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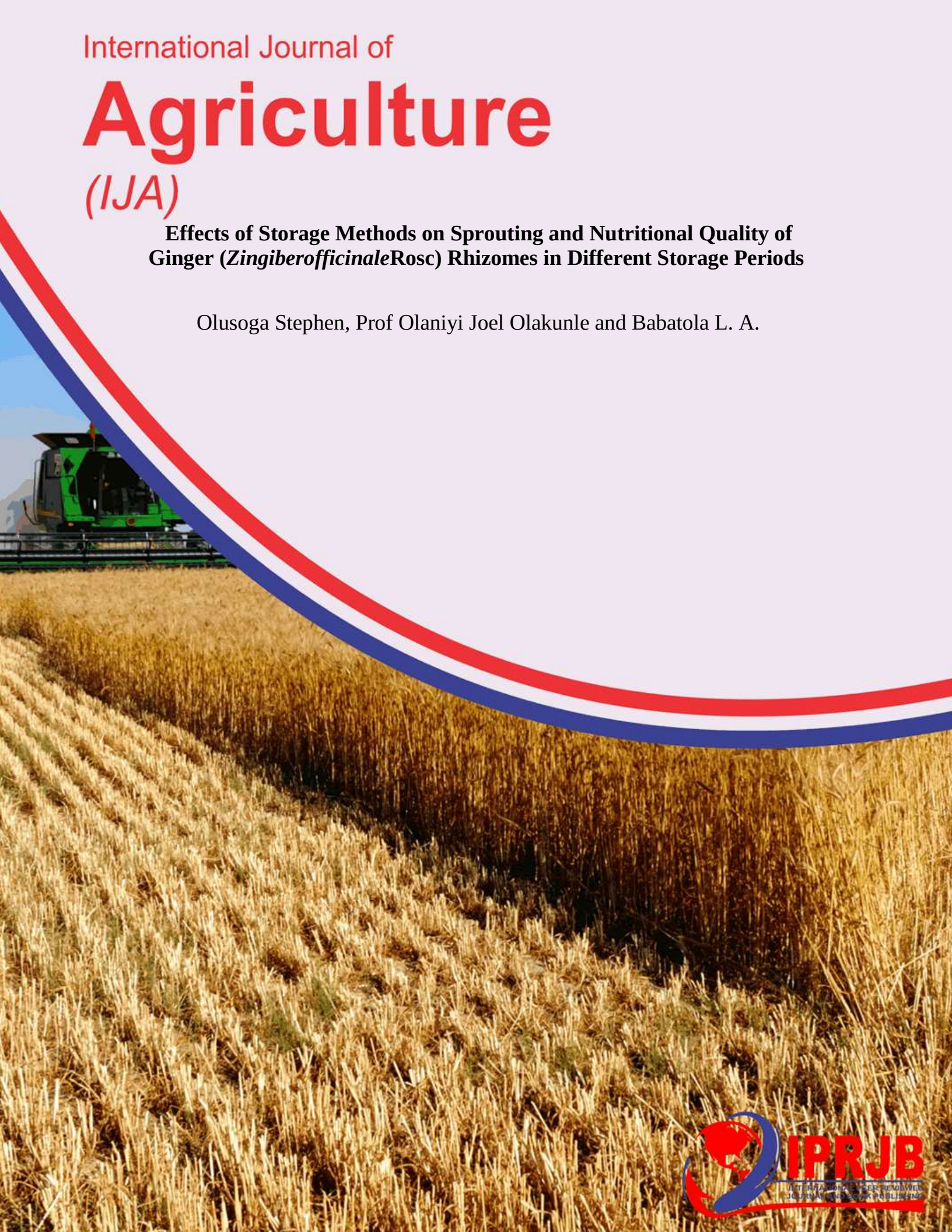

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Effects of Storage Methods on Sprouting and Nutritional Quality of Ginger (*Zingiberofficinale*Rosc) Rhizomes in Different Storage Periods

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Abstract

Purpose: Harvested ginger rhizomes are highly vulnerable to damage during postharvest storage due to soil borne pathogens or pest attack. Experiments were conducted to evaluate the effects of storage methods required for sprouting and maintaining the nutritional quality of ginger rhizomes under different storage periods in the laboratory.

