LAUCER 2(1):52-60 LAUTECH Crop and Environmental Reviews
© Department of Crop and Environmental Protection, Faculty of Agricultural Sciences, LAUTECH, Ogbomoso, Nigeria 2021

Nutritional and health benefits of sweetpotato that make it consumers' choice

Abiodun David Arowolo and Basiru Adeniyi Adegbite
Department of Agricultural Education,
Osun State College of Education Ilesa, Nigeria
*Corresponding Author's E-mail: arowolo_bdn@yahoo.com; Telephone: +234 803 041 3476

Abstract
In 2018, thirty sweet potato cultivars were collected from different parts of Osun State and evaluated at the Department of Agricultural Science, Osun State College of Education, Ilesa, Nigeria. The objectives of the study were to determine the total number of people that can be fed from sweet potato cultivars in Osun State and to highlight the nutritional and health benefits of the crop. In addition to the empirical studies, review on the health and nutritional benefits of sweet potato were undertaken. Vine multiplication was done between January and May 2018. Randomized complete block design with three replicates was used as the experimental design and the evaluation was carried out between June and November, 2018. Collection of data for the study was done at various stages of the crop and at harvesting. Fresh root yield obtained showed significant difference and it ranged from 1.86 to 19.10t/ha while dry matter was between 28.10 and 43.29%. Health benefits of sweet potato include prevention of vitamin A deficiency, managing diabetics, protection against cancer, minimizing the risk of cardiovascular diseases, boosting and promoting fertility among women and a host of others. Four of the cultivars namely Oyan, Inisa, Ijeda and Erin be can be used to feed the highest number of people.

Keywords: Nutrition, Health benefits, Sweet potato, Human consumption.

Introduction

Sweet potato (*Ipmoea batatas* (L) Lam), is a member of the Convolvulaceae family that is grown for its edible starchy roots and immature leaves, which are used for human consumption (Satheesh & Fanta. 2019), animal feed (Lebot, 2009) and to some extent for industrial purposes (Woolfe, 1992). Sweet potato ranks seventh most important food crop of the world after wheat, rice, maize, potato, barley and cassava (Abidin et al., 2015; CIP, 2017).

Sweet potato production was reported to be 112.8 million tons (in 115 countries) in 2018, and china is the leading producer, followed by Nigeria and Tanzania, Indonesia and Uganda (FAOSTAT, 2019). It is cultivated in an area of 8.62 million ha producing 105.19 million tons with a yield of 12.20 t/ha (FAO, 2016). Africa is the largest world sweet potato growing region contributing 48.56 percent of sweet potato area with production share of 21.27 percent in total world sweet potato production. Among these figures, Nigeria produces 3.92 million tons on an area of 1.55 ha (FAO, 2016).

Sweet potato is the most abundantly grown root crops in Africa. International potato center (2017) reported that sweet potato is 3rd vital food crop in six South African nations and 8th in four West African countries. Sweet potato is a key conventional crop, growing traditionally in limited area for domestic purpose. The crop is considered as the most important root or tuber of the tropics because of flexibility in planting and harvesting, short cropping season, use of non-edible parts for planting, non-trellising habit and low requirements for soil nutrients (Martin, 1994). This is an important reason it plays an important role in the economy of poor households (Satheesh & Workneh. 2019). Besides this important function, the crop has immense industrial value for extraction of starch and production of animal feed.

For all these reasons, the crop has great possibilities for enhancing food and nutrition security in Nigeria where most of the farmers' holdings belong to small and marginal categories. Although the crop is assuming greater significance, a lot of people are still not aware of its health and nutritional contents and benefits. Therefore, the aim of this article is to highlight the major nutritional contents of sweet potato and to correct the wrong assumption and misnomer attached to its consumption. It will also focus on the health benefits of the crop with a view to encouraging the production and consumption of the crop. It will also state the number of people the crop can feed from a hectare of land.

