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Effect of Ash and Sawdust of Shear Butter) (*Vitellaria paradoxa*) Storage Treatments on The Tuber Nutrient of Some Sweet Potato [*Ipomoea batatas* (L.) Lam.] Cultivars

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Abstract

Qualitative and quantitative postharvest losses of Sweet potato tubers occur due to pest, mechanical, physiological and lack of appropriate storage system of the crop. The objective of this study is to seek for a safe and cheap storage method which can preserve the tubers and retain much of the nutrients. Tubers of five sweet potato cultivars were stored in pits treated with ash and sawdust of Shea butter(Vitellaria paradoxa) for one hundred and fifty days (150) at the National Root Crop Research Institute (NRCRI), Kuru-Vom (latitude 09^{o} 44'N and longitude 08^{o} 47'E), Plateau State, Nigeria. Trease & Evans (1999) methods of phytochemical screening were adopted for the plant materials. Proximate food analysis method by Association of Official Analytical Chemist (AOAC, 2000) was adopted. Data collected were subjected to analysis of variance (ANOVA) test using Genstat software version 14(2000) and the means were separated using new Duncan Multiple Range Test. Phytochemical screening of the plant materials showed presence of Alkaloids, Resins, Cardiac glycosides, Terpenes and Steroids. The tubers stored in sawdust appeared fresh almost as at harvest. Proximate food nutrients show decrease but not significant in carbohydrate and nitrogen free extract (NFE) in all the cultivars after storage**.** Ash treatment had more decrease in moisture than sawdust treatment and control. Protein decreased in the cultivars but the decrease was significant ($P<0.05$) in CIP4400168 and TIS87/0087 cultivars**.** Ex-Igbariam cultivar had significant ($P<0.05$) increase in crude fibre. Crude ash and phosphorus significantly ($P<0.05$) decreased while Lipids significantly ($P<0.05$) increased in all the cultivars respectively. Calcium significantly ($P<.005$) increased in TIS2544Rusanya1.5, TIS86/0356 and TIS87/0087 cultivars while CIP4400168 and Ex-Igbariam cultivars had significant ($P<0.05$) decrease. Tubers stored in sawdust of shea butter gave the best preservation result. The results are further discussed.

Key words: Ash, sawdust, shea butter (*Vitellaria paradoxa)*, sweet potato, cultivar, storage treatment.

Introduction

Sweet potato [*Ipomoea batatas* (L.) Lam.] production is affected by a number of factors such as Nematodes and other animal pests in the field (Mehrota & Aggarwal, 2006; Ramesh & Tomlins, 2010; CIP, 2010), physical and physiological damages (Wikipedia, 2009; CIP, 2010), primary and secondary pathogenic micro-organisms (Uzuegbu & Okoro, 1999; Kucharek & Robert, 2006; Bomford, 2009) and environmental conditions. These factors predispose the crop products to various diseases and other kinds of damages leading to qualitative and quantitative tuber postharvest losses incurred by especially the local producers of the crop. ITRA (2006) observed that the right storage system remains a major obstacle to the production of sweet potato in many African countries.

A safe storage of food for home use should determine the best methods that can reduce the threat of food poisoning and risk of contamination by pathogenic microorganisms (Wikipedia, 2011). Bekele *et al*.(1996) warned of the toxicity and ecological safety for the use of insecticides in storage of food products. Alternative local storage methods such as the use of plant materials that are environmentally friendly have been found to be effective in food storage and preservation. Enobakhare & Azeez (2006) reported the use of Neem (*Azadirachta indica*) and Tobacco (*Nicotiana tobacum)* plant parts in controlling Bruchid (*Callosobruchus maculatus)* on cowpea (*Vigna unguiculata*) seeds in storage. However, UNIFEM (1988) warned that the selection of plant materials for use in the storage/preservation should be done with care. Some resinous woods, for example Pines, may impact unpleasant flavour and taste on the final product being stored.

