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VITAMIN COMPOSITION AND ANTIOXIDANT PROPERTIES OF SWEET POTATO (*Ipomea batatas*), PAWPAW (*Carica papaya*) AND CARROT (*Daucus carota*) FLOUR BLENDS

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ABSTRACT

This research focused on improving the nutritional composition and utilization of sweet potato through the addition of pawpaw and carrot fruits. Composite flour was produced from blends of sweet potato, pawpaw and carrot using different ratios: 85% Sweet potato 10% Pawpaw and 5% Carrots (SPCB), 70% Sweet potato 20% Pawpaw and 10% Carrots (SPCC), 55% Sweet potato, 30% Pawpaw and 15% Carrots (SPCD), 40% Sweet potato, 40% Pawpaw and 20% Carrots (SPCE) and 100% Sweet potato (SPCA) was used as control and the vitamin composition, antioxidant and functional properties of the flour blends were determined using standard methods. The result of the antioxidant potentials revealed that FRAP ranged from 10.05 to 18.18 mg/100g, DPPH 48.96 to 66.30%, total phenol 22.70 to 26.69 mg/100g and total flavonoid 0.18 to 0.30 mg/100g. Sample supplemented at level of 40% sweet potato, 40% pawpaw and 20% carrot has the highest antioxidant potentials. The results of the functional properties showed that the swelling index, gelling temperature, water absorption capacity of the flour blends increases as the substitution level increased. Vitamin A, vitamin C, vitamin E and vitamin B complex increased significantly ($p \geq 0.05$) in the supplemented flour blends. The findings in this research indicated that the flour blends could help to improve food security and sustainability.

Keywords*: Sweet potato, Pawpaw, Carrot, Antioxidants, Vitamins*

1.0 INTRODUCTION

Sweet potato (*Ipomoea batatas L.)* is one of the major staple crops and the most important food security promoting root crops in the world, especially in sub-Saharan Africa (Low *et al*., 2009). Well adapted to the tropical and subtropical regions, sweet potato has nutritional advantage for the rural and urban dwellers (Ingabire and Hilda, 2011). Sweet potato is an excellent source of energy (438 kJ/100 g edible portion) and can produce more edible energy per hectare per day than cereals, such as wheat and rice and has other advantages, such as versatility, high yield, hardiness, and wide ecological adaptability (Laurie *et al*., 2012). Sweet potato roots are rich in starch, sugar, vitamin C, β-carotene, iron, and several other minerals (Laurie *et al*., 2012; Oloo *et al.*, 2014). Despite its high carbohydrate content, sweet potato has a low glycemic index due to low digestibility of the starch making it suitable for diabetic or overweighed people (Ellong *et a*l., 2014; Fetuga *et al.*, 2014). The root is reported to usually have higher protein content than other roots and tubers, such as cassava and yams (Oloo *et al.*, 2014).

Pawpaw (*Carica papaya*) is one of the major fruit crops cultivated in tropical and subtropical zones. Although papaya is mainly grown (>90%) and consumed in

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developing countries, it is fast becoming an important fruit internationally, both as a fresh fruit and as processed products. The classification of papaya has undergone many changes over the years (Parle, 2011). Papaya is believed to prevent and cure a variety of medical conditions including gastric reflux, stomach ulcers and arthritis. Papaya enzyme commonly known as papain are sold as a dietary supplement. However, it also has anti-oxidant properties in stabilizing lipids contributing to its gastro-protective effects (Krishna *et al.*, 2008). Besides, papaya also has a rich source of Vitamin C. Papaya juice exert its gastro protective effect by free radical scavenging action. Carrot *(Daucus carota)* is a horticultural root crop eaten around the world, and it has been popular since ancient times. A naturally occur-ring subspecies of the wild carrot *Daucus carota subsp sativus* has been selectively bred over the centuries to reduce bitterness, increase sweetness, and minimize the woody core (Iorizzo *et al*., 2020). Carrot is rich in hydrophilic phenolic antioxidants which are known for a wide range of health promoting properties such as anticancer, antiatherogenic, anti-inflammatory and antimicrobial (Sun *et al.*, 2009). Production of flour blends from sweet potato, pawpaw and carrot which are underutilized crops could improve food security and conserve the country foreign exchange. The objective of this study is to determine the antioxidant potentials, functional properties and vitamin composition of sweet potato, pawpaw and carrot flour blends.