Materials and methods

Site selection and experimental design

Thirty sweet potato cultivars were assembled from different towns and villages where sweet potatoes were grown in Osun State, Nigeria. The assembled cultivars were first planted in pots to generate the vines used for the planting. Field experimentation including planting, maintenance, data collection and harvesting occurred between June and November, 2018. The site of the experimentation was the Teaching and Research farm of the Department of Agricultural Science, Osun State College of Education, Ilesa. Ilesa, a town in the South Western Nigeria falls between latitude 7o37l N and longitude 4o42l E. The altitude of the place is 381m above mean sea level. Ilesa is in the tropical rain forest zone; the rainfall distribution is bimodal with a mean annual rainfall of 1524mm. The annual mean temperature is 29.4oC. The soils of the study area have been classified as Ferruginous Tropical Soils. The soil is sandy clay loam with a pH of 5.8 and the site was dominated by secondary vegetation.

The experimental design was a randomized complete block design (RCBD) with three replicates. In situ planting of materials was done on ridges with distance between the ridges fixed at 1m to give enough room for the spread of vines and avoid mixture of stem. Eight vines per cultivar were established in each ridge at the spacing of 0.3m between plants. Vine cuttings which measured about 30cm long were taken from the top and middle portions of living sweet potato plants. Sites for the established plants were weeded thrice until the plants covered the ground and no fertilizer application was done.

Data collection

Data were collected at intervals on the above ground characteristics. While some were taken at four weeks after planting (WAP), others were taken at eight WAP. Root characteristics were evaluated at harvest, precisely 136 days after planting. Data were collected based on the morphological and agronomic descriptors developed by CIP (2017) and Huaman (1991).

Dry matter content determination

Determination of dry matter (DM) was done using the method described by Carey and Reynoso (1996). To avoid postharvest changes in DM content prior to DM determination, samples were taken to the oven before 24 hours after harvest. A known weight of the tuberous root was obtained for each cultivar. The weighed roots were oven dried at a temperature of 80oC for 72 hours to stable weights. The dried samples were weighed and the resulting figure used for calculating DM content as DM% = (dry weight/fresh weight) x 100.

Data analysis

Analysis of variance (ANOVA) of the yield and agronomic characteristics of the different cultivars were done using SAS and SPSS and mean separation was carried out using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Number of tuberous roots per plant ranged from 1 to 7. Igbajo had the least mean number of tuberous roots per plant (1.83) while Oyan had the highest mean (4.27). Number of tuberous roots per plant was significant ($p<0.05$). Inisa stood out conspicuously with a significantly different mean tuber weight per plant of 561.23 g ($p <0.05$). Most clones had mean tuber weight per plant of between 214.17 g and 469.83 g. Igbajo had the least with 97.58 g.

Significant difference was recorded in fresh tuberous root yield ($P <0.05$). Fresh tuberous root yield was highest in Inisa at 19.01tonnes/ha. Three clones had close performance in yield. They were Oyan, Erin and Ijeda at 16.67 tonnes/ha, 16.37 tonnes/ha and 16.08 tonnes/ha respectively. The least tuberous root yield was Igbajo with an average output of 1.86 tonnes/ha. The overall mean for fresh tuberous root yield for all the 30 cultivars was 8.69tonnes/ha, which is higher than the recorded mean yields of 7-8 tonnes/ha for Nigeria (Tewe et al., 2001). Table 1 presents the fresh tuberous root yields of sweet potato cultivars studied.