Plant materials are known to have phytochemicals (biochemicals) that have physiological activities on cells or tissues of living things due to their protective and disease preventive abilities (Tiger, 1998; Tena *et al*., 2001; Adamu *et al.,* 2007). The phytochemicals inhibit enzyme and other biochemical activities of organisms through reaction with their hydroxyl groups. They form complexes with the organism's cells and soluble proteins leading to adverse physiological reactions in the organism (Kubmarawa *et al*., 2005; Adamu *et al.* 2007). Godwin & Mercer (1983) have reported that cardiac glycosides contain special sugars and glycones that have some physiological activities on organisms. Terpenes and steroids produce free radicals which react with parasites' proteins and nucleic acids thereby resulting in the death of the parasites (Tiger, 1998 and Moerman, 1998). Furthermore, Okeke & Elekwa (2006) and Adamu *et al*. (2007) have reported that alkaloids have toxic effects and are important in physiological activities of organisms. The above reports on the therapeautic activities of phytochemicals have revealed their importance in storage process and preservation of food crops.

A storage method which ensures that stored foods retain much of their nutrient quality after a reasonably long storage period, has remained the focal point in researches aimed at curbing food losses (Dandayo, 2010). Similarly, Umar (2007) and Adebayo (2010) stated that good storage techniques that will make crop products last longer and warrant the stability of food supply over time is important in reducing losses of perishable crops. It is in the light of the above that this study seeks for an effective local storage method that can be used in preserving sweet potato tuber surpluses during the time of harvest and makes it readily available at any time after period of harvest with much of the food nutrients retained.

Materials and Methods

The vines of five sweet potato cultivars namely: TIS2544Rusanya1.5, CIP4400168, Ex-Igbariam, TIS86/0356 and TIS87/0087 were collected from Plateau Agricultural Development Project (PADP) experimental garden at Vom in Jos South Local Government Area of Plateau state, Nigeria . The cultivars were certified by the National Root Crops Research Institute (NRCRI) Umudike in Abia State, Nigeria. The sweet potato were cultivated for their tubers required for the storage trial at the Irish Potato Programme of the National Root Crop Research Institute (NRCRI), Kuru-Vom station (latitude 09^o 44'N and longitude 08^o 47'E, 1,239.2 metre above sea level, mean annual rainfall ranges from 122mm to 149mm) in Jos South Local Government Area of Plateau State, Nigeria.

A piece of land measuring 15 metres by 5 metres was used for the pit storage trials of the tubers. Three pits with two replicates were dug for storage of the tubers of each cultivar, which is six (6) storage pits per cultivar. The total number of pits used for the storage of the five cultivars was thirty (30). Thirty (30) tubers of each cultivar were stored in each pit of three sets per cultivar with two replications, giving a total of one hundred and eighty (180) tubers of each cultivar. The total tubers for the five cultivars stored in the pits were nine hundred (900) tubers. The storage pits were treated with wood ash and sawdust of Shea butter (*Vitellaria paradoxa*) before storing the tubers in them while the control pit had no treatment. Phytochemical screening of the ash and sawdust of Shea butter tree (*Vitellaria paradoxa*) was carried out by adopting the methods of Trease & Evans (1999).

Proximate analysis of the tuber's food nutrients were carried out in triplicates for each cultivar at harvest period, and later after storage of the tubers in pits treated with ash and sawdust of the Shea butter (*Vitellaria paradoxa)* for one hundred and fifty days (150DAS) respectively. The methods of proximate analysis of foods by Association of Official Analytical Chemist (AOAC, 2000) were adopted for the analysis of the sweet potato tuber nutrients in this study. Data collected were subjected to analysis of variance (ANOVA) test using Genstat software version 14(2000). The new Duncan Multiple Range Test was adopted in separating the means of the nutrients from the ANOVA test.