Methods: The rhizomes were stored inside five different storage methods viz., refrigerator, clay pots, pit lined with sand, pit lined with sawdust and black polythene bag with twelve perforations at three different storage periods of one, two and three months. The experiment was laid out in a complete randomized design and randomized complete block design for laboratory and field experiment respectively, replicated three times. Data were collected on temperature, percentage weight loss of stored rhizomes, percentage sprouting, plant height, number of leaves, leaf area and nutritional quality of ginger rhizomes. Data were subjected to analysis of variance using Statistical Analysis System Software (SAS, 2005). Differences among treatment means were compared using Least Significance Difference (LSD) at 5% probability level.

Results: The storage methods significantly ($P \leq 0.05$) influenced the percentage sprouting, weight loss, growth parameters and nutritional quality of ginger at various storage periods. The highest growth parameters were recorded from rhizomes stored for three months while the least value was recorded from rhizomes stored for one month. Highest percentage sprouting (94.90%) was recorded from rhizomes stored inside pit-sawdust followed by polythene (85.25%) while least percentage sprouting (66.28 %) was recorded from refrigerator. Rhizomes stored inside clay pots recorded least percentage weight loss of 27.89% closely followed by pit-sawdust (28.45%) and retained the nutritional quality of ginger at various storage periods while rhizomes stored inside refrigerator recorded highest percentage weight loss of 62.78.%.

Conclusion: In conclusion, storage of rhizomes inside pit-sawdust as well as clay pots for a period of three months before planting produced better ginger growth on the field and maintain the quality of stored rhizomes.

Keywords: *Ginger Rhizomes, Pre-Storage Treatments, Storage Methods*

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INTRODUCTION

Ginger (*Zingiberofficinale* Rosc) is a world grown spice crops and traded in three basic forms which include; green, pickled and dry ginger (Archana *et al*., 2013). There are yellow ginger (Taffingiwa) and black ginger (Yaltsunbiri**)** varieties in Nigeria at present (NRCRI, 2005). Ginger is used as folk cure for many ailments such as; diabetes, migraine headache and cough. It contains minerals like calcium, nitrogen, phosphorus, potassium and magnesium (Archana *et al*., 2013). It is propagated vegetatively using rhizomes. Nearly 17 -20 percent of the produce is retained and stored for subsequent cropping season. From the time of harvesting (December to January) of rhizomes till subsequent planting season (May – June) the rhizomes are to be stored for about 3 4 month in healthy and viable conditions (ThankAmani *et al*., 2002). Harvested rhizomes are highly vulnerable to damage during postharvest storage due to soil borne pathogens or pest attack. In pit storage methods, about 25-30% ginger rhizomes due to rot were recorded useless for sowing (Karuppaiyan *et al*., 2008). Various indigenous and modern storage methods are required to minimize the possible losses and maintain ginger quality during postharvest storage. Kandiannan *et al*. (2009) reported that rhizomes stored with sawdust, sand and 100%-gauge white polythene bags gave better sprouting percentage which may be due to lesser decay and moisture losses. However, there is need to evaluate the indigenous technology of storage methods in order to obtain more viable and better performance of ginger rhizome. The aim of this study is to determine the appropriate storage method and storage period required for sprouting of ginger plant on the field and maintaining the quality of stored rhizomes.

