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Comparative assessment of Nutraceutical Potential of Orange Flesh Sweet Potato and Sprouted white sorghum for the management of malnutrition and Micronutrient deficiency in Ekiti state, Southern Nigeria.

Ojo Olabimpe Iyabode[1*], Ajatta Mary Aanuoluwapo[2], Alonge Sunday Ayodele[3], Aniobi Christianah Chinenye[1], Ayo-Dada Oluwaseun Dorcas[4]

1.Department of Chemical Sciences, School of Pure and Applied Sciences,
2 Department of food Science and Technology,
3 Department of Biochemistry,
4 Department of Health Sciences, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, Ekiti State, Nigeria

ABSTRACT

The increase rate of malnourished children and Adults is alarming during the last few years according to Health Management record in Ekiti State. Malnourished people need to consume adequate calories for growth and maintenance in order to overcome the problem of economic crisis leading to under nutrition or Protein-Energy Malnutrition (PEM) according to World Health Organization. The increasing rate of population coupled with high cost and dwindling availability of plant foods and animal feeds have resulted into malnourishment. The aim of this study is to compare the beta carotene, nutritive anti-nutrient and antioxidant properties of orange flesh sweet potato (OFSP) and white sorghum (SWSB). The orange flesh sweet potato tubers were washed, dried and processed into flour while white sorghum seeds were washed, sprouted, dried and made into flours. The processed flours were then analyzed for proximate, anti-nutrient, antioxidant properties and Beta carotene content using standard methods. The ash content ranged from 2.59±0.01 in SWSB to 3.29± 0.02 in OFSP, carbohydrate content ranged between 78.82±0.04 in SWSB to 80.42± 0.03 in OFSP. The crude protein ranges from 6.28±0.06 in SWSB to 6.97±0.06 in OFSP all in percentage. OFSP has the highest Beta carotene content with 6.41±0.43mg/100g followed by SWSB with 5.1±0.40mg/100g.Flavonoids value ranged between 7.8±0.01 in OFSP to 32.94±0.05mg/100g in SWSB, the highest DPPH was found in OFSP with 13.78 ±0.02% followed by that of SWSB. The Beta carotene level and antioxidant properties evaluated were all higher in OFSP than SWSB. The Beta carotene and antioxidant properties of all the flour shows that OFSP would be best suitable than that of SWSB to combat micronutrient deficiency, malnutrition and food security in southern part of Nigeria especially in Ondo State.

Keywords: Malnutrition, Nutraceutical, Orange Flesh Sweet Potato, White Sorghum, Sprouted, Antioxidant.

*Corresponding Author Email: ojoolabimpeiyabode@gmail.com
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INTRODUCTION

Historically, plants were treated as one of the two kingdoms including all living things that can be of therapeutic benefit in treating diseases (Adesina, 2015)[1] The rate of micronutrient deficiency and malnutrition has increased since the last few decades. The utilization of bio-fortified crops, and sprouted plant based food could help to alleviate this malnutrition and micronutrient deficiency in Africa especially in Ekiti State, Nigeria.

Availability of plant-based food which could serve as cheap protein and energy sources, of which could be useful in the achievement of Sustainable Development Goals(SDGs) which are good health(Goal 1), zero hunger(Goal 2) and no poverty(Goal 3).

Orange Flesh Sweet potato (ipomoea batatas) is a dicotyledonous tuberous plant of Convolvulaceae family. It is an important staple crop (Low et al., 2017)[25]; it thrives in the tropical, subtropical and in some temperate regions of the developing world (Alam *et al*., 2016)[2]. It is precisely known to contain significant amount of vitamins, minerals and antioxidants (Kunyanga *et al.,* 2012)[3]. The varieties of sweet potato depend on either their skin flesh color and even both. Its color ranges from orange, red, purple, yellow, brown, cream and white (Adebisi *et al.*, 2015)[1].