Results and Discussions

Phytochemical screening of the ash and sawdust of Shea butter (*Vitellaria paradoxa*) used in the treatment of the pits show presence of Alkaloids, Cardiac glycosides, Terpenes and Steroids, and Resins (Table 1). The proximate food nutrients show decrease but not significant in carbohydrate and nitrogen free extract (NFE) in all the cultivars at one hundred and fifty days after storage (150DAS). There was no significant difference in the decrease between the treatments and also the control (Tables 2-6). There was decrease in moisture content in all the cultivars at 150DAS (Tables 2-6) but CIP4400168, Ex-Igbariam, and TIS86/0356 had significant ($P<0.05$) decrease (Tables 3, 4 and 5). Ash treatment had more decrease in moisture content than in sawdust and control in the same cultivars. Protein decreased in all the cultivars but the decrease was significant ($P<0.05$) in CIP4400168 and TIS87/0087 (Tables 3 and 6). The decrease was less in sawdust treatment than in ash. The crude fibre decreased in TIS2544Rusanya1.5, CIP4400168 and TIS87/0087 but further decreased significantly ($P<0.05$) in TIS86/0356. However, Ex-Igbariam had significant ($P<0.05$) increase in crude fibre at 150DAS (Tables 2-6). Lipid had a significant ($P<0.05$) increase but crude ash and phosphorus significantly ($P<0.05$) decreased in all the cultivars respectively at 150DAS (Tables 2-6). Calcium had significant ($P<0.05$) increase in cultivars TIS2544Rusanya1.5, TIS86/0356 and TIS87/0087 while CIP4400168 and Ex-Igbariam significantly ($P<0.05$) decreased. Ash treatment had more calcium but not significantly than sawdust treatments in the cultivars that had increase at 150DAS.

Tuber as a living organ is capable of undergoing biochemical syntheses while in storage leading to possible increase or decrease in some nutrients as was observed in the five cultivars of sweet potato in this study. Increase or decrease in the content of plant materials and their nutrient values is also attributed to the activities of the microorganisms and storage environment (Mehrotra & Aggarwal, 2006, Ugoh & Akueshi, 2008).

Storage conditions (temperature, moisture, light, environment, cultivar, plant age/maturity, geographic or climatic effects and agricultural practices/handling process) can affect plant nutrients positively or negatively during storage (Idah *et al*., 2010; Lawal, 2012). For example, freezing (temperature) can cause breakage of cell membranes leading to discharge of cell content including mineral elements. Freezing can also alter plant pigment leading to alteration in the nutrient synthesis by the plant. Johnson (1988) reported that some nutrients decrease or increase with increase in age of plant materials. The decrease or increase observed in the food proximate nutrients of the tubers of the five cultivars of the sweet potato after storage for 150days in this study is therefore; in line with the above reports.

Furthermore, Lawal (2012) reported decrease in nutrient contents of melon seeds(*Citrullus lanatus)* with increase time of storage. Similarly, Musa and Ogbadoyi(2014) reported reduction in the nutrient, anti-nutrient and toxic content level in bitter leaf (*Vernonia amygdalina*) after two weeks of cold storage condition in freezer at -4^{o}C. Onifade *et* **al.(2003) reported significant decrease in potassium(K), magnesium(Mg) and calcium(Ca), but an increase in zinc(Zn), iron(Fe) and sodium(Na) mineral elements in sweet potato after storage.** Suraji *et al*.(2013) reported low level of calcium in five orange fleshed cultivars of sweet potato. Idah *et al*.(2010) reported decrease in the nutrients of tomato and orange after periods of storage. However, Idah *et al*.(2010) were quick to note that storage that prevents light can keep the nutrients intact. They further reported that some nutrients such as protein, carbohydrates, etc have polar or charge side chains, these chains can react with other molecules in different ways leading to increase or decrease in some of the nutrients.

It has also been reported that environment, location, climatic conditions, cultivar, etc could affect the distribution of nutrients, polyphenolic and antioxidants in sweet potato (Choong *et al*., 2007; Hamouz *et al*., 2011). Similarly, Eleazu & Ironua (2013) opined that environment and climatic conditions could affect the distribution of the food parameters (nutrients) in sweet potato. However, Bosede & Musa (2010) reported an increase of between 13.54% to 46.39% in the dietary fibre of peanut butter after storage period of three months. In the same vane, Fagbohun & Lawal(2011) reported increase in ash and crude protein content in sundried soybean stored for twenty weeks. The reported decrease or increase in some of the nutrients depending on the age of the plant materials is a confirmation of what was observed in this study.