Table 1: Root characteristics of the 30 sweet potato cultivars at harvesting

CN	Clone Name	N	Tuber yield per plant (g)	Number of tuber/plant	Tuber yield (t/ha)
1	Inisa	20	561.23±218.45a	2.38±1.19b-d	19.01±9.35a
2	Oyan	23	457.17±75.75a-c	4.27±0.66a	16.67±3.3ab
3	Erin	24	429.83±24.23a-d	3.04±0.29a-d	16.37±0.92a-c
4	Ijeda	21	464.16±320.30ab	3.13±0.5a-d	16.08± 4.13a-d
5	Ilesa	21	447.0 ±168.75a-c	3.74±0.82ab	14.52±4.32a-e
6	Esa	18	469.83 ±60.21ab	3.19±0.93a-d	13.48±6.56a-f
7	Ilobu	18	429.50±69.21a-d	2.72±0.35b-d	11.48±1.82b-g
8	Ifon	23	302.83±151.4 b-f	2.11±0.88cd	11.32 ±6.13b-h
9	Obale	21	319.45±59.83b-e	3.29±0.82a-c	10.53±1.52a-g
10	Esado	23	281.80±51.18b-f	2.81±0.60b-d	10.20±1.07a-g
11	Ife	20	299.50±129.18b-f	2.94±0.58b-d	9.70±4.98a-g
12	Apomu	19	306.60±95.97b-f	3.19±0.74a-d	9.31±3.19b-h
13	Ikoyi	19	254.24±116.50b-f	1.86±0.71d	8.48±3.88c-i
14	Oba	19	217.82±161.61d-f	2.55±1.04b-d	8.22±2.67c-i
15	Etion	20	265.85±13.07b-f	2.51±0.55b-d	7.9 ±4.59c-i
16	Inaja	16	291.46±168.91b-f	3.00±1.42a-d	7.33±3.91d-I
17	Iree	21	228.88±105.20d-f	2.42±0.95b-d	7.25±4.89d-i
18	Ebusa	19	246.56±21.84c-f	2.13±0.61cd	7.10±0.91d-i
19	Ibodi	21	214.87±132.72d-f	2.82±0.66b-d	6.91±3.95d-i
20	Ikire	15	265.85 ±33.09b-f	2.51±0.23b-d	6.44±4.59e-I
21	Okitisa	14	243.45±87.51c-f	2.87±0.12b-d	6.16±2.26e-i
22	Efon	18	214.17±37.36d-f	2.28 ±0.19cd	6.13±1.07e-i
23	Odega	17	216.82±137.03d-f	2.19±0.83cd	6.10±5.09e-i
24	Ibokun	19	187.07±132.43ef	1.92±0.67cd	5.78±2.90e-i
25	Iba	21	153.63±114.01ef	2.17±0.29cd	4.59±3.20e-i
26	Atiro	17	160.49±72.03ef	2.56±0.21b-d	4.27±1.85e-I
27	Ara	19	164.37±22.40ef	1.83±0.2 d	4.16 ±1.80f-i
28	Ayoor	19	124.90±33.78ef	2.01±0.59cd	3.64±1.52g-i
29	Apata	17	98.95±29.44ef	2.64±0.67b-d	2.15±0.83hi
30	Igbajo	16	97.58±16.73f	1.83±0.38d	1.86±0.32I

Means with the same letter are not significantly different ($P < 0.05$). Mean separation was done using DMRT.

CN = Cultivar accession number.
N = Number of plants used for the computation.

Number of People to be Fed from Sweet potato

The number of people to be fed per ha was estimated. This estimate was arrived at by multiplying the fresh tuber yield in gram/ha by percent dry matter to obtain the total dry weight in gram/ha. It was converted to calories by multiplying grams of dry weight by 4,000 since on the average; one gram of dry food substance (carbohydrates or proteins) gives 4,000 calories. Anonymous (2008) states that the daily recommended intake of calories for an adult male and female is 2500 and 2000 kilo calories respectively. Therefore, the daily calories requirement for an adult will be the mean of the two which is 2250 kilo calories. The number of people to be fed per ha per adult per day was determined by dividing the total dry weight in kilo calories by 2250 kilo calories.

Estimated number of people to be fed/ha = fresh tuber yield x % dry matter x 4 kcal
2250 kcal.

Based on the calorie's requirement for an adult per day, Oyan could be used to feed the highest number of people as it could feed 1.28 million adults per day. Igbajo could be used to feed the least number of people as it could feed 0.12 million adults per day. Table 2 shows the estimated number of people that can be fed from the 30 sweet potato cultivars studied.

Table 2: Number of people to be fed with sweet potato per ha

CN	Cultivar Name	Dry matter Content %	Yield (t/ha)	Thousands of people to be fed/ha
1	Inisa	34.49	19.01	1165.7
2	Oyan	43.29	16.68	1283.4
3	Erin	36.95	16.37	1075.6
4	Ijeda	39.71	16.08	1134.9
5	Ilesa	41.13	6.10	445.7
6	Esa	32.70	13.48	783.8
7	Ilobu	34.58	11.48	705.6
8	Ifon	35.45	11.32	713.45
9	Obale	42.87	10.53	802.5
10	Esado	32.09	10.20	581.7
11	Ife	36.28	9.70	625.3
12	Apomu	28.10	9.31	464.9
13	Ikoyi	38.49	8.47	579.9
14	Oba	41.36	8.22	604.7
15	Etion	39.32	7.91	553.1
16	Inaja	36.19	7.33	471.4
17	Iree	36.72	7.25	460.6
18	Ebusa	36.38	7.43	480.9
19	Ibodi	38.09	6.91	468.2
20	Ikire	38.98	6.44	446.4
21	Okitisa	38.72	6.16	424.2
22	Efon	39.56	6.13	430.8
23	Odega	36.47	14.58	945.4
24	Ibokun	40.89	5.78	420.1
25	Iba	37.79	4.59	308.3
26	Atiro	34.89	4.27	264.6
27	Ara	32.86	4.16	243.1
28	Ayoor	36.89	3.64	232.3
29	Apata	36.73	2.15	140.2
30	Igbajo	36.31	1.86	116.7

