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PROXIMATE COMPOSITION OF THREE SWEET POTATO VARIETIES TREATED WITH PLANT LEAVE EXTRACTS OF NEEM AND MORINGA IN MAKURDI, NIGERIA

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Abstract
The experiment was conducted in 2018 and 2019 at the Food Science and Technology Laboratory of the Joseph Sarwuan Tarka University Makurdi. The purpose of the experiment was to investigate some proximate properties of three sweet potato varieties (Ipomoea batatas L) treated with plant extracts of neem and moringa. After acquiring the roots, 45 roots from each variety were selected and divided into three groups of 15 roots each. Three serial concentrations (high, medium and low) extracts of both plant leaves were prepared and applied to two of the groups respectively, while the third group was reserved as control before storage. After a storage period of three months, samples of moisture content, ash, fibre, protein, fat and carbohydrate were determined. Data collected were analyzed statistically to determine the effect of nutritional composition on the properties of sweet potatoes. The results shows that both plant extracts (neem and moringa) significantly influenced moisture, carbohydrate and protein content among all varieties at both storage levels. More so, the high application rate significantly gained the best effect of nutrients composition. The white flesh TIS 87/0087 maintain a better proximate contents followed by the yellow flesh TIS 86/0356 while orange flesh 440293 was more prone to nutrients loss. The treated sweet potato varieties used had no significant effects (p<0.05) on the fats, ash and crude fibre contents. Therefore, it was concluded that both neem and moringa extracts are additional sources to essential nutrients and minerals, the leaves and green fresh flowers are rich in carotene and ascorbic acid (vitamin C) with good profile of amino acids which serve as bio active nutritional factors to sweet potato especially when applied using the high application rate.

Keywords: sweet potato, plant extracts, proximate

Introduction
Sweet potato [*Ipomea batatas* (L.) Lam] is one of the main root crops that efficiently provide a significant potential for increasing food availability and creating opportunity for steady income there by alleviating poverty and properly giving Nigeria a guarantee to food security. Sweet potatoes are consumed without much processing in most parts of the tropics. Sweet potatoes present diverse industrial uses, some of which are potentially highly profitable, such as sweet potato snacks. (Adewumi, *et al.,* 2008).

Its botanical origin is believed to be from Central America, but the crop's cultivation is now worldwide. Based on production figures, sweet potato is ranked as the seventh most important food crop word wide after wheat, rice, maize, potatoes, barley and cassava, whereas in developing countries, sweet potato is ranked as the fifth most important food crop (Woolfe, 1992). Annual global production is estimated at 105 million metric tonnes with China producing over 80% of this total. Although production is high in China 50% of the crop is used for animal feed. In contrast, sweet potato produced in Sub- Saharan African countries is mainly used for human consumption (Rees *et al*., 2003, Padmaja, 2009)

Today, Nigeria is the largest producer of sweet potato in Africa and the second largest in the world after China. In Benue State, Nigeria, approximately 212,840 ha was subjected to sweet potato production with a mean yield of 9.80 t/ ha in 2008 (BNARDA, 2008).

Some cultivars which are orange/yellow fleshed are very rich in carotenoids and a good dietary source of β-carotene from which the human body synthesizes the vitamin A (Low and Van, 2008). It is a crop that thrives very well in both temperate and tropical climates (Woolfe, 1992).

A number of initiatives in Nigeria encourage consumption of orange-fleshed sweet potatoes, which contain beta-carotene and help fight vitamin A deficiency, which can result in blindness for pregnant women and children and even death for 250,000-500,000 children per year. (Anyaegbunam*, et al.,* 2011) In Nigeria, estimates suggest 29.5% of all children under the age of five are vitamin-A deficient. (Burri, 2011)

In parts of Eastern Nigeria tubers are sometimes sliced and sun-dried to produce chips, which are later ground into flour. In the Northern part of Nigeria, a garri-like product from sweet potato has been produced and evaluated; it is found to be in high nutritional value (Kure, *et al*., 2012). Sweet potatoes are rich source of energy, antioxidants and vitamins (especially vitamin C) as well as carotenoids (Wakjira, *et al.,* 2011).