Orange Flesh Sweet Potato (OFSP) is a bio-fortified variety of sweet potato with high beta (β) carotene which is a precursor of vitamin A, that is OFSP is a provitamin A food crop (Júnior *et al*., 2018; Tumuhimbise *et al.,* 2019; Azeem *et al.*, 2020)[4-6]. In advance, researchers has worked tremendously on OFSP: Adebisi *et al.* (2015)[1] worked on its utilization, Alam *et al.* (2016)[2] gave a report on the proximate composition and carotenoid contents of the different varieties of OFSP in Bangladesh, while Tiruneh, Urga, Tassew and Bekere (2018) gave a reported on the biochemical compositions and functional properties of orange-fleshed sweet potato variety in Hawassa, Ethiopia. Other report on OFSP by researchers includes Oloniyo *et al.* (2020)[7]; Omoba *et al.* (2020)[8]; Ruttarattanamongkol *et al.* (2016)[9]; Tumuhimbise *et al.* (2019)[5] among others.

Sorghum and millets have been important staples in the semi-arid tropic of Africa countries which are still the principal sources of energy, protein, vitamin and minerals for millions of the people in these regions (Yadare, 2016).

Sorghum bicolor and Pennisetumglaucum plant seeds are good sources of dietary fibers which come from the part of plant food that the body cannot digest (Ogunlade, *et al*, 2011).

Bioactive compounds (such as flavonoids, carotenoids) have a profitable biological action in the body, and emerging research suggests that they are responsible for many of the health effects of the whole grains (Riahanatu *et al*, 2011). The Sorghum seeds are locally used against:

Malnutrition Cardiovascular disease (Achana, 2002), Colorectal Cancer (NML, 2001), Diabetes (Dabiya and Kapoor, 1994, Abnormal weight (Serna-Saldiwar, 1996) and Gastrointestinal disease (Wilson *et al*, 1991)

Various processing treatments, most especially sprouting process improve the nutritional quality as well as the consumer acceptability of cereals especially sorghum. It also enhances nutritive value shelf life of cereal flours depends upon the grain processing techniques. The various processing methods are the following: milling decorations, germination, malting, blanching, fermentation, popping and sprouting. The quest to source for nutrient rich plant food that can adequately supply the nutrient needed for adult and children calls for a continuous research into cereals (Ogunlade *et al*, 2011).

MATERIALS AND METHOD

Materials

Orange flesh sweet potato was obtained from orange flesh sweet potato research farm land in Akure, Ondo state, while white sorghum was obtained from main market in Akure, Ondo state, Nigeria.

Methods

Preparation of orange sweet potato and sprouted white sorghum flours.

The tubers of orange flesh sweet potato (OFSP) were washed, sliced and air-dried while the seed of white sorghum bicolor (WSB) were washed, sprouted and air-dried. The two samples were later processed into flour by the method described by Oloniyo *et al.* (2020)[7].

Sample Analysis

Proximate composition

The proximate (moisture, crude protein, crude fat, crude fibers, and crude ash) composition of orange flesh sweet potato and white sorghum flour were determined according to the method described by AOAC (2010)[10]. Carbohydrates were calculated by difference. The caloric value was calculated by Atwater factor method as described by Osborne and Voogt (1978)[26].

Beta (β)-carotene content

Carotenoid content of orange flesh sweet potato and white sorghum flour was determined using organic solvents (acetone-petroleum ether) for the extraction followed by spectrophotometric method of analysis, as described by Rodriguez-Amaya and Kimura (2004)[27].

Anti-nutritional composition

The phytate content of orange flesh sweet potato and white sorghum flour was determined using the indirect colorimetric method as described by Wheeler and Ferrel (1971)[11]. The oxalate content of the sweet potato flour was determined as described by AOAC (2010)[10] method. The tannin content of the sweet potato flour was determined as described by Joslyn (1970)[12].

TOTAL FLAVONOID

Total flavonoid content of the orange flesh sweet potato flour was determined using the method described by Meda *et al.* (2005)[13], its concentration were calculated and expressed as mg quercetin equivalents per gram (QE)/g of the sample.

Ferric reducing antioxidant power (FRAP) of flour

FRAP of the orange flesh sweet potato and white sorghum flour extract was determined with the method described by Oyaizu (1986)[14] and its content was calculated and expressed as mg ascorbic acid equivalent/g (mg AEE/g) of the sample.