Nutritional Benefits

The roots of sweet potato plants are primary storage organs and act as sinks to photosynthetic products, and it resulted in the deposition of different micro (phytochemicals) and macro (carbohydrates) nutrients (Lemonier et al., 2013). Sweetprotato was reported to have highest dry matter content due to its sink strength (Rukundo et al., 2013) and this crop is highly appreciated for the positive agronomic and nutritive characteristics (Abidin et al., 2017).

Sweet potato is a tuber crop of immense potential as it produces more edible energy on marginal land than any other major food crop (194 MJ /ha/day; (Woolfe, 1992). Similarly, Stathers et al., (2013) and CIP (2017) corroborated the fact that it can produce more edible energy per ha per day than wheat, rice, or cassava. The main nutritional material in sweet potato tubers are carbohydrates (starches and simple supers), proteins, fats and fat-soluble vitamins Moreover, cultivars with a yellow flesh also contain significant amount of carotenes (Allen et al., 2012).

Maloney et al. (2012) pointed out that potentially valuable proteins can be extracted from the peel of peel during the processing of sweet potatoes. Sweet potato tubers have anti-diabetic, anti-oxidant and anti-proliferative properties due to the presence of valuable nutritional and mineral components (Jaarsveld et al., 2005; Abubakar et al., 2010).

Sweet potato tubers appear to be very beneficial in the diet of diabetics and consumers with an insulin resistance, because they have a low glycemic index (GI). (Ludvick et al., 2004; Allen et al., 2012). Knowledge of the GI diet for diabetics may help to predict their daily diet in order to control a blood glucose level. GI of a pure glucose which is used as the standard and a pattern for other products is 100, while the GI of sweet potato tubers depending on whether they are boiled, baked or prepared in a microwave is 63, 6 or 66, respectively. This discovery encourages using them in the diet of diabetics.

Sweet potato is a good raw material with excellent nutritional values for the food and pharmaceutical industries. Nigeria economy is warming up for the production of alcohol from starchy crops. Sweet potato has a good potential for alcohol production as ethanol yields from it vary with varieties from 0.07-0.15litre/kg of fresh root (Akoroda et al., 2008).

Sweet potato is probably the food crop that produces the most energy per unit area (Janssens, 2001). A hectare of sweet potato can feed more people than a hectare of cereal grains, with less energy input (Duke, 1983). The root of sweet potato is reported to contain 108-121 calories.

Reports are awash in the literature of the usefulness of sweet potato. It is widely reported that shoots and tuberous roots provide energy, proteins, vitamins and minerals for both man and livestock (Navale & Salvi, 1983; Cordell, 2008). Table 3 shows the nutritional composition of 100g of sweet potato tubers. The Centre for Science in the Public Interest (CSPI) rated the relative nutritional value of common vegetables and the sweet potato came out on top with a score of 184, compared with a similarly prepared white potato which scored only 83 points (Ehler, 2008). Points were given for content of dietary fiber, naturally occurring sugars and complex carbohydrates, protein, vitamins A and C, iron and calcium. Points were deducted for fat content (especially saturated fat), sodium, cholesterol, added refined sugars and caffeine. The higher the score, the more nutritious is the food. Similarly, the Nutrition Action Health Letter rated 58 vegetables by adding up the percentages of US Recommended Daily Allowance (USRDA) for six nutrients (vitamins A and C, folate, iron, copper and calcium), plus fibre. Sweet potato topped the list with a whopping 582 points; its nearest competitor, a raw carrot came in at 434.