They are also an excellent source of fibre and minerals, which are important in reducing blood cholesterol and aid digestion (Effah-Manu, *et al.,* 2013), (Chukwu, *et al*., 2012) The most common methods of cooking sweet potato before consumption include boiling (either with the peel or without the peel), roasting, frying and baking. Cooking has been reported to either be beneficial or detrimental to the nutritional content of food (Chukwu, *et al*., 2010).

In Nigeria and Benue State in particular, farmers and consumers do not patronage sweet potatoes as much as other tubers such as yam and cassava however, it is still used as stable food diet in many households and also traded in local markets in other to generate income and provides financial needs

Sweet potatoes are usually consumed either raw or cooked. The fresh tuber is boiled, roasted, baked, or fried as chips, which may be sold as snacks or salted and eaten as potato crisps in Benue State and in most parts of Nigeria.

The skin is edible and has high nutritional value. One hundred grams of fresh sweet potato leaves contain more iron, vitamin C, folates, vitamin K, and potassium but less sodium than the roots (USDA, 2011). The roots have a high level of carbohydrates for daily energy production. Sweet potatoes are appropriate for meeting the nutritional needs of malnourished children and elderly populations who need high-energy foods that are also suitable for human consumption (Abubakar *et al*., 2010).

It is on the note highly noticeable that the excessive use of chemicals is becoming more frequent in the storage of roots in Benue State and Nigeria, in regard to the quick response of chemicals to roots preservation, more attention has been centered on chemicals compare to natural plants botanicals which also serve as good source of vitamins and amino acids in addition to essential nutrients and minerals.

The aim of this study is to compare some proximate properties of different sweet potato varieties treated and stored with plant leave extracts of neem and moringa in Makurdi, Benue State Nigeria.

Materials and Method

Source of materials

Three sweet potato varieties comprising of white flesh TIS 87/0087, yellow flesh TIS

86/0356, and orange flesh 440293 for 2018 and 2019 were produced at the Teaching and Research Farm, the experiment was a 3 x 3 x 3 factorial arrangement laid out in Randomized Complete Block Design. In both 2018 and 2019 seasons, a total land area of 45 x 7 meters was cleared and divided into three equal plots of 15 x 5 meters each, 0ne meter distance was left in between plots. A big traditional hoe was used make 70 heaps in each plot, each of the three variety were allocated to a specific plot, planting was done on 17th June 2018 and 4th July 2019 respectively, 36 cm long vine cutting was planted on each heap, weeding was done on the second and fourth weeks with the use of a small hoe, NPK 15:15:15 compound fertilizer was applied by placement method at the rate of 30 kg N ha^{-1}, 30 kg Pg0ha^{-1} and 30 kg kg0ha^{-1}. Harvest was conducted on 22th November 2018 and 15th December 2019 respectively with the use of a small hoe, laboratory experiments were conducted at the Food Science and Technology Laboratory Joseph Sarwuan Tarka University Makurdi, Nigeria.

Collection and preparation of plant materials

Fresh leaves of moringa (*Moringa oleifera*) and of neem (*Azadiracta indica*) were obtained at the University Teaching and Research Farm and cleaned with the use of running tap water and soaked in 1% solution of sodium hypo chloride for 30 seconds. They were then rinsed with sterile distilled water and air dried at normal room temperature (25 – 30^{0}C) for 8 days. 500 g each of moringa and neem leaves were weighed and pounded using a mortar and pestle. The mortar and pestle were washed after pounding each type of leaf to avoid mixtures. The pounded plant materials were then grounded into fine powder using an electric blender (Zhejiang hk-8300, 2010 model). The powders were further sieved to pass through a 0.05 mm sieve and 500 g each of plant powders were obtained and immediately packed in plastic bottles and stored in a refrigerator at 4^{0}C for a period of 48 hours to minimize loss of volatile organic substances.