MATERIALS AND METHODS

Laboratory and field experiments were carried out during December.2014 –May2015 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso to determine the effects of storage methods and storage periods on sprouting and nutritional quality of ginger rhizomes. Fresh, healthy and uniform sized yellow ginger variety (Ug1) was obtained from Ladoke Akintola University of Technology, Ogbomoso. and used as test crop. The rhizomes were stored inside five storage methods at three different storage periods. The storage methods include; refrigerator, polythene, clay pots, pit lined with sand and Pit lined with sawdust while the storage periods are one month, two months and three months. The experiment was laid out in a complete randomized design and randomized complete block design for laboratory and field experiment respectively, replicated three times. The different storage methods were evaluated to determine their ability to maintain quality, reduced microbial growth and prevent rot of ginger rhizomes during storage.

Land was cleared using cutlasses and tilled thoroughly with hoe to bring the soil to fine tilt. Fifteen beds were prepared on the field, each size of 1.2 m x 1.2 m with an inter-space of 0.5 m between beds. Harvested ginger rhizomes were stored in each of the storage method and samples of ginger rhizomes were taken from each storage method at one month interval of storage and planted on raised bed. Cultural practices such as mulching, watering and weeding were carried out for proper crop establishment. Data were collected on percentage rhizome weight loss, temperature in the various storage methods, sprouting date and number of sprouted plants per bed from each treatment combinations at one week interval. Early growth of ginger plant was determined by assessing the

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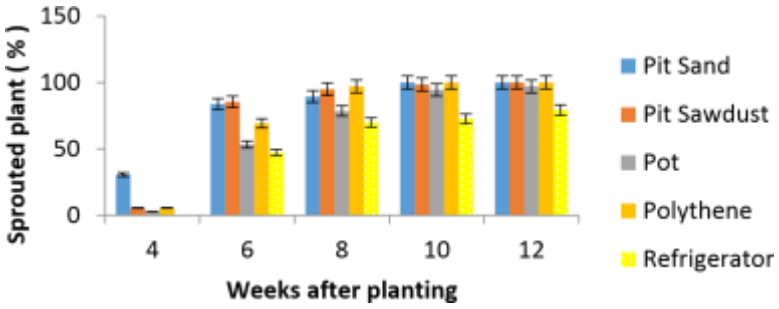
plant height, number of leaves and leaf area (using length x breadth x 0.6475). The percentage sprouting was calculated by the number of sprouted rhizomes divided by total number of rhizomes planted on each bed and multiplied with 100.PercentageCa, Fe, Crude protein, Crude Fibre, moisture, fat and ash contents were determined using the official method of analysis described by the Association of Official Chemist (AOAC,1990). Data collected were analyzed using Standard Analysis System (SAS, 2005) for analysis of variance (ANOVA). Difference among treatments means were computed using least significance differences (LSD) at 0.05 probability level.

RESULTS AND DISCUSSION

The storage method significantly (P≤0.05) influenced the percentage sprouting of ginger at various storage periods as shown in Figure 1. Highest percentage sprouting was recorded from ginger rhizomes stored for one month while the least growth was obtained from rhizomes stored for three month irrespective of the storage methods. At one month storage period rhizomes stored inside pit-sawdust (100%) gave highest percentage sprouting closely followed by clay pots (97.00%) while rhizomes stored inside refrigerator recorded the least value of 79.25 % at 12WAP.At two months' storage period rhizomes stored inside pit-sawdust (94.33%) gave highest percentage sprouting closely followed by polythene (97.00 %) while rhizomes stored inside refrigerator recorded the least value of 66.83 % at 12 WAP. At three months storage period rhizomes stored inside pit-sawdust (90.50%) gave highest percentage sprouting followed by polythene (72.5 %) while rhizomes stored inside refrigerator recorded the least value of 52.75 % at 12 WAP. This was in line with Thankamani *et al*. (2002) on turmeric that pit-sawdust gave highest percentage sprouting due to reduced rhizome rot and low temperature environment provided during storage.