Health Benefits

In vivo studies conclude that carbohydrate from sweet potato stabilizes the sugar levels in blood and decreases the resistance to insulin (Mohanraj & Sivasankar (2014). Hernandez et al. (2016) reported that sweet potato also provides the substantial quantities of selected vitamins (vitamins A and C), specific minerals (potassium, magnesium, and calcium), and various bioactive compounds (phenolic acids and anthocyanins for consumers.

In recent time, demand and attention on orange fleshed sweet potato (OFSP) are raised due to the high concentrations of β-carotene and non-pro-vitamin A carotenoids. Kurabachew (2015) reported that OFSP has high potential to address vitamin A deficiency by food-based intervention programmes in targeted nations. OFSP has been given credit in recent scientific reports for its role in bakery, snack and confectionery foods (Satheesh & Workneh, 2019).

Prevention of Vitamin A deficiency

Deficiency of vitamin A has been implicated in increase in infectious morbidity, dry eyes and increased mortality for both pregnant and lactating women and their children.

Table 3: Raw sweet potato nutritional value per 100g of peeled tuber

Nutrient	Amount	Percentage
Carbohydrate	20.1g	
Sugars	4.2g	
Dietary fibre	3.0g	
Fat	0.1g	
Protein	1.6g	
Vitamin A equiv	709μg	79
μ-carotene	8509 μg	79
Thiamin (Vit.B1)	0.1mg	8
Riboflavin (Vit. B2)	0.1mg	7
Niacin (Vit. B3)	0.61mg	4
Pantothenic acid (Vit.B5)	0.8mg	16
Vitamin B6	0.2mg	15
Folate (Vit. B9)	11μg	3
Vitamin C	2.4mg	4
Calcium	30.0mg	3
Iron	0.6mg	5
Magnesium	25.0mg	7
Phosphorus	47.0mg	7
Potassium	337mg	7
Zinc	0.3mg	3

Source: United States Department of Agriculture National Nutrient Data Base (2015)

Sweet potatoes are an extremely important source of vitamin A because they contain high levels of beta-carotene. Beta-carotene is transformed into vitamin A in the liver, with every molecule producing two molecules of vitamin A (West Jr, 2003).

Managing Diabetics

The relatively low of sweet potato means that the sweet potatoes release sugar into the blood stream slowly, unlike other starchy foods. This steady release of sugar is what aids in controlling the blood sugar levels of individuals so that it does not go low or high. Thus, the sweet potatoes can be used in the regulation of blood sugar levels especially in people with diabetes. This regulation is witnessed in both types of diabetes, i.e. type I and type II (McClelland et al., 2007). The fibre in sweet potato is also known to be beneficial for diabetes management. 10-15% of the fibres in a sweet potato consists of soluble fibres such as pectin, which are effective in reducing food consumption and spikes in blood sugar (Adam et al., 2015).

Preventing and Managing cancer

Sugata et al. (2015) reported that the purple fleshed sweet potato is very effective in the fight against cancer. This anti-cancer activity is attributed to the high anthocyanin content in the crop. This component in sweet potato is able to inhibit growth of specific cancers that include breast cancer, gastric cancer, and colon cancer. Other studies have shown that the high polyphenol content in sweet potato can also induce cell death in prostate cancer cells, ensuring that the cancer does not grow and spread to other parts of the prostate. (Taiwo et al., 2016).

Guarding against ulcers

Studies on the extracts obtained from sweet potatos have shown that the crop contains chemicals that can heal wounds and ulcers in the stomach. Therefore, dietary consumption of sweet potatoes can be an effective treatment plan against major types of ulcers including ethanol and aspirin induced ulcers (Hermes et al., 2012). The results of these studies have proved that the sweet potatoes can be used in the treatment and management of peptic ulcers.

Minimizing the risk of cardiovascular diseases

Cardiovascular diseases are among the disease dreaded by humans because of their high morbidity and mortality rate. However, leaf extracts from sweet potatoes were tested and scientists found that the high levels of polyphenols in the leaf extracts were able to suppress oxidation in humans, decreasing the chances of cardiovascular diseases (Nagai et al., 2011). They found out that the high levels of radical scavenging activity as well as a high amount of polyphenol

compounds contribute to the crop's antioxidant properties which help in minimizing the risk of developing cardiovascular diseases.