Conclusion

The storage of sweet potato tubers in sawdust of shea butter (*Vitellaria sparadoxa*) gave the best results in term of preserving the shelf life of the tubers. The presence of some of the phytochemicals analysed from the ash and sawdust of shea butter (*Vitellaria paradoxa*) is suggestive of their therapeutic activities in determining the health status of the tubers after the storage period in this study. The increase in lipid content in all the cultivars between at harvest period and after storage is important information about sweet potato lipid. Cultivars TIS2544Rusanya1.5 and Ex-Igbariam had significant ($P<0.05$) increase in Calcium and crude fibre which are required in man's diet. The control had consistent more decrease in the nutrients than in the treatments. The decrease in the nutrients which was less in the treatments as compared to the control after storage is a contribution to knowledge as to the desirability for a storage method that can preserve and retain much of the food nutrients of the tubers after a relatively long storage period. The use of ash and sawdust of Shea butter *(Vitellaria paradoxa)* plant materials is recommended as a possible local storage method in preserving sweet potato tubers.

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Table 1: Phytochemical Determination of Ash and Sawdust

Phytochemicals	Sawdust	Ash
Alkaloids	+	+
Flavonoids	-	-
Tannins	-	-
Saponins	-	-
Balsam	-	-
Cardiac glycosides	+	+
Terpenes and Steriods	+	+
Resins	+	+
Phenols	-	-

Key:
+ = Present or detected
- = absent or not detected

Table 2. Effect of Storage Treatments on the Nutritional Contents of TIS2544 Rusanya 1.5 Cultivar of Sweet Potato

Storage treatment	Carbohydrate (kcal.)	Moisture (g)	Crude protein (g)	Crude fibre (g)	Lipids (g)	Total ash (g)	NFE (mg)	Calcium (mg)	Phosphorus (mg)
Harvest	382.00 ^{a}*	5.25 ^{a*}	3.39^{a*}	2.05 ^{a*}	1.00^{b}	3.70 ^{a}	89.60^{a*}	0.45^{b}	0.96^{a}
Ash	339.82 ^{a}	5.16^{a}	3.28^{a}	1.90^{a}	2.45a *	2.11^{b*}	72.85^{a}	0.75^{a*}	0.10^{b*}
Sawdust	341.73 ^{a}	5.14^{a}	3.76^{a}	1.68^{a}	2.32^{a}	2.18^{b}	72.67^{a}	0.82^{a}	0.08^{b}
Control	332.58	5.12	3.17^{a}	2.04^{a}	2.44^{a}	2.07^{b}	72.81^{a}	0.77^{a}	0.09^{b}
S E ±	55.41	1.76	0.89	0.47	0.62	0.97	16.21	0.21	0.06

* Means followed by the same letter(s) do not differ significantly at 5% level probability (Duncan's new Multiple Range Test = DMRT).

Table 3: Effect of Storage Treatments on the Nutritional Contents of CIP4400168 Cultivar of Sweet Potato.

Storage Treatment	Carbohydrate (kcal.)	Moisture (g)	Crude Protein (g)	Crude Fibre (g)	Lipids (g)	Total Ash (g)	NFE (mg)	Calcium (mg)	Phosphorus (mg)
Harvest	388.00 ^{a*}	5.70^{a}	3.54^{a}	2.70 ^{a*}	1.71^{b}	3.33^{a}	90.65 ^{a*}	0.42^{a}	0.14^{a}
Ash	374.68 ^{a}	4.23^{d}	2.53^{b*}	2.55 ^{a}	2.92^{a*}	1.43^{b*}	83.57 ^{a}	0.21^{b*}	0.10^{b}
Sawdust	374.53 ^{a}	5.32^{bc}	2.49^{b}	2.60 ^{a}	2.89^{a}	1.38^{b}	84.12 ^{a}	0.19^{b}	0.12^{ab}
Control	366.70 ^{a}	5.58^{ab}	2.25^{b}	1.33 ^{a}	2.83^{a}	1.29^{b}	79.94 ^{a}	0.20^{b}	0.11^{b}
S E ±	51.23	1.32	0.61	0.39	0.45	0.64	17.1	0.07	0.02

* Means followed by the same letter(s) do not differ significantly at 5% level of probability (Duncan's new Multiple Range Test =DMRT)

Table 4: Effect of Storage Treatments on the Nutritional Contents of Ex- Igbariam cultivar of Sweet potato