Serial dilutions of the crude extracts of each plant material were then prepared to give three different concentration levels of 20, 60 and 100 g/ml thus: 20 g/ml of the extract was obtained by mixing 20 g of each plant botanical with 100 ml of water using a measuring cylinder. The macerates were transferred to beakers and then allowed to stand for six hours after which they were filtered through Whatman No.1 filter paper before filter-sterilizing them by means of Millipore filters (Millipore filter corporation, Bedford, Massachusetts USA) to form extract concentrations. The same procedure was used in producing the other two concentration levels by substituting 60 g plant botanical to replace 20 g and 100 g to replace 20 g in order to obtain 60 g/ml and 100 g/ml concentrations respectively. Each of the three groups of each variety was separately applied with both plant extract concentrations (20, 60 and 100 g/ml) The application was in replicates of five roots each for each group.

Proximate composition

The proximate composition viz., estimation of moisture, protein, carbohydrate, fats and crude fibre content were carried out according to the stipulated procedures laid down for analysis (AOAC,2005).

Data collected on all the evaluations were subjected to analysis of variance using Genstat 12th edition and significant differences were separated using Least Significant Difference at 5% level of probability.

Results

Proximate analysis of sweet potato roots treated with extracts of neem leaves

Moisture content of neem treated roots

The moisture content of neem treated roots at pre-storage analysis in 2018 (Table 1 and 2) shows that sweet potato roots at low application rate differ significantly with the other rates and recorded the highest moisture. The moisture content of roots from the high and medium application rate were however, non significant.

At the post-storage analysis, sweet potato roots differ significantly from each other, higher moisture content was recorded from roots that were stored at the low application rate, it was gently followed by roots stored at the medium application rate while roots from the high application rate significantly recorded the least moisture content.

Moisture determination also revealed that at both pre storage and post storage analysis, the untreated (control) roots significantly produced the highest moisture which supersedes that of the treated varieties whereas in themselves 440293 variety recorded higher moisture followed by TIS 86/0356 while TIS 87/0087 recorded the least moisture content.

At pre-storage analysis in 2019 (Table 3 and 4), sweet potato roots differs significantly with respect to application rate. Roots from the low application rate recorded the highest moisture content which was significantly higher than that produced by medium and high application rate roots. Sweet potato from medium and high application rate gained lower moisture content. The same results was noticed at post storage evaluation, significant differences in moisture values were recorded between each application rate and another with the highest value obtained at the low application rate, followed by medium and high respectively, whereas all the application rates conversely gained moisture after storage.

Table 1: Pre-storage proximate evaluation of three varieties of sweet potato roots treated with neem extract in 2018

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	11.18	5.49	72.02	1.66	1.64	1.48
Medium	11.18	5.15	69.10	1.61	1.59	1.48
Low	12.41	4.46	70.69	1.38	1.56	1.47
LSD	0.01	0.01	0.38	0.02	0.02	0.02
Variety (V)						
TIS 86/0356	11.71	5.14	70.76	1.55	1.61	1.48
TIS 87/0087	11.74	5.15	72.33	1.68	1.63	1.51
440293	12.05	4.81	68.72	1.54	1.59	1.44
Control	13.97	3.25	54.80	1.11	1.22	1.00
LSD	0.01	0.01	0.54	0.03	0.03	0.04
A x V Int..	**	**	**	*	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Me1.79dium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

Table 2: Post-storage proximate evaluation of three varieties of sweet potato roots treated with neem extract in 2018