Other useful health benefits

According to Lim et al. (2010), dietary consumption or supplementation of vitamin E has the potential of significantly increasing hair numbers in individuals who are suffering from hair loss. This is due to the fact that vitamin E contains antioxidant properties that help reduce oxidative stress, a major cause of alopecia. Vitamin C has been known to be an effective dermatological treatment that can be used in the treatment of photo aging and hyper pigmentation (Telang, 2013).

Furthermore, Sweet potatoes contain significantly high amount of fibre which are essential in promoting a well-functioning digestive tract. These fibres also function as constipation substances (Slavin, 2013). Sweet potatoes can also help in controlling blood pressure because of their richness in both magnesium and potassium. These two nutrients are essential in the fight against hypertension (Durlach et al., 1992). Other health benefits of sweet potatoes include boosting and promoting fertility among women; promoting good vision; maintaining satiety as well as reducing the overall weight of an individual and enhancing memory (Jungsook et al., 2003; Adam et al., 2015; Sommer, 2008; Kalampokas et al., 2014).

Conclusion

A lot of health benefits are inherent in sweet potato and it has many nutritional values as a tuber crop. However due to ignorance many people do not seem to consume the crop. As contained in this article, various studies indicate that nutrients which are obtained in consuming sweet potato can significantly improve the nutritional status of consumers and reduce their nutrition and health problems. Common ailments of people can be treated, cured or managed by including sweet potato in the diets of individuals concerned.

Inclusion of sweet potato in the meal given to pupils in the school feeding programme embarked upon by various governments. This will enable the pupils to avail themselves of the numerous nutritional benefits contained in the crop. Patients in the hospital who are receiving treatments in the ailments that sweet potato can be used to treat are to be fed with sweet potato. Government should embark on awareness and sensitization campaign for the populace on the health and nutritional benefits of sweet potato with a view to encouraging its consumption.

References

Abidin P. E., Carey E., Mallubhotla S., and Sones K. (2017). Sweet potato cropping guide: Africa soil health consortium. Nairobi, Kenya: CAB International.

Abubakar, I. N., Olayiwola, I. O., Sanusi, S. A., and Idowu, M. A. (2010). Chemical composition of sweet potato *(Ipomoea batatas* (L. Lam) dishes as consumed in Kwara State, Nigeria. *International Food Research Journal* 17: 411-416.

Adam, C. L., Williams, P. A., Garden, K. E., Thomson, L. M. and Ross, A. W. (2015). Dose-dependent effects of a soluble dietary fibre (pectin) on food intake, adiposity, gut hypertrophy and gut satiety hormone secretion in rats. Free PMC article, e-collection 2015.

Akoroda, M.O., Egeonu, N., & Odebode, S.O. (2008). Promotion of sweet potato for the food industry in Nigeria. *Bulgaria Journal of Agricultural Science* 14: 300-308.

Allen, J. C., Corbitt A. D., Maloney, K. P., Butt, M.S. and Truong, V.D. (2012). Glycemic index of sweet potato as affected by cooking methods. *The Open Nutrition Journal* 6:1-11.

Anonymous. (2008). The office diet: healthy living for busy people. http://www.theofficediet.com. Retrieved June 19, 2008, from http://www.theofficediet.com.

Carey, E. and Reynoso, D. (1996). Procedures for the evaluation of pathogen-tested sweet potato clones. Sweet potato germplasm management training manual 3.0. Evaluation and breeding in CIP report.

Cordell, R. (2008). Sweet potato – nature's health. North Carolina sweet potato commission, North Carolina, USA.

Durlach, J., Durlach, V., Rayssiguier, Y., Baba, M and Guieta-Bara, A. (1992). Magnesium and blood pressure II. Clinical Studies Magnes Research 5(2): 147-153.

Ehler, J.T. (2008). Sweet potato ranks number one in nutrition – vegetable facts. Retrieved Jan. 20. 2018 from James@food-reference.com.

Food and Agricultural Organization. (2016). FAO Statistics, Food and Agricultural Organization, Rome, Italy.

FAOSTAT (2019). Food and Agricultural Organization Statistics (FAOSTAT). Retrieved from http: www.fao.org/faostat/en/#data/QC (Google scholar).

Huaman, Z. (ed.) (1991). Descriptors for sweet potato. International Board for Plant Genetic Resources, Rome, Italy.