Statistical analysis

The data were generated in triplicates; it was analyzed using Statistical Package for Social Sciences (SPSS) Version 21. The significant differences between the means were separated using Duncan Multiple Range Test (DMRT) at 95% confidence level (P 0.05). The proximate and mineral values were also compared with the international permissible limits of FAO (2010)[15] and USDA (2010)[16].

RESULTS AND DISCUSSION

Proximate composition of orange flesh sweet potato and white sorghum flours

The results of the proximate composition and β-carotene content of orange flesh sweet potato and white sorghum flours are presented in Table 1. Moisture contents ranged from 5.35±0.01%in OFSP to 8.29±0.03% in SWSB having the highest moisture content (8.29±0.03%). Moisture content of OFSP samples were significantly (p 3.06) different from each other. The moisture content values obtained were lower than the recommended moisture content (10%) for storage stability (Iwe *et al.* 2017, FAO (2010))[15,17] thus, the orange flesh sweet potato flour will have a longer shelf life if properly stored under a good condition.

Crude ash contents ranged from 2.59±0.01%in SWSB to 3.29±0.02% in OFSP, the highest ash content was observed in OFSP, this indicates that OFSP could be a rich source of mineral salts. Ash is an inorganic compounds present in a food which helps in the breaking down of some organic compounds such as protein, fat and carbohydrates (Iwe *et al*., 2017)[15]. Crude fat contents ranged from 2.11±0.22% in SWSB to 2.23±0.31% in OFSP. Sweet potatoes are known for their low-fat content (Alam *et al*., 2016)[2]. It was observed that fat contents of OFSP were significantly higher than SWSB. The low fat content obtained in this study is in agreement with the findings of Alam *et al*., (2016)[2] that sweet potato is low in fat.

Crude protein content of the samples of orange flesh sweet potato and sprouted white sorghum flours ranged from 6.28±0.21% in SWSB to 6.97±0.04% in OFSP, This agrees with the report of Dako *et al.* (2016)[18] that sprouted white sorghum cultivars has low protein content values. OFSP samples had the highest contents of protein of 6.97±0.04%when compared with SWSB (6.28±0.21%).

Crude fiber contents ranged between 1.74%±0.03in OFSP and 1.81%±0.04 in SWSB, this implies that orange flesh sweet potato could be utilized as a good source of dietary fiber in a food system. SWSB had the highest fiber content (1.81%±0.04). The carbohydrate content ranged between 80.42%in OFSP and 78.92% in SWSB, the high carbohydrate content observed implies that orange flesh sweet potato was a rich source of carbohydrate. Carbohydrate is needed by infants for energy for the rigorous crawling and other activities for their growth and development.

The β carotene value ranged from 5.10±0.4mg/100g in SWSB to 6.41±0.43mg/100g in OFSP. The highest β carotene content was observed in OFSP (6.41±0.43mg/100g), while the least was observed in SWSB (5.10±0.4mg/100g). This result agrees with the report of previous researchers that OFSP variety of sweet potato has higher content of carotenoids (Alam et al., 2016; Tumuhimbise *et al*., 2019)[2, 5]. The higher content observed in them could be attributed to the deep orange colouration observed in both its skin and flesh of OFSP (Adebisi *et al*., 2015)[1]. β-carotene is a red-yellow pigment in plants, it is an antioxidants that protect the cells from the production of free radicals which damages the cells (Ramya and Patel, 2019)[19]. Beta (β) carotenes are micronutrient in foods, when consumed it is converted to rhodopsin and retinal, a visual pigment and precursor of retinoid acid, which regulates growth and visual development in the body (Fraser and Bramley, 2004)[20].