2. MATERIALS AND METHODS

2.1 Source of materials

The sweet potato, pawpaw and carrot were purchased from "Oja Bisi" market in Ado Ekiti. All the reagents used were of analytical grades.

2.2 Methods

2.2.1 Production of Sweet Potato Flour

The sweet potato roots were sorted, washed with water to remove dirts, peeled, and washed again. The peeled roots were cut into chips and soaked in 0.05 % (w/v) sodium metabisulphite for about 20 min, to prevent browning. The chips were drained, dried in hot air oven at 60°C for 24 h, cooled, milled using hammer mill, and sieved using 250 µm mesh to obtain uniform size flour. It was then packaged in high density polyethylene bag for further use.

2.2.2 Production of Carrot flour

Carrot was washed with clean water, the back was scraped off and cut into 0.3 cm think slices. The carrot was dried at 60°C for 10 hours, cooled, milled using hammer mill and sieved using 250 µm mesh to obtain uniform size flour. It was then packaged in high density polyethylene bag.

2.2.3 Production of Pawpaw flour

The unripe pawpaw was washed with clean water, peeled, cut into two halves, the seeds were removed and the pawpaw was cut into small sizes. The sliced pawpaw was oven dried at 60 °C for 10 hours, cooled, milled using hammer mill and sieved using 250 µm mesh to obtain uniform size flour. It was then packaged in high density polyethylene bag.

2.3 Formulation Ratio of the Flour Blends

The flour blends were mixed at different ratio: 85% Sweet potato 10% Pawpaw and 5% Carrots (SPCB), 70% Sweet potato 20% Pawpaw and 10% Carrots (SPCC), 55% Sweet potato, 30% Pawpaw and 15% Carrots (SPCD), 40% Sweet potato, 40% Pawpaw and 20% Carrots (SPCE) and 100% Sweet potato (SPCA) was used as control.

2.4 Analysis

2.4.1 Antioxidants activities

FRAP was determined as described by Aderinola *et al*., (2018), DPPH was determined as described by Agunbiade *et al.*, 2022, the total phenol (TPC) and total flavonoid content (TFC) were measured according to method described by Chougui *et al*., (2013).

2.4.2 Functional Properties Determination

Bulk Density was determined as described by Asoegwu, (2006), Water Absorption Capacity and Oil Absorption Capacity (AOAC, 2012) and Swelling Index (Vidriales *et al.*, 2020).

2.4.3 Vitamin Composition

The vitamins (vitamin C, vitamin B group, vitamin A and E) were determined according to a previously described method (AOAC, 2012).

3.0 Results and Discussion

3.1 Antioxidant properties of Sweet Potato, Pawpaw and Carrots Flour Blends

The result of antioxidant properties of sweet potato, pawpaw and carrots flour blends are shown in Table 2. The Free Reducing Antioxidant Power (FRAP) content ranges from 22.70 – 26.69 mg/g. The FRAP content increased as the level of supplementation of pawpaw and carrots flour increased. There are significantly different ($p<0.05$) in the values obtained for all the samples while Sample SPCE showed the best antioxidant activity thereby making it more dietary and having the highest rate of reducing oxidative stress diseases (Lushchak *et al.*, 2015).

The DPPH values ranges from 48.96 – 66.30%. Sample SPCB (85% sweet potato, 10% pawpaw and 5% carrot) had the least value while sample SPCA (100% sweet potato) had the highest value. The DPPH content increased as substitution of sweet flour with pawpaw and carrots blends reduces. The samples are significantly different ($p<0.05$). The differences observed could be an indication of differences enhanced due to particle size effect. Sample SPCE has the highest free radical scavenger of hydrogen donors.