One month



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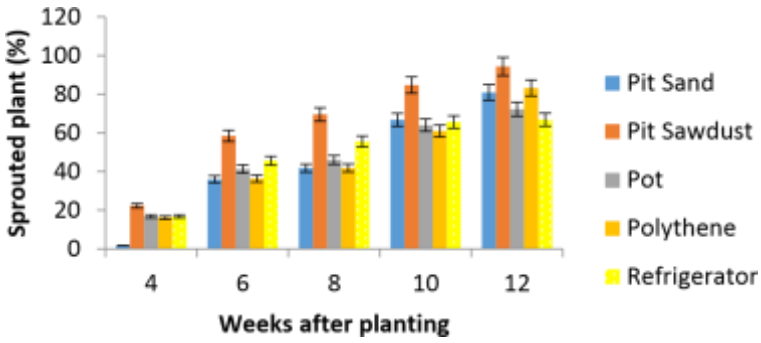

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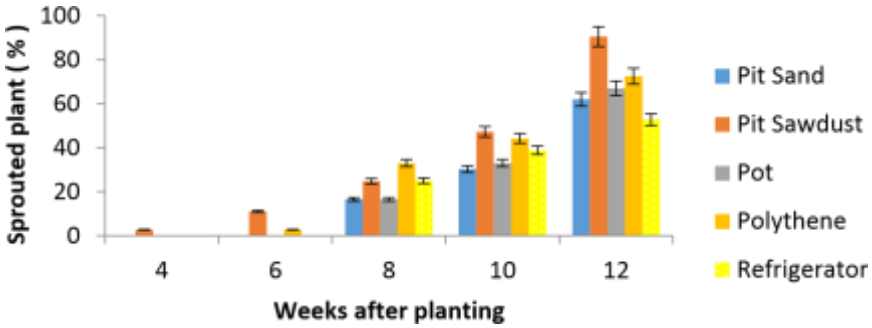

Figure 1: Effects of storage methods on the percentage sprouting of ginger rhizomes at different storage periods

The storage method significantly (P≤0.05) increased the height of ginger plant at various storage periods (Table 1). The highest height of ginger plant was recorded from ginger stored for three months while the least plant height was obtained from rhizomes stored for one month irrespective of the storage methods. At one month after storage the highest height (8.84cm) of ginger plant was recorded from rhizomes stored inside Pit-sawdust at 12 WAP. At two months after storage the highest height (9.96cm) of ginger plant was recorded from rhizomes stored inside clay pots at 12 WAP. At three months after storage, rhizomes stored inside clay pots gave the highest plant height of 9.74cm closely followed by rhizomes inside pit-sawdust (8.96cm) while rhizomes inside refrigerator recorded the least value (5.53cm) at 12WAP. This was in accordance with Shadap *et al*., (2014) who reported that rhizomes stored under healthy condition for 90 days prior to subsequent planting season prevent rhizomes rot and improved viability of ginger rhizomes. The storage methods significantly (P≤0.05) increased the number of leaves of ginger plant at various

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storage periods (Table 2). At one month after storage the highest number of leaves (9) of ginger plant was recorded from rhizomes stored inside Pit-sawdust at 12 WAP. At two months after storage highest number of leaves (12.24) of ginger plant were recorded from rhizomes stored inside Pit-sawdust at 12 WAP. At three months after storage rhizomes stored inside Pit-sand gave the highest number of leaves of (11.75) closely followed by rhizomes inside pit-sawdust (10.75) while the rhizomes inside refrigerator recorded the least value of (7.25) at 12 WAP. The storage method significantly ($P \leq 0.05$) increased the leaf area of ginger plants at various storage periods as shown in Table 3. At one and two months after storage the highest leaf area of ginger plant (49.44cm^2 and 60.56cm^2) were recorded from rhizomes stored inside Pit-sawdust at 12 WAP. At three months after storage, rhizomes stored inside Pit-sawdust gave the highest leaf area of (60.56cm^2) closely followed by rhizomes inside polythene (53.33cm^2) while the rhizomes inside refrigerator recorded the least value of 42.88cm^2 at 12WAP.The growth character of ginger plant was highest in the rhizomes stored inside pit-sawdust which may be due to the favorable effects of the storage method in minimizing moisture loss and controlling the temperature of the storage environment.(Thankamani *et al*.,2002)

