thaumacoccus danielle* (Table 1). Mean temperature over the 27 days revealed that polythene bag packaging had the highest mean temperature during storage which may have been the causal factor of its high rate of deterioration because of increase in respiration as compared to foil paper packaging with the lowest storage mean temperature, having the lowest rate of deterioration. The differences observed between the packaging materials revealed the importance of packaging material in prolonging the shelf life of carrot roots.

Table 1: Mean ambient temperature (^{O}C) during storage of carrot root

Packaging materials	Mean Temperature (^{0}C)	Mean Relative Humidity (%)	Shelf-life (Days)
Polythene bag	37.4	77.3	9
Leaf	30.8	70.5	27
Foil paper	30.4	72.0	24
Control	33.0	71.5	12
Mean	*32.8*	*72.8*	

Effect of packaging material on the shelflife and sensory assessment of fresh carrot root

Carrot roots wrapped with foil paper stayed for 27 days in shelf, followed by roots wrapped with leaves of *Thaumacoccus danielle* (24 days) while carrot roots packaged in polythene bags had least (9 days) shelf-life. Carrot roots are vulnerable to water loss, and proper packaging prevents desiccation, reduces respiration and prolongs the shelf life from time of packaging until consumption. Foil paper packaging material significantly increased the shelf life of carrot roots by 6 days over leaf, 18 days over polythene bag and 12 days more than the unpackaged control treatment (Table 2).

Table 2 : Effect of packaging material on the level of carrot root decay (shelflife) during storage

Packaging materials	0	3	6	9	12	15	18	21	24	27
	Number of Days in Storage									
Polythene bags	0	0	0	3	3	5	5	7	7	7
Foil paper	0	0	0	0	0	0	0	0	0	3
Leaf	0	0	0	0	0	0	3	3	3	5
Control	0	0	0	0	0	3	3	5	5	7

Key: 0 = Fresh, 3 = Bloat, 5 = Active decay 7 = Advanced decay

At 27th day in storage, highest decayed carrot root (90%) was recorded from polythene bag packaging, followed by unpackaged carrot (80%); packaging with the leaves of *Thaumacoccus danielle* had 40% decayed carrot root while the least decay (10%) was from packaging with foil paper (Figure 1). The quality of the carrot roots deteriorated over the days with the fastest decline from packaging with polythene bags. These results confirm the usefulness of packaging materials, such as foil paper otherwise known as flexible plastic film in extending the shelf life of carrot.

The plastic film prolongs shelf life by reducing respiration, defending weight loss and microbial growth rates, as well as delaying enzymatic deterioration (Kumar *et al.* 1999). Caron *et al.* (2003) stated that packaging is a very important factor affecting weight loss and storage period of carrot roots. The important role of packaging from the aspect of weight loss and shelf life of stored products was also confirmed by Korladdiand and Devendrappa (2011) who examined the effects of various types of packing materials with several vegetable species in refrigerator. However, Ayub *et al.* (2010) observed a higher percentage of carrot roots sprouting when stored wrapped in PVC film.