Storage Treatment	Carbohydrate (kcal.)	Moisture (g)	Crude Protein (g)	Crude fibre (g)	Lipids (g)	Total Ash (g)	NFE (mg)	Calcium (mg)	Phosphorus (mg)
Harvest	361.00^{a*}	7.78^{a}	3.29 ^{a*}	5.83^{b}	1.44^{b}	5.69^{a}	83.75 ^{a*}	0.44^{a}	0.15^{a}
Ash	364.88 ^{a}	5.13^{b*}	2.59 ^{a}	10.59^{a*}	2.68^{a*}	1.54^{b*}	82.44 ^{a}	0.27^{b*}	0.10^{b*}
Sawdust	359.72 ^{a}	5.59^{b}	2.87 ^{a}	10.23^{a}	2.73^{a}	1.67^{b}	84.31 ^{a}	0.25^{b}	0.11^{b}
Control	363.94 ^{a}	5.20^{b}	2.73 ^{a}	10.53^{a}	2.63^{a}	1.57^{b}	83.76 ^{a}	0.26^{b}	0.10^{b}
SE±	49.21	1.60	1.04	2.56	0.34	0.87	17.80	0.09	0.02

* Means followed by the same letter(s) do not differ significantly at 5% level of probability (Duncan's new Multiple Range Test =DMRT)

Table 5: Effect of Storage Treatments on the Nutritional Contents of TIS86/0356 cultivar of Sweet potato.

Storage Treatment	Carbohydrate (kcal.)	Moisture (g)	Crude Protein (g)	Crude fibre (g)	Lipids (g)	Total Ash (g)	NFE (mg)	Calcium (mg)	Phosphorus (mg)
Harvest	369.00 ^{a*}	5.96^{a}	3.15 ^{a*}	5.68^{a}	1.10^{b}	5.80^{a}	84.25 ^{a*}	0.38^{b}	0.18^{a}
Ash	359.81 ^{a}	5.20^{b*}	3.34 ^{a}	4.23^{b*}	2.93^{a*}	1.48^{b}	79.02 ^{a}	0.64^{a*}	0.11^{b*}
Sawdust	358.43 ^{a}	5.53^{ab}	2.97 ^{a}	4.14^{b}	2.96^{a}	1.47^{b}	79.12 ^{a}	0.66^{a}	0.09^{b}
Control	358.61 ^{a}	5.25^{ab}	3.31 ^{a}	4.32^{b}	2.91^{a}	1.46^{b}	78.93 ^{a}	0.63^{a}	0.10^{b}
SE±	52.76	0.75	0.74	1.12	0.33	0.57	16.87	0.25	0.05

* Means followed by the same letter(s) do not differ significantly at 5% level of probability (Duncan's new Multiple Range Test = DMRT)

Table 6: Effect of Storage Treatments on the Nutritional Contents of TIS87/0087 cultivar of Sweet potato.

Storage Treatment	Carbohydrate (kcal.)	Moisture (g)	Crude Protein (g)	Crude Fibre (g)	Lipids (g)	Lipids ash (g)	NFE (mg)	Calcium (mg)	Phosphorus (mg)
Harvest	352.50 ^{a*}	6.84 ^{a*}	3.85^{a}	5.65 ^{a*}	0.50^{b}	6.85a	83.15 ^{a*}	0.51^{b}	0.19^{a*}
Ash	341.49 ^{a}	6.41 ^{a}	2.97^{b*}	5.60 ^{a}	2.73^{a*}	2.29^{b*}	76.26 ^{a}	0.64^{a*}	0.11^{b}
Sawdust	342.43 ^{a}	6.43 ^{a}	3.25^{ab}	5.26 ^{a}	2.75^{a}	2.13^{b}	75.82 ^{a}	0.58^{a}	0.14^{a}
Control	342.11 ^{a}	6.40 ^{a}	3.03^{b}	5.40 ^{a}	2.72^{a}	2.22^{b}	75.87 ^{a}	0.63^{a}	0.11^{b}
SE±	52.12	1.54	0.45	0.41	0.28	0.89	15.74	0.08	0.07

* Means followed by the same letter(s) do not differ significantly at 5% level of probability (Duncan's new Multiple Range Test = DMRT