EFFECT OF DIFFERENT STORAGE METHODS ON SHELF LIFE AND PHYSICOCHEMICAL PROPERTIES OF CASSAVA (*Manihot esculenta*) VARIETY MU51

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INTRODUCTION

Cassava (*Manihot esculanta)* belonging to the family Euphorbiaceae is known as a root crop commonly cultivated in all tropical countries including Sri Lanka, as a cash crop that can be used to process food products, including flour, starch, chips, and animal feed (Jaiyeoba *et al*, 2017). Different cassava varieties can be identified in Sri Lanka such as Kirikawadi, MU51, CARI555, Shani, Suranimala, Swarna, HordiMU51, wild accession and landrace (Dissanayake *et al.*, 2018). Among them, MU51 and Kirikawadi are the most popular varieties in Sri Lanka (Wijesinghe *et al.*, 2010).

The cassava plant can withstand adverse conditions and it endures being in soil without harvesting for prolonged periods. However, the presence of cyanogenic glucosides and rapid postharvest physiological deterioration is a major drawback of cassava (Iyer *et al*, 2010). Cassava is one of the most perishable root crops which can be stored freshly at most for a few days after harvesting. Blue black streaking, unpleasant aroma, and taste are typical symptoms of cassava deterioration (Iyer *et al*, 2010). Mechanical damage during harvesting and handling mainly affects the rapid deterioration (Rajapaksha et al, 2017). The rapid deterioration consequentially affects marketing and eating quality. Hence, post-harvest management is a very important practice to improve the quality of fresh cassava roots and reduce post-harvest losses. Development of proper technology to increase the shelf life of fresh cassava will help both local and export markets during season and off-season, and also generate foreign currency through exportation (Dissanayake *et al*, 2018).

The post-harvest losses can be reduced by using improved cultivars with a longer shelf life, application of proper agriculture practices during cultivation, proper handling during and after harvest, and use of appropriate processing techniques. Post-harvest packaging and storage techniques can enhance food quality by preventing excessive moisture loss and injuries (Daramola *et al*, 2010). Uchechukwu-Agua (2015) reported various methods that have been developed to extend the shelf life of fresh cassava root, such as storing in moist sawdust, storing in plastic bags, and some advanced methods including refrigeration, freeze drying and waxing with paraffin wax. This study was carried out to identify the best method to store fresh cassava and to increase the shelf life through better packaging. The findings will benefit in increasing the exportation and industrial uses of fresh cassava in Sri Lanka and will improve its quality to both the local and export markets.

METHODOLOGY

Raw material collection and Sample preparation

Samples of raw tuber of cassava variety MU51 were purchased from a farmer field in Doluwa, Pahingamuwa. The plants were at the same maturity stage and harvested at the age of twelve months from plantation. Collected samples were immediately transported carefully to the laboratory of the Food Research Unit, Gannoruwa, Peradeniya. At the laboratory, the samples were sorted, washed with clean water, and air dried to remove excess moisture for further analysis.

After cleaning, cassava tubers were dipped in a fungicide solution named as Billet@ solution. Billet Carbendazim 50% w/w (MBC= Methyl 2-Benzimidazolecarbamate) was used as the fungicide treatment which prevents various fungi within the stored period.

Storage Procedure

Five different storage methods were evaluated for the MU 51 cassava tubers in room temperature; including storage in cardboard boxes with moist sawdust (T1), waxing with paraffin wax (T2), wrapping with plastic wrap (T3), storing in polythene bags (T4). These treatments were compared using fresh cassava tubers in cardboard boxes that were not being treated (control) (T5).

T1- Storing in moist sawdust
Sawdust and cassava tubers were placed alternatively in the cardboard boxes. The sawdust was kept moist avoiding root decay due to dryness or wetness. Samples were monitored and water was applied when necessary.
T2- Waxing with paraffin wax
Paraffin wax was melted at 95° C and cassava tubers were dipped in melted paraffin wax for 30 seconds. After drying, the cassava was stored in cardboard boxes.
T3- Wrapping with plastic wrap
Cassava tubers were wrapped using plastic wrap (Falcons brand cling film) and then stored in cardboard boxes.
T4- Storage in polythene bags
Cassava tubers were packed in 250 gauge polythene bags and were sealed using polythene sealer.
T5- Control
Fresh cassava tubers were stored in cardboard boxes.

Sample Analysis
Determination of moisture content
The moisture content of each sample was determined by using the AOAC 2000 method. Moisture content was calculated using equation 01.

Equation 01:

$$\frac{Initial\ weight\ of\ the\ sample - Final\ weight\ of\ the\ dried\ sample}{Initial\ weight\ of\ the\ sample} * 100$$

Determination of ash content
Ash content was determined according to the method specified in AOAC, (2000). Ash content was calculated using equation 02.