Table 1: Effects of storage methods on plant height(cm)of ginger at different storage periods

	STORAGE PERIODS					
	ONE MONTH		TWO MONTHS		THREE MONTHS	
	WEEKS AFTER PLANTING					
Storage Methods	10	12	10	12	10	12
Pit Sand	8.5	9.35	4.38	7.56	6.09	7.25
Pit Sawdust	8.74	11.16	3.29	9.21	6.98	8.96
Clay pot	6.2	8.84	6.75	9.96	8.64	9.74
Polythene	6.34	7.59	3.78	7.43	6.48	7.94
Refrigerator	2.76	5.41	3.24	5.31	4.13	5.53
LSD(0.05)	0.59	0.21	0.56	0.36	0.5	0.57

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Table 2: Effects of storage methods on the number of leaves of ginger plant at different storage periods

	STORAGE PERIODS					
	ONE MONTH		TWO MONTHS		THREE MONTHS	
	WEEKS AFTER PLANTING					
Storage Method						
Pit Sand	4.88	7.54	6.50	9.00	10.25	11.75
Pit Sawdust	6.00	9.00	8.38	12.24	9.70	10.75
Clay pot	4.50	8.25	7.67	9.54	9.55	9.64
Polythene	3.63	6.50	6.92	10.88	8.25	9.00
Refrigerator	2.93	4.05	2.38	4.63	6.10	7.25
LSD(0.005)	0.51	0.59	0.57	0.62	0.53	0.57

Table 3: Effects of storage methods on the leaf area(cm^2) of ginger at different storage periods

	STORAGE PERIODS					
	ONE MONTH		TWO MONTHS		THREE MONTHS	
	WEEKS AFTER PLANTING					
Storage methods						
Pit Sand	21.32	36.69	28.57	47.37	33.52	47.37
Pit Sawdust	44.68	49.44	28.46	60.56	49.9	60.56
Pot	29.54	38.55	28.43	49.61	49.61	49.89
Polythene	35.07	38.42	28.55	53.33	36.44	53.33
Refrigerator	19.27	21.98	28.53	35.50	35.51	42.88
LSD (0.05)	0.71	1.12	0.17	0.79	1.69	0.09

The storage methods significantly ($P \leq 0.05$) influenced the percentage weight loss of ginger rhizomes at different storage periods as shown in Figure 2. The highest percentage weight loss was

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recorded from ginger rhizomes stored for three months while the least percentage weight loss was obtained from rhizomes stored for one month irrespective of the storage methods. At one month storage period, the least percentage (11.91 %) weight loss was recorded from rhizomes stored inside pots followed by rhizomes stored inside pit-sawdust (12.25%) while highest percentage weight loss was obtained from rhizomes stored inside the refrigerator (21.2%). At two months storage periods least percentage weight loss (15.26 %) was recorded from rhizomes stored inside clay pots followed by rhizomes stored inside pit-sawdust (12.25%) while highest percentage weight loss (16.13%) was obtained from rhizomes inside the refrigerator. At three months of storage periods least percentage weight loss (27.89 %) was recorded from rhizomes stored inside clay- pots followed by rhizomes stored inside pit-sawdust (28.35%) while percentage weight loss (62.78%) was obtained from rhizomes inside the refrigerator. This was in line with Bahri and Rashidi (2009) who reported that water loss significantly increased with increased in storage period. The storage methods retained the nutritional of ginger rhizomes at different storage periods as shown in Figure 3. This support the work of Thankamani *et al*. (2002) on turmeric, that quality of stored rhizomes is retained due to low temperature provided by the storage environment.