Hermes, D., Dudek, D.N., Maria, M.D., Horta, L.P., Lima, E.N; de Fatima, A., Sanches, A.C., and Modulo L.V. (2012). In vivo wound healing and antiulcer properties of white sweet potato (Ipomea batatas). *Journal of Advanced Research* 4(4): 411-415.

Hernández, S. M., Hernández, A. I., Rodríguez, G. B., Hernández, R. L., Cabrera, C. E., Ríos M. D. and Romero, C. (2016). Application of multidimensional scaling technique to differentiate sweet potato (*Ipomoea batatas* (L.) Lam) cultivars

according to their chemical composition. *Journal of Food Composition and Analysis* 46: 43–49.

International Potato Center (2017). Sweet potato in Africa. Retrieved on 30 September, 2019 from https ://cipotato.org/research/sweet potato-in-africa.

Jaarsveld, P. J., Faber, M., Tanumihardjo, S. A., Nestel, P., Lombard, C. J. and Spinnler. B. J. (2005). Beta-carotene – rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *American Journal of Clinical Nutrition* 81: 563-569.

Janssens M.J.J. (2001). Sweet potato. In: Raemaekers R.H. (ed.) Crop production in Tropical Africa. Directorate General for International Co-operation (DGIC), Brussels, Belgium. Pp 205-221.Jungsook,

Jong, C. S.K. Pham, H. L. Jhang, J. Yiho, B. and Kyeong, C. (2003). Antioxidant and memory enhancing effects of purple sweet potato anthocyanin and cordyceps mushroom extract. *Archives of Pharmaceutical Research* 26(10): 821-825.

Kalampokas, T., Shetty, A, and Maheswari, A. (2014). Vitamin A deficiency and female fertility problem: A case report and mini review of the Literature. *Journal of Women's Health Care* 3(6): 34-39.

Kurabachew, H. (2015). The role of orange fleshed sweet potato *(Ipomea batatas)* for combating vitamin A deficiency in Ethiopia: A review. International *Journal of Food Science and Nutrition Engineering* 5(3): 141–146.

Lebot, V., Michalet, S., and Legendre, L. (2016). Identification and quantification of phenolic compounds responsible for the antioxidant activity of sweet potatoes with different flesh colours using high performance thin layer chromatography (HPTLC). *Journal of Food Composition and Analysis* 49: 94–101.

Lemoine, R., Camera, S. L., Atanassova, R., Dédaldéchamp, F., Allario, T., Pourtau, N. and Durand, M. (2013). Source to sink transport of sugar and regulation by environmental factors. *Frontiers in Plant Science* 4:1–21.

Lim, A. B, Wong, J. W. and Yuen, K. H. (2010). Effects of Tocotrienol supplementation on hair growth in human volunteers. *Tropical Life Science Resources* 21(2): 91-99.

Ludvick, B., Neuffer, B. and Pacini, G. (2004). Efficacy of Ipomoea batatas (Caiapo) on diabetics control in type 2 diabetic subjects treated with diet. Diabetics Care 27: 436-440.

Maloney W.T., Truong, V.D., and Allen, J. C. (2012). Chemical optimization of protein extraction fron sweet potato *(Ipomoea batatas)* peel. *Journal of Food Science* 77: 306-312.

Martin, F.W. (1994). Effects of age of planting on yields of sweet potato from cuttings. *Tropical Root and Tuber Crops Newsletter* 15: 22-25.

McClelland, J. W., Allen, J.C. and Zakir, S. (2007). Biomedical effect of sweet potato in people with diabetes. *Journal of the American Diabetic Association* 107 (8): A104

Mohanraj, R., and Sivasankar, S. (2014). Sweet potato (Ipomoea batatas [L.]) – A valuable medicinal food: A review. *Journal of Medicinal Food* 17(7): 733–741.

Nagai, M., Tani, M., Kishimoto, Y., Lizuka, M., Saita, E., Toyozaki, M., Kamiya, T., Ikeguchi, M.; and Kondo, K. (2011). Sweet potato (Ipomea batatas L.) leaves suppressed oxidation of low-density lipoprotein (LDL) in vitro and in human subjects. *Journal of Clinical Biochemistry and Nutrition* 48(3):203-208

National Nutrient Data Base. United States Department of Agriculture (USDA), Agricultural Research Service, Nutrient Data Laboratory. 2015. Retrieved September 30, 2019 from http://www.ars.usda.gov./ba/bhnrc/cdl.