Equation 02:

$$\frac{Weight\ of\ the\ ash\ contained\ crucible - Weight\ of\ the\ sample}{Weight\ of\ the\ sample} * 100$$

Determination of total soluble solids (Brix value)
Total soluble solids were measured by a digital brix meter (Model-3830PAL-3). Results were expressed in ˚Brix value.

pH value
A 5.0 g of fresh cassava was weighed into a beaker. Thereafter, juice was extracted using mortar, pestle and muslin cloth. The pH value was determined with the aid of a pH meter (Model-BP3001).

Cooking time
Cassava was peeled, sliced in to one inch thickness and then dipped in boiling water. Then time was counted in minutes until cassava slices were fully cooked.

Observation of contaminations
Rotting of tubers and appearance were identified through visual observation, hand feeling and smelling.

Statistical Analysis

The data were expressed as mean (± standard deviation) with each experiment having a minimum of three replicates of each sample. Probability of 5% or less was considered statistically significant. Statistical comparison was performed using Minitab 18.1 statistical software and the Tukey method was used for mean separation.

RESULTS AND DISCUSSION

Polythene packed cassava were softened and contaminated with microbes 6 weeks after. Fresh cassava (control) occurred to be in dry appearance within the storage period. But, roots texture, colour, odour had not changed up to 8 weeks. The samples stored in moist sawdust, waxed with paraffin wax and wrapped with plastic wrap had not changed the root texture, colour and odour up to 16 weeks.

Moisture content

The moisture content of stored cassava is presented in Table 1. There was no significant difference in moisture content over the stored period except for control. The highest moisture content was recorded in control during the whole period. Initial moisture content of fresh cassava was 59.76%.

Table 1: Moisture content of cassava stored under different packaging techniques

Storage duration	T1	T2	T3	T4	T5
2 weeks	57.60±2.36^{a}	57.95±0.70^{a}	56.34±2.04^{a}	59.16±1.38^{a}	59.27±2.77^{b}
4 weeks	60.07±2.88^{a}	58.16±0.46^{a}	59.46±2.98^{a}	58.46±0.55^{a}	58.59± 1.30^{b}
6 weeks	59.47±0.38^{a}	59.74±2.17^{a}	59.39± 0.50^{a}	58.63±2.51^{a}	60.05±1.53^{b}
8 weeks	60.75±0.63^{a}	60.15±2.87^{a}	59.36±2.39^{a}	-	77.13±0.25^{a}
11 weeks	61.79±1.87^{a}	58.13±0.51^{a}	60.12±4.19^{a}	-	-
14 weeks	62.69±2.83^{a}	60.56±3.89^{a}	61.18±2.07^{a}	-	-
16 weeks	62.06±1.29^{a}	60.56±1.29^{a}	59.26±5.52^{a}	-	-

Note: Means in the same column with same letter are not significantly different at $p>0.05$ (Mean ± SD, n = 3)

Ash content

Ash content of stored cassava in room temperature is shown in Table 2. The ash content has shown significant difference during storage period in T1, T2 and T5 treatments. Initial ash content of fresh cassava was 0.69%.

Table 2: Ash content of cassava stored under different packaging techniques

Storage duration	T1	T2	T3	T4	T5
2 weeks	0.78±0.08^{a}	0.77±0.13^{ab}	0.79±0.03^{a}	0.65±0.05^{a}	0.58±0.09^{b}
4 weeks	0.79±0.06^{a}	0.71±0.02^{ab}	0.81±0.04^{a}	0.80±0.08^{a}	0.84±0.70^{a}
6 weeks	0.63±0.05^{b}	0.70±0.06^{ab}	0.66±0.01^{a}	0.81±0.07^{a}	0.75±0.06^{ab}
8 weeks	0.77±0.03^{a}	0.77±0.09^{a}	0.79±0.06^{a}	-	0.74±0.02^{ab}
11 weeks	0.63±0.08^{b}	0.72±0.09^{ab}	0.68±0.07^{a}	-	-
14 weeks	0.77±0.05^{ab}	0.70±0.03^{ab}	0.64±0.07^{a}	-	-
16 weeks	0.72±0.03^{ab}	0.64±0.00^{b}	0.71±0.19^{a}	-	-

Note: Means in the same column with the same letter are not significantly different at $p>0.05$ (Mean ± SD, n = 3)

Total soluble solid content

The total soluble solid content during the storage period is shown in Table 3. Except in T4, other treatments did not show any significant difference in the total soluble solid content during storage. The Polythene packed samples showed significantly lower ($p<0.05$) and higher total soluble solid content 7.53±0.97 and 14.77±0.63 at 2nd week and 6th week of storage respectively. Starch can convert to soluble solids due to hydrolysis by the endogenous enzymes of the roots which influence the deterioration of roots and final quality (Rajapaksha et al, 2017). This may be the reason for showing different values during the stored period. Initial total soluble solid content was 7.2.