Sample SPCE (40% sweet potato, 40% pawpaw and 20% carrots) had the highest total flavonoid (0.30 mg/g) and the least was found in sample SPCB (0.18 mg/g). The differences may be due to the different rate of their substitution level. Sample SPCE which has the highest flavonoid content could tend to regulate cellular activity and fight off free radicals that cause oxidative stress in the body. The values obtained in this study were comparable with the result obtained by Claudia *et al.*, (2013).

The phenolic content of the samples was significantly different ($p<0.05$) ranging between 10.05 – 18.18 mg/g with least value found in sample SPCB, sample SPCE had the highest phenol content. The value increased as the level of substitution increased. According to Adefegha, (2018), the highest phenol content value will have increased nutritional and highest rate of natural antioxidant compounds which are capable of scavenging free radicals, inhibiting oxidases, activating antioxidant enzymes and reducing metallic ions compared to other samples with low phenol content.

3.2 Functional properties of Sweet Potato, Pawpaw and Carrots Flour Blends

The functional properties of sweet potato, pawpaw and carrot flour blends is shown in

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Table 2. Functional characteristics are required to evaluate and possibly help to predict how proteins, fat, fiber and carbohydrates may behave in a specific system. The bulk density ranged from 0.52-0.55 mg/100g. Sample SPCA (100% Sweet potato) and sample SPCC (70% Sweet potato, 20% pawpaw and 10% carrots) recording the highest value of 0.55g/ml respectively and SPCC (70% sweet potato, 20% carica papaya and 10% carrots) recording lowest value of 0.52g/ml. Bulk density is desirable for it great ease at dispersibility and reduction of paste thickness. The low bulk density of the flour blends in sample SPC C could be an advantage in the formulation of complementary foods. The lower bulk density of the flour blends also implies less quantity of the food sample in terms of volume during packaging. The bulk density of this result is in agreement with the report of Iwe *et al*., (2017).

Swelling power (SP) values ranges from 3.00 to 4.20g/g. Sample SPCE recorded the highest value and sample SPCC (70% sweet potato, 20% pawpaw and 10% carrots) has the lowest value. Swelling power connotes the expansion accompanying spontaneous uptake of solvent. Kinsella, (2006) reported that swelling causes changes in hydrodynamic properties of a food thus impacting characteristic such as body, thickening and increase viscosity to foods. Swelling index is the amount of water soluble solids per unit weight of the sample. It is an index of protein functionality such as denaturation and its potential applications. The higher the solubility, the higher the functionality of the protein in a food. The higher swelling power of flours compared to others indicates that the protein component of the samples is still intact. The result obtained is in line with the result of Nuwamanya *et al.*, 2013, a comparative study of sweet potato. Flour with high amylose content tends to have high swelling capacity (Nuwamanya *et al.*, 2013)

The water absorption capacity (WAC) of the flour sample range between 195.00 and 390.00g/ml respectively. According to Banu *et al.*, (2013) who also reported the same observation on sweet potato, pawpaw and carrot flour stated that the polar amino acid in protein and polysaccharides are responsible to varying water absorption. Hence the observation on the water absorption capacity may be a reflection of the protein and carbohydrate contents of the blends (Banu *et al.*, 2013).

The oil absorption capacity range from 200.00-290.00 g/ml. Sample SPC B (85% sweet potato, 10% pawpaw and 5% carrots) and SPC C (70% sweet potato, 20% pawpaw and 10% carrots) has the highest value of oil absorption capacity while sample SPC D (55% sweet potato, 30% pawpaw and 15% carrots) and sample SPC A (100% Sweet Potato) has the least value. Similar findings were observed by Kaushal *et al.*, (2012). However, the flours in the present study would be potentially useful in structural interaction in food, especially in flavor retention, improvement of palatability and extension of shelf life particularly in bakery or products where fat absorption is desired (Aremu *et al.*, 2007). The major chemical component affecting OAC is protein which is composed of both hydrophilic and hydrophobic parts. Non-polar amino acid side chains can form hydrophobic interaction with hydrocarbon chains of lipids (Jitngarmkusol *et al.*, 2008).