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	11.77	4.74	63.19	1.04	1.46	1.45
Medium	12.75	4.19	61.13	1.03	1.44	1.45
Low	13.71	3.55	58.93	1.01	1.44	1.43
LSD	0.01	0.02	0.43	0.03	0.03	0.03
Variety (V)						
TIS 86/0356	12.45	4.20	61.72	1.04	1.45	1.47
TIS 87/0087	12.72	4.28	65.91	1.04	1.45	1.45
440293	13.44	3.40	55.63	1.02	1.44	1.42
Control	15.28	2.98	45.32	1.18	1.00	1.00
LSD	0.02	0.02	1.62	0.04	0.04	0.04
A x V Int..	**	*	**	Ns	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Medium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

Table 3: Pre-storage proximate evaluation of three varieties of sweet potato roots treated with neem extract in 2019

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	10.86	5.22	74.55	1.85	1.84	1.85
Medium	11.69	4.88	74.55	1.83	1.83	1.84
Low	12.27	4.40	71.87	1.79	1.83	1.83
LSD	0.10	0.23	0.53	0.06	0.03	0.03
Variety (V)						
TIS 86/0356	10.55	4.98	73.34	1.82	1.84	1.84
TIS 87/0087	10.55	5.11	75.28	1.84	1.85	1.84
440293	11.00	4.41	73.34	1.81	1.82	1.83
Control	12.51	3.39	62.07	1.70	1.60	1.61
LSD	0.13	0.33	0.75	0.09	0.04	0.04
A x V Int..	**	Ns	*	Ns	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Me1.79dium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

Table 4: Post-storage proximate evaluation of three varieties of sweet potato roots treated with neem extract in 2019

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	11.14	4.84	65.01	1.82	1.83	1.81
Medium	12.18	4.45	63.86	1.81	1.80	1.81
Low	12.81	4.01	61.08	1.80	1.79	1.78
LSD	0.14	0.21	0.80	0.03	0.04	0.04
Variety (V)						
TIS 86/0356	11.97	4.42	66.81	1.82	1.80	1.80
TIS 87/0087	11.95	4.86	66.81	1.84	1.83	1.83
440293	12.56	4.32	60.27	1.78	1.79	1.78
Control	13.82	2.84	54.30	1.67	1.65	1.67
LSD	0.19	0.30	1.13	0.05	0.06	0.05
A x V Int..	**	*	**	Ns	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Medium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

Moisture determination at pre-storage analysis recorded 440293 with significantly higher values than both TIS 86/0356 and TIS 87/0087 which in themselves produced non-significant values. The moisture content of untreated roots (control) was significantly higher than that of all the varieties. The same results obtained at the pre-storage analysis repeated itself at post-storage analysis for moisture content.

Protein content of neem treated sweet potato roots

Table 1 and 2 in 2018 shows that, at pre storage results of sweet potato roots from the high application rate were higher and differs significantly from other rates, followed by roots of the medium application rate while roots from the low application rate differs significantly but gained the least protein. At the post storage analysis, a similar result observed at the pre storage analysis re occurred.

Proximate composition of the untreated (control) root produced the least protein which was significantly lower than the treated roots, TIS 87/0087 among the treated varieties significantly recorded the highest protein followed by Tis 86/0356 while 440293 variety significantly recorded the least protein. At the post storage analysis, there was a general loss in protein among the treated and untreated varieties. TIS 87/0087 recorded a non significant difference with TIS 86/0356 which values were significantly higher than 440293 variety whereas, the untreated (control) lost more protein than all the treated varieties and recorded the least significant effect.

In 2019 However as shown in (Table 3 and 4), whereas there were non significant differences at the pre storage analysis, at the post storage analysis, TIS 87/0087 significantly recorded the highest protein which was superior to the non significant value obtained by TIS 86/0356 and 440293 varieties. The untreated (control) roots loss more protein thereby recorded the least amount of protein.

Carbohydrate content of neem treated roots

Table 23 and 24 shows that the pre storage analysis in 2018 significantly gained superior carbohydrate content on roots from the high rate of application followed by roots stored at the low rate of application whereas roots stored at the medium rate of application significantly recorded the least carbohydrate. However, at the post storage analysis, the significant differences shows that a lots of carbohydrates were lost with more emphasis concentrating on roots stored at the low rate of application followed by roots from the medium rate whereas roots from the high rate of application had higher carbohydrate content.