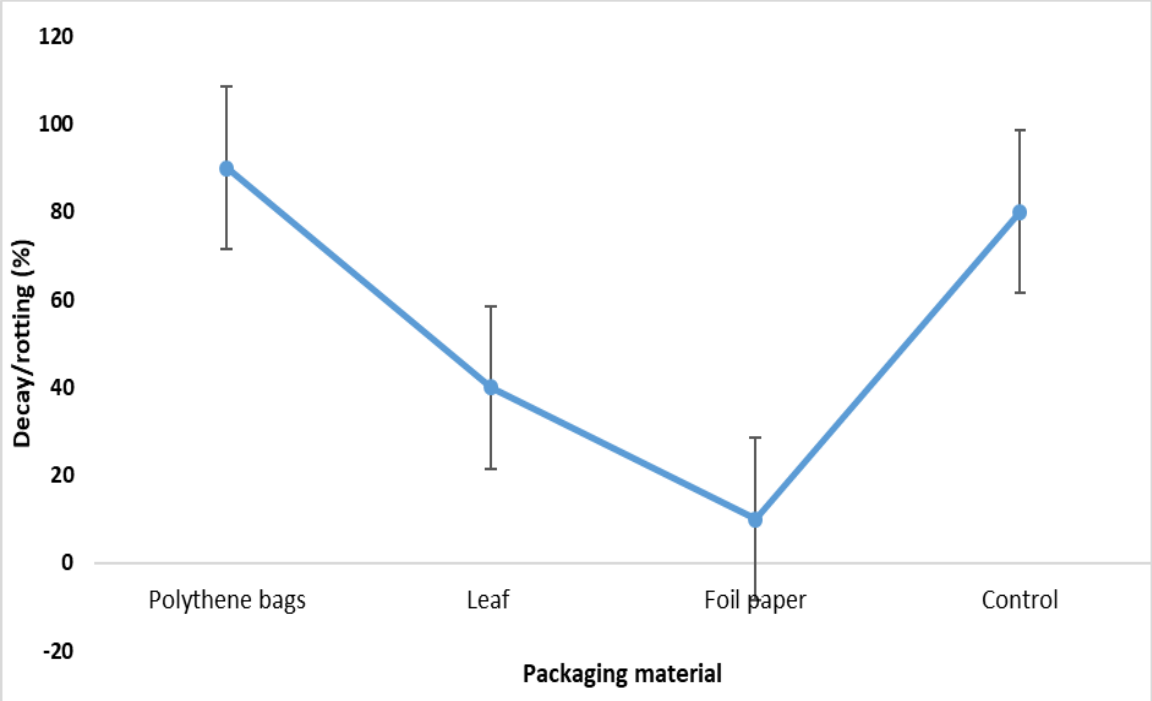

Figure 1: Decay/Rotting (%) of carrot root at 27th Day in Storage using different packaging materials

Appearance of carrot root at 27th Days at storage (Figure 2) showed that carrot root in foil paper were good; carrot roots packaged in leaves of *Thaumacoccus danielle* were fair; those packaged in polythene bags were unusable while the unpackaged roots were in poor condition (Figure 2).

The lowest Percentage Weight Loss (PWL) at 27DAS (5.23%) was observed in roots packaged with foil paper (Figure 3) while the highest PWL (14.23%) was from carrot roots packaged with polythene bags; leaf packaging had 10.11% PWL and control had 13.43% PWL.

This result also shows foil paper and leaf as been the best packaging material for storing carrot which was also observed in the visual quality/appearance over 27 days in storage (Plate 3). This was buttressed in Plate 4 which shows daily observation of carrot root as influenced by packaging materials. This was also reported by Oliveira, *et al.*, (2001) who found the most suitable packaging material from the aspect of weight loss to be PVC film.

The colour, flavour, sweetness, mouth-feel and taste of the carrot root packaged with foil paper were liked a lot at 9 DAS, (Table 3), 18 DAS (Table 4) and 27 DAS (Table 5) while carrot roots packaged with leaves of *Thaumacoccus danielle* were liked a lot at 9 DAS, (Table 3) and 18 DAS, (Table 4) and liked a little at 27 DAS, by the panellists when compared with other carrot roots packaged with polythene bag and unpacked roots at 18 DAS (Table 4) and 27 DAS, (Table 5).

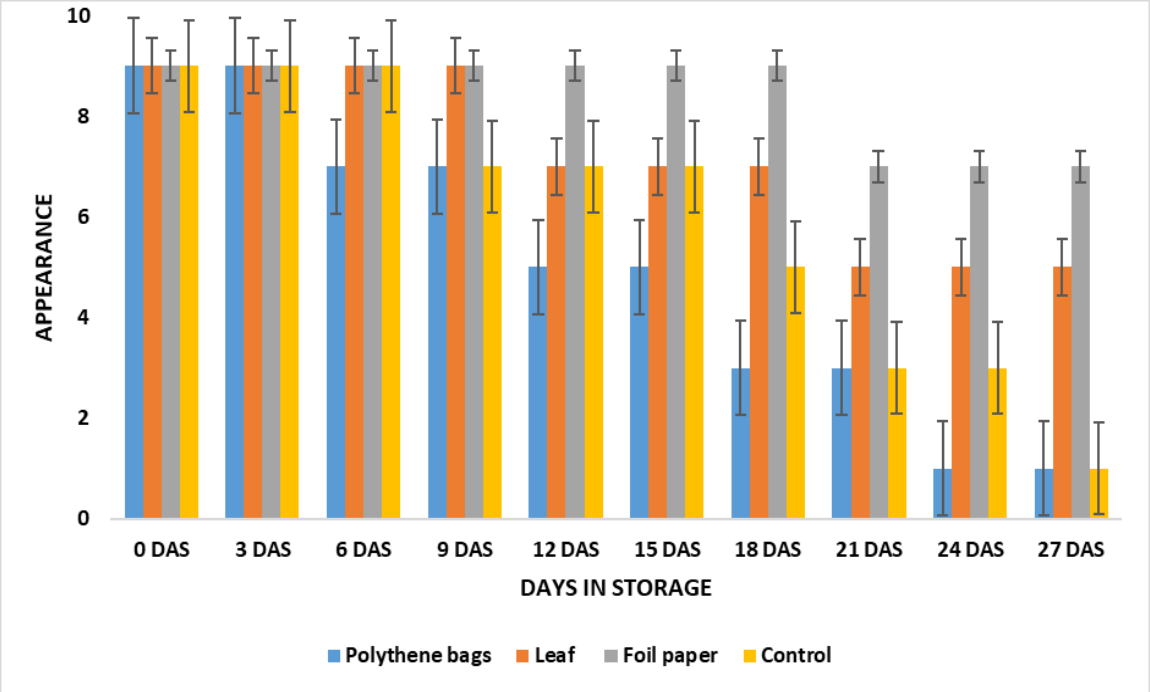

Figure 2: Visual quality of carrot root in storage with different packaging materials
Key; 9 = Excellent; 7= Good; 5= Fair; 3 = Poor and 1= Unusable