.LSD 5 %

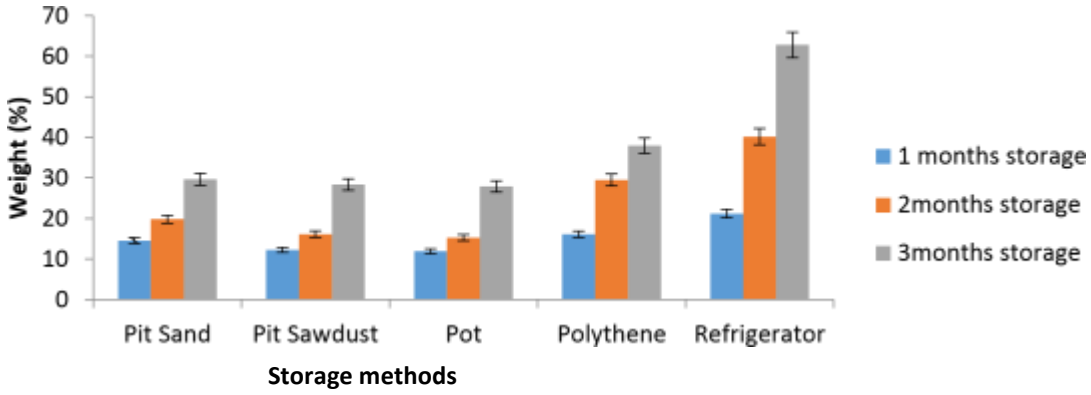

Figure 2: Effects of storage methods on the percentage weight loss of ginger rhizomes at different storage periods

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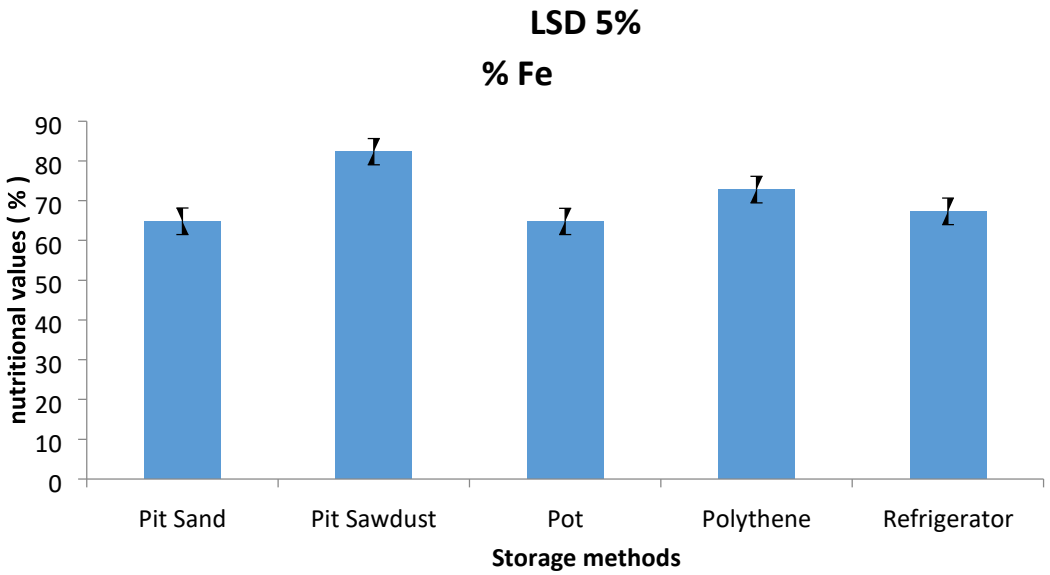
One month