There were significant differences between the treated and untreated roots, TIS 87/0087 roots recorded the highest and more superior significant difference of carbohydrate at pre storage followed by the values gained by roots of TIS 86/0356 variety whereas that of 440293 roots gained the lowest values of carbohydrate among the treated roots. The untreated (control) roots were less superior to the treated and gained the least carbohydrate. This same result was reproduced at the post storage analysis.

In 2019 at pre storage analysis, roots stored at high and medium application rate recorded a non significant value of carbohydrate which values were higher than roots stored at the low application rate (Table 3 and 4). However, at the post storage analysis, roots stored at the high application rate differ significantly and recorded the highest carbohydrate followed by the medium application rate while roots stored at the low application rate significantly recorded the least values of carbohydrate.

TIS 87/0087 gained the highest significant effect of carbohydrate at the pre storage analysis, these values differed significantly with the values gained by TIS 86/0356 and 440293 which in themselves were significantly the same but significantly higher than the untreated (control) roots. Whereas at the post storage analysis it was TIS 87/0087 and TIS 86/0356 that were significantly the same and also significantly higher than the carbohydrate loss from 440293 variety, the untreated (control) roots on the other hand recorded the least carbohydrate content.

Ash content of neem treated roots
Table 1 and 2 shows that at the pre storage analysis of 2018, the high application rate differ significantly and the roots recorded the highest ash followed by roots stored at the medium application rate while roots stored at the low application rate significantly recorded the least ash content whereas at the post storage analysis, all the three application rates were non- significant.

The ash content recorded on stored TIS 87/0087 roots were highest and differed significantly with the ash on stored roots of TIS 86/0356 and 440293 variety whose ash content were non-significant but differed significantly with the untreated (control) roots.

Ash contents of roots were non-significant at both pre storage and post storage analysis in 2019 as shown in (Table 3 and 4).

Crude fibre content of neem treated roots
Non significant differences were recorded for crude fibre content at both pre storage and post storage analysis in 2018 and 2019 (Table 1 - 4)

Fats content of neem treated roots
Fats contents of stored roots were non-significant at both pre storage and post storage analysis in 2018 and 2019 (Table 1 - 4)

Proximate analysis of sweet potato roots treated with extracts of moringa leaves

Moisture content of moringa treated roots
The proximate analysis of roots treated and stored using extracts of moringa leaves differed significantly at the pre storage analysis in 2018 (Table 5 and 6). In preserving roots moisture content, the high rate of application recorded the least moisture which significantly differs from roots stored at the other rates of application. The moisture of stored roots at the medium rate of application were lower and also differ significantly with roots stored at the low rate of application which moisture values were the highest.

The same results on moisture were obtained at the post storage analysis whereas roots from the high rate of application differs significantly and recorded the least moisture followed by roots stored at the medium rate of application while roots from the low rate of application gained more moisture and were significantly higher than all the other rates.

The untreated (control) roots on the other hand significantly differ from all the treated roots and recorded the highest moisture content. Among the treated roots, 440293 variety gained the highest moisture but differs significantly from the other treated varieties followed by TIS 87/0087 whose moisture was higher but differ significantly from the least moisture content obtained from roots of Tis 86/0356 variety. There were non- significant differences at the post storage analysis.

The same results were observed at both the pre storage and post storage analysis in 2019 (Table 7 and 8), the moisture content of roots from the low application rate were the highest and differ significantly from roots of the other application rates. The moisture content obtained from roots of the medium application rate was significantly higher than those of the high application rate whose moisture values were the least obtained.