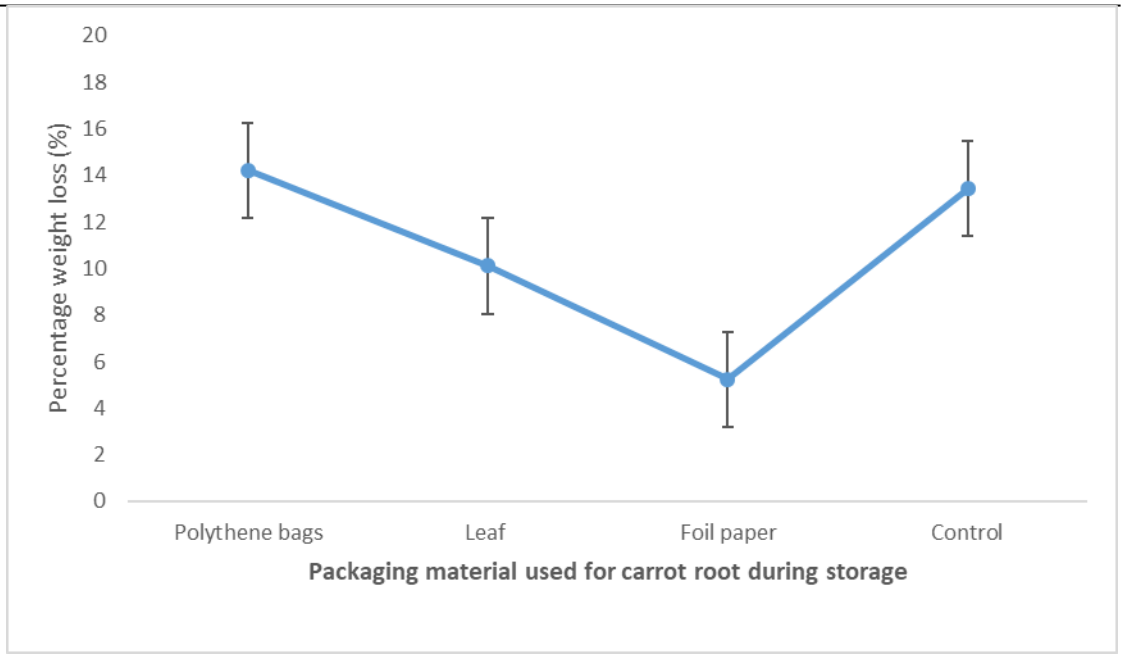

Figure 3: Percentage weight loss at 27th Day in storage of carrot root in storage using different packaging materials

A **B** **C** **D**

Plate 3: Cuts of carrot root at 27th Days After Storage showing level of decay

Plate 4: Shelf-life of carrot root wrapped in different packaging materials from Day 1 – 27)

Table 3: Sensory Evaluation of carrot root at 9 days after storage

Packaging materials	Flavour	Taste	Colour	Sweetness	Mouth feel	Overall acceptability
Polythene bags	5	4	3	4	3	4
Foil paper	5	5	5	5	5	5
Leaf	5	5	5	5	5	5
Control	5	4	4	5	4	4

Key: 5= Like a lot, 4=like a little, 3= neither like nor dislike, 2= dislike a little, 1= dislike a lot

Table 4: Sensory Evaluation of carrot root at 18th days after storage

Packaging materials	Flavour	Taste	Colour	Sweetness	Mouth feel	Overall acceptability
Polythene bags	3	2	3	2	2	2
Foil paper	5	5	5	5	5	5
Leaf	5	5	4	4	4	4
Control	3	4	3	4	3	3

Key: 5= Like a lot, 4=like a little, 3= neither like nor dislike, 2= dislike a little, 1= dislike a lot

Table 5: Sensory Evaluation of carrot root at 27th days after storage

Packaging materials	Flavour	Taste	Colour	Sweetness	Mouth feel	Overall acceptability
Polythene bags	2	1	1	1	2	1
Foil paper	5	4	4	4	5	5
Leaf	4	4	4	4	4	4
Control	3	3	2	2	2	2

Key: 5= Like a lot, 4=like a little, 3= neither like nor dislike, 2= dislike a little, 1= dislike a lot

CONCLUSION

The process of deterioration begins the moment a crop is harvested. From this point through storage to marketing and consumption, a significant loss is experienced. The shelf life of a crop can either be prolonged or shortened by the type of packaging material and storage conditions. Carrot loses weight rapidly after harvest. The results of this study confirm that packaging material is a very important factor affecting the shelf-life of carrot. All three packaging materials investigated remarkably prolonged storage period of carrot roots. Carrot packaged with foil paper and *Thaumacoccus danielle* leaf had excellent and good taste, sweetness, colour, mouth-feel, flavour and acceptability from consumers. However, paper foil extended the useful life of carrot roots the most. Due diligence is needed to select carefully the best packaging material for the duration of storage needed.

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