IJAAR 9 (2021) 35-41 ISSN 2053-1265

International Journal of Advance Agricultural Research
www.bluepenjournals.org/ijaar

Proximate, mineral compositions and sensory evaluation of peanut burgers incorporated with vegetables

doi.org/10.33500/ijaar.2021.09.003

Babalola Taiwo*, Omobuwajo Taiwo and Akanbi Charles

Department of Food Science and Technology, Faculty of Technology, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

Article History
Received 07 March, 2021
Received in revised form 07 May, 2021
Accepted 11 May, 2021

Keywords:
Vegetables, Peanut burger, Mineral, Proximate, Sensory, Blanching.

Article Type:
Full Length Research Article

ABSTRACT

This work is concerned with the supplementation (enrichment) of peanut burgers by addition of two plants that is, Netlespurge (*Jatropha tajorensis*) and Black nightshade (*Solanum nigrum*) into the coating of the peanuts. These two underutilized vegetables were processed (cleaned, sliced, blanched/unblanched, dried, sieved and packaged) into flour and incorporated into peanut burger snack. The proximate compositions, mineral compositions and sensorial acceptability of the veggie peanut burgers were determined with view of determining the effect of blanching and drying at different temperatures on the coated peanuts. Inclusion of vegetables to peanut burgers increased the protein content but decreased the moisture content. Calcium (4.18 – 7.88 mg/100 g), magnesium (19.83 – 34.97 mg/100 g), manganese (4.80 – 6.95 mg/100 g), sodium (1.23 – 16.86 mg/100 g), potassium (1.96 – 8.26 mg/100 g) and phosphorus (5.15 – 7.10 mg/100 g) increased upon inclusion of vegetable to peanut burgers (Ca – 1.94 mg/100 g, Mg – 0.43 mg/100 g, Mn – 0.11 mg/100 g, Na – 0.77 mg/100 g, K – 0.80 mg/100 g and P – 0.77 mg/100 g). In overall acceptability, veggie peanut burgers were preferred based on crispiness, mouthfeel and flavor. Peanut burgers from blanched vegetable leaves were preferred to those from unblanched vegetable leaves and those of oven-dried samples were preferred to those from sun-dried samples. The paper highlighted the enrichment of the peanut burger with some minerals like calcium, magnesium, manganese, sodium, potassium, and phosphorus.

INTRODUCTION

The joint FAO/WHO (2004) discussion on food, nutrition and the prevention of chronic diseases endorsed at least 400 g consumption of vegetables every day (FAO/WHO, 2004). In 2004, WHO refocused consideration on this via its universal policy on food, bodily activities and health. During the mutual Kobe (Japan) workshop on fruits and vegetables for health, both WHO and FAO established an agenda that suggested means of encouraging increase, manufacture, convenience, access and greater consumption vegetables (FAO/WHO, 2004).

Vegetables which are usually in small quantity in diets play an essential function as a source of nutrient in sustaining good health (Mohammed and Sharif, 2011). Nutrients been supplied by vegetables after been absorbed are used as regulatory and protective materials, and also for body building. Vegetables have become substantial part of human foods providing the body with little calories and significant quantities of essential minerals and vitamins (Fasuyi, 2006).

The little caloric content of vegetables is of significance; plants produce food in the leaves but do not hoard food in the leaves. Accordingly, vegetables do not provide

*Corresponding author. E-mail: taiworacheal@yahoo.com.

excessive energy to the body. The fibres in vegetables are identified for promoting digestion and preventing constipation (Aliyu, 2006). Vegetables' lipids (fat and oil) are phyto origin and as such do not contribute to the occurrence of diseases associated with coronary artery failure (Onunogbu, 2002). Vegetables had also been classified as possessing antioxidative properties.

Netlespurge vegetable (*Jatropha tanjorensis)* also known as *iyana ipaja* or *hospital too far* belongs to the family of *Euphorbiacea*. It is grown in the tropics and the leaves are used as a soup ingredient in place of other locally available vegetables (Watt and Breyer –Brandwijk, 1992). Black Nightshade vegetable (*Solanum nigrum*) also known as *odu* is an annual plant. It is usually eaten as prepared accompaniment to the main basic meal like yam, cocoyam, cassava, etc. (Ajala, 2009). It is an easily available plant in African continent and Europe (Atanu et al., 2011).