Table 5: Pre-storage proximate evaluation of three varieties of sweet potato roots treated with moringa extract in 2018

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	10.99	5.14	69.12	1.88	1.84	1.84
Medium	11.79	4.93	67.03	1.83	1.83	1.84
Low	12.71	4.36	66.08	1.82	1.83	1.83
LSD	0.01	0.24	1.04	0.03	0.04	0.03
Variety (V)						
TIS 86/0356	12.68	4.94	67.27	1.84	1.84	1.83
TIS 87/0087	11.57	5.12	68.74	1.95	1.84	1.85
440293	13.23	4.38	65.21	1.80	1.82	1.82
Control	14.64	3.43	55.31	1.73	1.69	1.70
LSD	0.01	0.33	1.47	0.05	0.05	0.04
A x V Int..	**	**	**	*	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Me1.79dium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

Table 6: Post-storage proximate evaluation of three varieties of sweet potato roots treated with moringa extract in 2018

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	12.94	3.99	46.39	1.70	1.70	1.70
Medium	13.57	3.68	44.08	1.70	1.69	1.70
Low	14.25	3.31	37.39	1.68	1.69	1.69
LSD	0.26	0.18	0.42	0.04	0.03	0.03
Variety (V)						
TIS 86/0356	13.38	3.67	42.97	1.70	1.70	1.69
TIS 87/0087	13.34	4.25	44.35	1.71	1.71	1.72
440293	14.34	3.06	40.53	1.67	1.68	1.69
Control	15.45	2.53	33.78	1.55	1.56	1.56
LSD	0.37	0.25	0.60	0.05	0.05	0.04
A x V Int..	Ns	Ns	*	Ns	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Medium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

Table 7: Pre-storage proximate evaluation of three varieties of sweet potato roots treated with moringa extract in 2019

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	10.00	5.54	75.45	1.67	1.64	1.47
Medium	11.80	6.17	69.75	1.60	1.60	1.46
Low	12.52	4.49	60.39	1.33	1.57	1.45
LSD	0.01	0.01	1.04	0.03	0.03	0.03
Variety (V)						
TIS 86/0356	11.75	5.23	69.64	1.52	1.61	1.45
TIS 87/0087	11.35	6.06	75.18	1.55	1.62	1.49
440293	12.10	4.91	64.78	1.49	1.58	1.44
Control	13.82	3.21	54.84	1.12	1.28	1.00
LSD	0.01	0.02	0.54	0.03	0.04	0.04
A x V Int..	**	**	*	**	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Me1.79dium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

Table 8: Post-storage proximate evaluation of three varieties of sweet potato roots treated with moringa extract in 2019

	Percentage Proximate Composition					
App. Rate (A)	**Moisture content**	**Protein content**	**Carbohydrate content**	**Ash content**	**Crude fibre content**	**Fats content**
High	11.76	4.68	59.64	1.44	1.46	1.46
Medium	12.76	4.12	57.64	1.42	1.45	1.46
Low	13.75	3.49	54.72	1.41	1.45	1.45
LSD	0.01	0.01	1.12	0.02	0.03	0.03
Variety (V)						
TIS 86/0356	12.75	4.09	57.27	1.42	1.45	1.45
TIS 87/0087	12.20	4.20	61.78	1.44	1.46	1.47
440293	13.86	4.01	52.95	1.41	1.44	1.45
Control	15.31	2.95	44.85	1.00	1.00	1.00
LSD	0.02	0.02	1.57	0.04	0.04	0.04
A x V Int..	*	Ns	*	Ns	Ns	Ns

Means are values of three replicates; High = 100gm/ml, Medium = 60g/ml, Low = 20g/ml; LSD: Least Significant Difference at 5% level of probability; ns = non significant; * = Interaction was significant at P<0.05; ** = Interaction was significant at P>0.01

The moisture content of the untreated (control) roots significantly differs from the treated roots and recorded the highest moisture. TIS 87/0087 roots on the other hand differs significantly from TIS 86/0356 and 440293 but recorded the least moisture followed by roots of TIS 86/0356 while 440293 roots differs significantly but gained higher moisture among the treated roots. The same results were duplicated at the post storage analysis.