Table 3: Total soluble solids content of cassava stored under different packaging techniques

Storage duration	T1	T2	T3	T4	T5
2 weeks	9.37±1.21^{a}	10.83±0.08^{a}	11.58±0.36^{a}	7.53±0.97^{c}	10.65±0.61^{a}
4 weeks	10.65±0.44^{a}	11.00±0.31^{a}	10.98±0.57^{a}	10.52±0.42^{b}	11.55±0.23 ^{a}
6 weeks	10.68±0.32^{a}	11.70±0.1^{a}	11.15±1.01^{a}	14.77±0.63^{a}	11.33±0.61^{a}
8 weeks	9.48±0.19^{a}	11.23±0.58^{a}	11.82±0.41^{a}	-	11.43±0.13^{a}
11 weeks	10.20±0.60^{a}	11.30±0.56^{a}	11.53±0.38^{a}	-	-
14 weeks	9.37±0.89^{a}	11.83±0.56^{a}	12.33±0.72^{a}	-	-
16 weeks	10.03±0.59^{a}	11.67±0.35^{a}	12.37±0.67^{a}	-	-

Note: Means in the same column with same letter are not significantly different at $p>0.05$ (Mean ± SD, n = 3)

pH value

According to Table 4, the pH level of the cassava stored under different methods did not significantly change over the storage period. According to the previous findings, the pH value of cassava is 6.3 - 7.3 (Omosuli et al, 2017). The pH values of the tested samples were also in this range. Initial pH value was 6.63.

Table 4: pH value of cassava stored under different packaging techniques

Storage duration	T1	T2	T3	T4	T5
2 weeks	6.72±0.15 [a]	6.48±0.11 [a]	6.55±0.09 [a]	7.00±0.46 [a]	6.53±0.21 [a]
4 weeks	6.60±0.04 [a]	6.47±0.07 [a]	6.45±0.09 [a]	6.64±0.16 [a]	6.60±0.01 [a]
6 weeks	6.41±0.08 [a]	6.55±0.08 [a]	6.42±0.06 [a]	6.48±0.05 [a]	6.49±0.04 [a]
8 weeks	6.49±0.06 [a]	6.56±0.09 [a]	6.39±0.06 [a]	-	6.71±0.09 [a]
11 weeks	6.54±0.09 [a]	6.49±0.09 [a]	6.53±0.13 [a]	-	-
14 weeks	6.55±0.06 [a]	6.59±0.09 [a]	6.56±0.10 [a]	-	-
16 weeks	6.46±0.07 [a]	6.59±0.07 [a]	6.49±0.09 [a]		

Note: Means in the same column with same letter are not significantly different at $p>0.05$ (Mean ± SD, n = 3)

Cooking time

Cooking time of stored cassava under room temperature is shown in Table 5. The cooking time did not show any significant difference during storage period of T1, T2 and T3. However, T4 and T5 recorded the lowest ($p<0.05$) cooking times of 8.33±0.58 and 11.33±0.58 in the 6th week and 8th week respectively. Initial cooking time was 11.33 minutes.

Table 5: Cooking time of cassava stored under different packaging techniques

Storage duration	T1	T2	T3	T4	T5
2 weeks	13.67±0.58^{a}	12.00±1.00^{a}	12.67±0.58^{a}	12.67±1.16^{a}	13.67±0.58^{a}
4 weeks	13.67±0.58^{a}	11.33±0.58^{a}	12.00±0.00^{a}	12.33±1.16^{a}	13.33±0.58^{a}
6 weeks	13.67±0.58^{a}	11.00±0.00^{a}	12.33±0.58^{a}	8.33±0.58^{b}	12.33±0.58^{ab}
8 weeks	14.00±0.00^{a}	12.33±0.58^{a}	11.67±1.16^{a}	-	11.33±0.58^{b}
11 weeks	13.67±0.58^{a}	12.33±0.58^{a}	12.00±0.00^{a}	-	-
14 weeks	13.67±0.58^{a}	12.33±0.58^{a}	11.33±0.58^{a}	-	-
16 weeks	13.67±0.58^{a}	11.00±0.00^{a}	11.33±0.58^{a}		

Note: Means in the same column with same letter are not significantly different at $p>0.05$ (Mean ± SD, n = 3)

CONCLUSION

According to the results, cassava stored in moist sawdust, waxed with paraffin wax and wrapped with plastic wrap can be stored for 16 weeks without compromising the quality characteristics. This study will lead to an expansion of industrial uses and exportation of cassava through minimizing the postharvest losses using a suitable storage method.

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