Table 1: Proximate analysis result of OFSP and SWSB

Sample	Moisture%	Ash%	Protein%	Fat%	Fiber%	Carbohydrate%
OFSP	5.35±0.01	3.29±0.02	6.97±0.04	2.23±0.31	1.74±0.03	80.42±0.32
SWSB	8.29±0.03	2.59±0.01	6.28±0.21	2.11±0.22	1.81±0.04	78.92±0.23

Anti-nutrient, antioxidant and β-carotene properties of orange flesh sweet potato and sprouted white sorghum flours

The Anti-nutrient, antioxidant and β-carotene properties of orange flesh sweet potato and sprouted white sorghum flours are presented in Table 2. Statistically, there were significant (p 0.05) difference in the samples examined. OFSP had the highest phytate value (22.20±0.03mg/100g) while SWSB (8.24±0.13mg/100g). The values obtained in this study were lower compared to the phytate values reported by Dako *et al.* (2016) for peeled and unpeeled

OFSP (77.75 and 95.15 mg/100g, respectively). Phytate produces phytic acid which is a major phosphorous storage component that chelate metallic ion such as Zinc, Calcium and Iron, thereby reducing their bioavailability (Connorton et al. 2017)[21].

Tannin values of sweet potato ranged from 2.93±0.14 to 2.23±0.12mg/100g. The highest tannin is in OFSP (2.93±0.14mg/100g) and the least value was observed in SWSB (2.23±0.12mg/100g). The results obtained in this study were lower than values reported by Tiruneh *et al.* (2018) who reported that the tannin values for Kulfo & Tulla (varieties of OFSP in Ethiopia) are 89.36 and 40.02 mg/100g respectively. High values of anti-nutrient (phytate, oxalate and tannin) in food are undesirable because they form complexes with minerals and proteins resulting in its unavailable to the body system (Gibson *et al.*, 2010; Tiruneh *et al.*, 2018) thereby leading to carcinogenesis, shock and renal damage (Onwuka, 2005)[22]. Anti-nutritional factors are substances that destructively affect the nutritional composition of a food thereby reducing both the mineral and protein

Total flavonoid content (TFC) of flours ranged from 7.86±0.13 to 32.94±0.21mg/g. The highest value of TFC was observed in SWSB (32.94±0.21mg/g) while the least was observed in OFSP (7.8±0.13mg/g). The ferric reducing antioxidant properties (FRAP) of flours ranged from 4.12±0.16 to 2.26±0.15µmol Fe^2 þ/g. The highest value of FRAP was observed in SWSB (4.12±0.16µmol Fe^2þ/g) while the least value was observed in OFSP (2.26±0.15µmol Fe^2þ/g).It was observed that OFSP had the highest value of all the antioxidant properties determined and the least value was observed in SWSB. The higher antioxidant properties observed in OFSP might be attributed to the higher beta carotene content as observed in Table 2 that OFSP flour has high beta carotene compared to other variety considered. Awuni *et al.* (2018)[23] reported that beta (β) carotenes are good sources of antioxidant molecules that are available in plants. Carotene is natural plant produced yellow pigment that exists in several forms: alpha (α), beta (β) and gamma (γ). It is pro-vitamins that may be converted into vitamin A in the body. Antioxidants are capable of scavenging free radicals, chelate metals catalysts, reduce α-tocopherol radicals, activate antioxidant enzymes and inhibit oxidases (Omoba *et al.*, 2015)[24].

Table 2: Anti-nutrient, antioxidant and β-carotene properties of OFSP and SWSB

Sample	Tannin mg/100g	TFC mg/100g	FRAP µmol Fe^2þ/g	DPPH %	Oxalate mg/g	Phytate mg/g	B-Carotene mg/100g
OFSP	2.925±0.14	7.86±0.13	2.26±0.15	13.775±0.2	22.70±0.02	22.20±0.03	6.41±0.43
SWSB	2.225±0.12	32.94±0.21	4.12±0.16	2.25±0.26	19.50±0..1	8.24±0.13	5.10±0.40

CONCLUSION

This study established that the high β carotene values obtained from OFSP and SWSB could make them useful for therapeutic diet for patient with malnutrition and degenerated disease such as high blood pressure, hypertension, cardiovascular disease, obesity and children with embryonic heart. It was observed that OFSP has the highest protein and β carotene for the production of weaning foods in flour mill industries. OFSP showed higher antioxidant properties compared to SWSB, thus; this will could make OFSP suitable to combat micronutrient deficiency, malnutrition and food insecurity in Africa especially in, Ondo and Ekiti state, Nigeria.

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