Protein content of moringa treated roots

Table 27 and 28 reveals that at the pre storage analysis, roots from the high application rate acquired more protein and recorded the highest significance difference from the others, followed by roots from the medium application rate while low application rate differs significantly and recorded the least protein. There were non-significance differences at the post storage analysis.

TIS 87/0087 among the treated roots gained the highest protein and significantly differs from all other roots, TIS 86/0356 roots followed significantly with higher protein than that of 440293 whose roots recorded the least protein among the treated roots. On the other hand, the untreated (control) roots differ significantly with the treated roots and recorded the least protein on stored roots. At post storage analysis, there were non- significance differences.

In 2019 (Table 7 and 8) protein content at pre storage analysis shows that roots from the high application rate were significantly difference from all the other rates and gained the highest amount of protein followed by the roots from the medium application rate which also differs significantly from the high and low application rate. Sweet potato roots stored at the low application rate differs significantly with the other rates but loss more protein thereby records the least protein content. The post storage analysis result reveals that there were non- significant differences.

The untreated (control) roots were significantly difference from all the treated roots and recorded the least values of protein. Among treated roots, TIS 87/0087 roots gained superior protein and differs significantly from all other roots followed by roots of TIS 86/0356 which also differs significantly from other roots while 440293 roots recorded the least protein. The results of the post storage analysis were non significance.

Carbohydrate content of moringa treated roots

Table 5 and 6 reveals at pre-storage analysis in 2018, sweet potato roots at high application rate recorded the highest carbohydrate content which was significantly higher than that produced by roots of medium and low application rate. The carbohydrate content of medium and low application rate roots were however, non significant. At post storage evaluation however, significant differences in carbohydrate values were recorded between each application rate and another with the highest value obtained at medium application rate, followed by high and low respectively, whereas all application rates conversely lost moisture carbohydrate after storage.

Carbohydrate determination at pre-storage analysis recorded TIS 87/0087 and TIS 86/0356 with non significant higher values than 440293 which in itself significantly produced the least carbohydrate values among the treated roots. The carbohydrate content of untreated roots (control) was significantly lower than that of all the varieties.

The post storage result shows that, all the roots recorded significant differences with each other. Among the treated roots, TIS 87/0087 recorded the highest values of carbohydrate followed by TIS 86/0356 while values of 440293 were lowest. The untreated (control) roots lost greater amount of carbohydrate after storage and its values were the least obtained.

In 2019 (Table 7 and 8) shows that, roots stored at pre-storage analysis differs significantly between each application rate, roots at high application rate recorded the highest carbohydrate content followed by roots at the medium application rate while roots at the low application rate recorded the least values of carbohydrate. Results at the post storage analysis were similar to that of the pre storage.

The evaluation of carbohydrate at pre storage analysis indicates that TIS 87/0087 differs significantly and recorded the highest values of carbohydrate than that of the other roots followed by TIS 86/0356 and 440293 respectively. The untreated (control) roots also differs significantly from the treated roots but recorded the least values of carbohydrate. At the post storage analysis, the sequence of the result was maintained however, all the treated and untreated roots simultaneously loss amount of carbohydrate.

Ash content of moringa treated roots

The results in (Table 5 and 6) shows that the pre storage roots at the high application rate differs significantly with the other rates, also recorded higher ash content than that of medium and low application rate which in themselves were non significant. At the post storage analysis, non significant differences were recorded on application rate.

Ash nutritional composition at the pre storage analysis recorded TIS 87/0087 with the highest ash content which was significantly different from the non significant values of TIS 86/0356 and 440293. However, the ash content of TIS 86/0356 and 440293 were significantly higher than that of the untreated (control) roots.

There were non significant differences at the post storage analysis.

As shown in (Table 7 and 8), sweet potato roots at the pre storage analysis reveals that each application rate differs significantly with another, sweet potato roots at the high application rate recorded the highest ash content followed by medium and low application rate respectively. At the post storage analysis, there were non significant differences.