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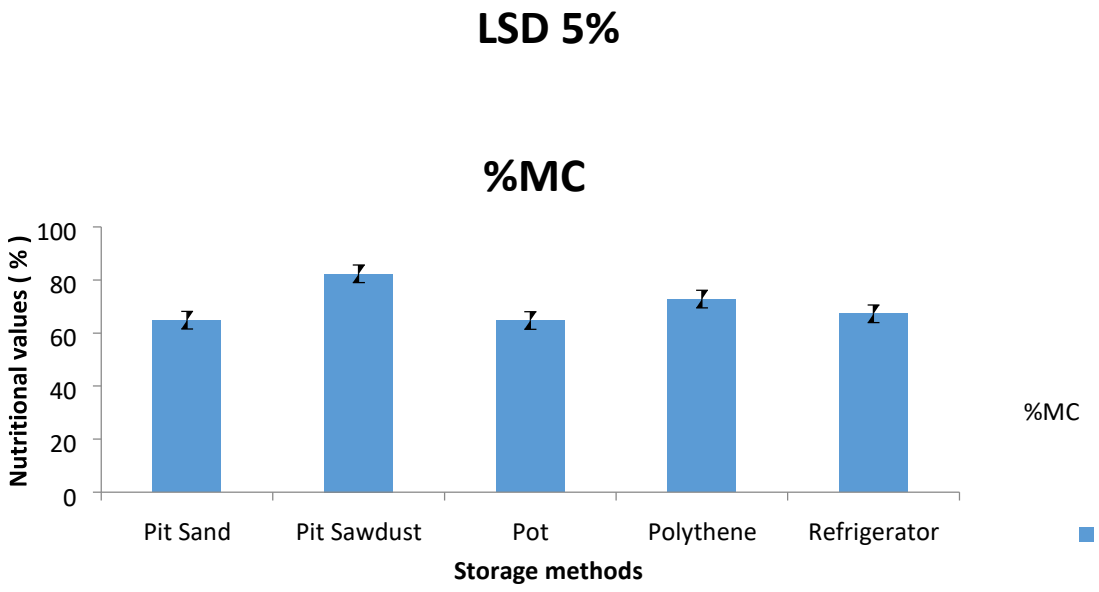

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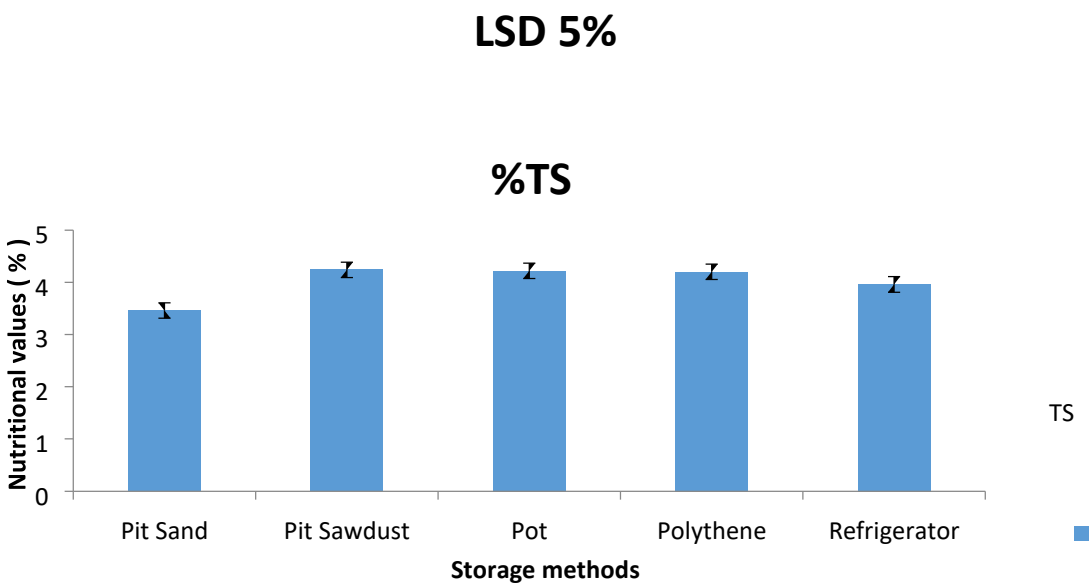

Figure 3: Effects of storage methods on the nutritional quality of ginger rhizomes at different storage periods

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