Navale, R.N. and M.J. Salvi. (1983). Effects of season on yield of sweet potato. *Journal of Root Crops* 9 (1 and 2): 55-58.

Rukundo, P., Shimelis, H., Laing, M., and Gahakwa, D. (2013). Storage root formation, dry matter synthesis, accumulation and genetics in sweet potato. *Australian Journal of Crop Science* 7(13): 2054.

SAS (Statistical Analysis System). SAS Institute. (1995). SAS/Stat user's Guide. Version 6, 4th Edition volume 1and II. SAS Institute Inc. Cary N.C.

SPSS (Statistical Procedure for Social Science) SPSS version 17. SPSS Institute. Satheesh, N, and Workneh S. 2019). Review on nutritional composition of orange fleshed sweet potato and its role in management of vitamin A deficiency. Food Science and Nutrition 7: 1920–1945.

Slavin, J. (2013). Fiber and prebiotics: Mechanisms and health benefits. Nutrients (5) 4:1417-1435. Published online 2013 April 22.

Sommer, A. (2008). Vitamin A deficiency and clinical Disease: An Historical Overview. *The Journal of Nutrition* 138(10): 1835-1839.

Stathers T., Bechoff A., Sindi K., Low J., and Ndyetabula D. (2013). Everything you ever wanted to know about sweet potato: Reaching agents of change ToT manual. 5: Harvesting and postharvest management, processing and utilization, marketing and entrepreneurship (volume 5). Nairobi, Kenya: International Potato Center.

Sugata, M., Lin, C. Y. and Shih, Y. C. (2015). Anti-inflammatory and anti-cancer activities of Taiwaneses purple-fleshed sweet potatoes (Ipomoea batatas L. Lam) extracts. Biomed Res. Int. published online.

Taiwo, B. A., Ramachela, K., and Mukwevho, E. (2016). A review of therapeutic potentials of sweet potato:pharmacological activitiesand influence of the cultivar. *Tropical Journal of Pharmaceutical Research* 15(12): 2751-2761.

SPSS (Statistical Procedure for Social Science) SPSS version 17. SPSS Institute. Satheesh, N, and Workneh S. 2019). Review on nutritional composition of orange fleshed sweet potato and its role in management of vitamin A deficiency. *Food Science and Nutrition* 7: 1920–1945.

Slavin, J. (2013). Fiber and prebiotics: Mechanisms and health benefits. Nutrients (5) 4:1417-1435. Published online 2013 April 22.

Sommer, A. (2008). Vitamin A deficiency and clinical Disease: An Historical Overview. *The Journal of Nutrition* 138(10): 1835-1839.

Stathers T., Bechoff A., Sindi K., Low J., and Ndyetabula D. (2013). Everything you ever wanted to know about sweet potato: Reaching agents of change ToT manual. 5: Harvesting and postharvest management, processing and utilization, marketing and entrepreneurship (volume 5). Nairobi, Kenya: International Potato Center.

Sugata, M., Lin, C. Y. and Shih, Y. C. (2015). Anti-inflammatory and anti-cancer activities of Taiwaneses purple-fleshed sweet potatoes *(Ipomoea batatas* L. Lam) extracts. Biomed Res. Int. published online.

Taiwo, B. A., Ramachela, K., and Mukwevho, E. (2016). A review of therapeutic potentials of sweet potato:pharmacological activitiesand influence of the cultivar. *Tropical Journal of Pharmaceutical Research* 15(12): 2751-2761.

Telang, P. S. (2013). Vitamin C in dermatology. India Dermatology Online Journal 2(2): 143-146. West Jr. K. P. (2003). Vitamin A deficiency disorders in children and women. Food Nutrition Bulletin, 24(4): 78-90.

Tewe O.O., Abu O.A., Ojeniyi E.F. and Nwokocha N.H. (2001). Sweet potato production, utilization and marketing in Nigeria. In: Akoroda, M.O. and J.M. Ngeve (eds.) Root crops in the twenty-first century. Proceedings of the Seventh Triennial Symposium of the International Society for Tropical Root Crops – Africa Branch, Cotonou, Benin, Oct. 11-17, 1998.