3.3 Vitamin Composition of Sweet Potato, Pawpaw and Carrots Flour Blends

The vitamin composition of sweet potato, pawpaw and carrots flour blends is showed

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in Table 3. The samples were significantly different ($p<0.05$). Supplementation of sweet potato with pawpaw and carrot improve the vitamins composition except vitamin B_3 that was reduced as the supplementation increased. Vitamin A ranged from 0.51 to 0.99 mg/100g, vitamin C 2.41 to 4.29 mg/100g, vitamin B_1 0.12 to 0.36 mg/100g, vitamin B_2 0.75 to 1.25 mg/g, vitamin B_3 2.61 to 5.98 mg/100g, vitamin B_6 1.40 to 12.5 mg/100g and vitamin B_9 69.44 to 97.20 mg/100g. Sample SPCE (40% Sweet potato, 40% pawpaw and 20% carrots) has the highest value while sample SPCA (100% Sweet potato) has the least value for all the vitamins except vitamin B_3. Vitamin A helps form and maintain healthy teeth, skeletal and soft tissue, mucus membranes, and skin. It is also known as retinol because it produces the pigments in the retina of the eye. Vitamin A promotes good eyesight, especially in low light. Vitamin B_1 (Thiamine) helps promote the growth and strengthens nerves and muscles in children. It also helps the body convert carbohydrates into energy. Vitamin B_2 (Riboflavin) promotes the production of healthy red blood cells in the body. It also supports energy production and digestive system function. Vitamin B6 (pyridoxine) is important for normal brain development and for keeping the nervous system and immune system healthy. Folic acid is the synthetic form of B9, found in supplements and fortified foods, while folate occurs naturally in foods. Folate is crucial for proper brain function and plays an important role in mental and emotional health. Vitamin B complex is important for making sure that the body's cell is functioning properly. They help body convert food into energy (metabolism). Create new blood cell and maintain healthy skin cells, brain cells and other body tissues (Aroojis *et al.*, 2007).

4.0 Conclusion

The study showed that there is the possibility of producing sweet potato, pawpaw and carrot flour blends with high antioxidant properties. Sample SPCE had the highest antioxidant and vitamin content. The flour blends produced revealed improved quality parameters in terms of the antioxidant, functional and vitamin composition. Supplementation of sweet potato with pawpaw and carrot in the production of composite flour would improve the utilization of these underutilized crops in the production of bakery products.

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Table 1: Antioxidant Properties of Sweet Potato, Pawpaw and Carrots Flour Blends

Sample	Total Flavonoid (mg/100g)	Total Phenol (mg/100g)	FRAP (mg/100g)	DPPH (100%)
SPC A	0.20 ± 0.00^{d}	25.62 ± 10.10^{b}	11.44 ± 0.03^{a}	49.41 ± 0.07^{c}
SPC B	0.18 ± 0.00^{e}	22.70 ± 10.00^{b}	10.05 ± 0.03^{a}	48.96 ± 0.07^{e}
SPC C	0.21 ± 0.00^{c}	25.71 ± 10.00^{b}	17.30 ± 0.03^{a}	51.19 ± 0.07^{c}
SPC D	0.22 ± 0.00^{b}	26.07 ± 10.00^{a}	18.15 ± 0.03^{a}	59.56 ± 0.07^{b}
SPC E	0.30 ± 0.00^{a}	26.69 ± 10.00^{a}	18.18 ± 0.03^{a}	66.30 ± 0.07^{a}

Mean values ± standard deviation along the same column with different superscript are significantly different from each other ($p<0.05$)