The determination of ash content at pre-storage analysis recorded TIS 87/0087 and TIS 86/0356 with non significant higher values than 440293 which in itself significantly produced the least ash among the treated roots. The ash content of untreated roots (control) was significantly lower than that of all the varieties.

Crude fibre content of moringa treated roots

Crude fibre content recorded non significant differences both at the pre storage and post storage analysis in 2018 and 2019 were insignificant (Table 5- 8)

Fats content of moringa treated roots

Fats contents was non-significant at both pre storage and post storage analysis in 2018 and 2019 season (Table 5 - 8)

Discussion

Results of the proximate analysis showed that all the studied varieties provided good percentages of moisture, protein, carbohydrate, ash, crude fibre and fats contents. Protein, carbohydrate and fats contents in 2019 season recorded higher percentages than that of 2018 season.

Moisture content increases while protein and carbohydrate contents decreased as storage progresses, 440293 maintained the highest moisture content among other varieties, TIS 87/0087 gained the highest percentages of both protein and carbohydrate content at both pre and post proximate evaluation.

The superior performance of TIS 87/0087 and TIS 86/0356 in nutritional composition over 440293 could imply that TIS 87/0087 and TIS 86/0356 are more suitable and environmentally friendly for cultivation in makurdi this confirms with the result earlier reported by Egbe, (2012). The differences in the nutritional composition among the sweet potato varieties can be attributed to the difference in the genetic composition and also the agro cultural practices.

The various changes in the nutritional contents could also be attributed to findings of Ray and Ravi, (2005) who reported that careless postharvest handling of sweet potato root and tubers often leads to loss of roots quality and nutrients. The sweet potatoes roots contained ash content which even though low but falls within the range reported by Li *et al.*, (1994). There was a general decline in crude fibre and fats content relative to storage according to Ray and Ravi, (2005) respiration and transpiration contribute to weight loss and alteration of internal and external appearance of the potatoes. Fats are used as a respiratory substrate, ash content decreased during storage and subsequently the carbohydrate content also decreased.

At the pre storage proximate evaluation of neem in 2018, the low application rate shows superior significant difference in moisture content than the other rates which could not distinguished significantly in themselves whereas at the post storage proximate evaluation, low application rate maintained superiority followed by the medium application rate while the high application rates indicated the least percentage of moisture content. The values of moisture contents are found to be within the range of values obtained by Omodamiro *et al.,* (2013)

Protein and carbohydrate contents at both pre and post storage proximate evaluation indicates that the high rate of application offered superior effect to that offered by the medium while that of medium application rates also shows significant superiority. In 2019 however, the differences between each application rate and another was clearly revealed at both pre and post storage evaluation.

At the pre and post proximate evaluation of moringa in both 2018 and 2019, the low application rate surpasses the other rates in moisture content and in the same trend the medium application rate was also superior in moisture than the high application rate. Protein and carbohydrate contents were both superb at the high application rates followed by the medium application rate while the low application rate showcased the least contents

Conclusion

Based on the conditions under which the study was conducted, it could be concluded that the two plant extracts (neem and moringa) were effective and regarded as good treated materials and can be used as antioxidant for storage of sweet potato roots in Makurdi. However, neem extracts treated samples were more effective in the nutritional content than moringa treated samples.

It could also be concluded that all the serial concentrations (high medium and low) rates gave a good amount of nutritional composition of sweet potato roots in makurdi. The pre storage proximate analysis was more effective than that of the post storage proximate analysis.

Recommendation

Based on the results of the study, the following recommendations could be made:

- Plant extracts of neem and moringa are good and effective potentials and could be used to treat and stored sweet potato roots in Makurdi Benue State for a period up to three months and can maintain and preserve the nutritional content of the sweet potato roots.

Farmer's sensitization programmers should be made available for educating farmers on the importance and use of plant materials such as neem and moringa which are natural properties and can produced no harmful effect.

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