Keys:
SPCA -100% Sweet potato
SPCB - 85% Sweet potato, 10% Pawpaw and 5% Carrots
SPCC - 70% Sweet potato, 20% Pawpaw and 10% Carrots
SPCD - 55% Sweet potato, 30% Pawpaw and 15% Carrots
SPCE - 40% Sweet potato, 40% Pawpaw and 20% Carrots

Table 2: Functional properties of Sweet Potato, Pawpaw and Carrots flour blends

Sample	Bulk Density (g/ml)	Swelling Index (ml)	Solubility Index (ml)	Gel Temperature (°C)	Water Absorbtion (g/g)	Oil Absorption (g/g)
SPCA	0.56 ± 0.00^{a}	3.35 ± 0.35^{ab}	0.30 ± 0.10^{a}	79.50 ± 0.05^{a}	195.00 ± 15.00^{c}	220.00 ± 0.00^{b}
SPCB	0.54 ± 0.02^{b}	4.15 ± 0.45^{a}	0.20 ± 0.00^{a}	78.00 ± 0.00^{cd}	230.00 ± 10.00^{c}	290.00 ± 10.00^{a}
SPCC	0.56 ± 0.00^{a}	3.00 ± 0.70^{b}	0.40 ± 0.58^{a}	79.00 ± 0.00^{ab}	315.00 ± 5.00^{a}	290.00 ± 10.00^{a}
SPCD	0.55 ± 0.00^{ab}	3.90 ± 0.40^{a}	0.30 ± 0.00^{a}	78.50 ± 0.50^{bc}	390.00 ± 10.00^{a}	200.00 ± 0.00^{a}
SPCE	0.55 ± 0.00^{ab}	4.20 ± 0.20^{a}	0.20 ± 0.00^{a}	77.50 ± 0.05^{d}	375.00 ± 0.20^{a}	220.00 ± 0.00^{a}

Mean values ± standard deviation along the same column with different superscript are significantly different from each other ($p<0.05$)

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SPCD - 55% Sweet potato, 30% Pawpaw and 15% Carrots
SPCE - 40% Sweet potato, 40% Pawpaw and 20% Carrots

Table 3: Vitamin composition of sweet potato, pawpaw and carrots flour blends

SAMPLE	Vit.A (mg/100g)	Vit.C (mg/100g)	Vit. E (mg/100g)	Vit. B_1 (mg/100g)	Vit. B_2 (mg/100g)	Vit. B_3 (mg/100g)	Vit. B_6 (mg/100g)	Vit B_9 (mg/100g)
SPC A	0.51 ± 0.00^a	2.41 ± 0.00^e	6.90 ± 0.15^e	0.12 ± 0.00^e	0.69 ± 0.00^e	5.98 ± 0.00^a	0.87 ± 0.25^d	69.44 ± 0.03^c
SPC B	0.64 ± 0.00^b	2.75 ± 0.00^d	6.60 ± 0.21^d	0.18 ± 0.00^d	0.75 ± 0.00^d	4.26 ± 0.00^b	1.03 ± 0.21^c	81.78 ± 0.20^b
SPC C	0.73 ± 0.00^e	3.11 ± 0.00^c	9.60 ± 0.15^c	0.19 ± 0.00^c	0.75 ± 0.00^c	3.63 ± 0.00^c	1.14 ± 0.15^b	86.94 ± 0.03^d
SPC D	0.85 ± 0.00^a	3.61 ± 0.00^b	10.90 ± 0.26^b	0.21 ± 0.00^b	0.92 ± 0.00^b	3.19 ± 0.00^d	1.15 ± 0.23^b	92.54 ± 0.04^a
SPC E	0.99 ± 0.00^d	4.29 ± 0.00^a	11.20 ± 0.26^a	0.36 ± 0.00^a	1.25 ± 0.00^a	2.61 ± 0.00^e	1.25 ± 0.20^a	97.20 ± 0.03^e

Mean values ± standard deviation along the same column with different superscript are significantly different from each other ($p<0.05$)

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