Antioxidants as chemical constituents provides electron to the free radical and changes it to a inoffensive molecule (Olayinka et al., 2012). Antioxidants are those materials that interrupt free radical and protect cells from the oxidative damage causing aging and diseases. It also thwart injury to blood vessel membranes, it augments the flow of blood to the heart as well as the brain. It is a defensive measure against cancerous DNA and it lessens the hazard of cardiovascular diseases. Supply of antioxidants to the body system is via our eating, majority are obtained from fruits, grains and vegetables (Olayinka et al*.,* 2012).

In this present dispensation when the role of a healthy diet in preventing non-communicable diseases is well accepted, the borderline between food and medicine is becoming very thin (Abuajah et al., 2015). Focus is now majorly on fast foods and snacks, how to reduce if not eliminate their hazardous effects on the health of consumers. Functional foods bridge the gap between these foods and health. Functional foods are foods with nutritional health benefits.

Snack foods are the items eaten for pleasure and during relaxation, they play vital roles in our day to day life. These include peanut/groundnut burger; deep fried potato chips, biscuits, sausages, doughnuts, etc. Civilization has changed our eating lifestyle making us more dependent on snack foods. Health related issues are also increasing among the people. Though warnings had been given by nutritionists concerning the eating of fried foods, which contain enormous quantities of calories, cholesterols and saturated fats, the demand for it is still on increase daily. In order to maintain a healthy lifestyle, the consumption of fat-based foods should be moderated (Vinothini et al., 2015).

Peanut burger snack is a very simple crunchy snack. It is as well a spicy and delicious treat. Some Nigerians ometimes call this snack 'groundnut burger' or 'coated peanut' however, one thing is common, it is simply coated with flour and sugar. It is a fried snack prone to lipid oxidation. Fortifying peanut burger with these vegetables (*J. tanjorensis* and *S. nigrum*) could delay rancidity thereby extending the shelf life of the peanut burger and as well protecting the consumer's health.

Peanut burger is a fried snack prone to lipid oxidation. Additionally, peanuts have the tendency to be contaminated with aflatoxin microbial activities. With respect to these factors, protection techniques are imperative to peanut snacks. Coating with protein based isolate has been studied but its contribution to long term storage of peanut was discovered to be uncertain (Han et al., 2009). Arya et al. (2015) suggested additional impact of coating on peanuts. This study proposed the coating/fortifying peanut burger with Black nightshade and Netlespurge. It is believed that oxidation would be inhibited thereby extending the shelf life of the peanut burger and as well protecting the consumer's health.

MATERIALS AND METHODS

Material Collection

Netlespurge (*J. tanjorensis*) vegetable was harvested from Obafemi Awolowo University Teaching and Research Farm, Ile-Ife, Nigeria. Black nightshade (*S. nigrum*) vegetable was bought *in situ* from a farmer in Ile-Ife, Nigeria. Flour, vegetable oil, salt, eggs, peanuts/groundnuts and sugar were obtained from retail outlets in Ile-Ife. All chemicals used were of analytical grade.

Sample preparation

Netlespurge and Black nightshade samples were prepared according to the modified method of Okpala and Ekechi (2014). Freshly harvested vegetable leaves of (*J. tanjorensis*) and (*S. nigrum*) were washed, destalked, and sliced using a sharp kitchen knife. Each vegetable type was then separated into two equal portions; one portion was blanched in water at 100°C for 60 s while the second portions were not blanched. This step was followed by different drying techniques: sun and oven (50 and 60°C).

Experimental design

Types of vegetables (Netlespurge and Black nightshade)	2
Treatments (Blanched/Unblanched)	2
Drying methods (Sun, Oven: 50 and 60°C)	3
Total number of samples	12

Production of veggie peanut burger

Peanut burger was prepared according to the modified

method described by Christina (2016) using the recipe itemized in Table 1. Dried vegetable leaves prepared according to Figure 1 were milled and sieved. Fresh peanuts were sorted, rinsed, blanched at 100°C for 15 min, strained and air-dried at room temperature (27°C ± 2°C) for 24 h. Sugar was stirred with whisked egg and the solution was simultaneously sprinkled alongside with flour (wheat and vegetable) and salt on the peanuts. The process was repeated till all the peanuts were evenly coated after which it was deep fried, strained and packaged.

Proximate composition determination

Protein, fat, moisture, fibre and ash contents were determined using the crude method of AOAC (2000). Carbohydrate content was determined by method of difference between 100 and the addition of other proximate parameters. The energy values of the peanut burgers were calculated from their fat, protein and carbohydrate contents.

Energy value (kJ/g) = [(9 x fat) + (4 x protein) + (4 x carbohydrate)]

Mineral element analysis

Analyses for mineral element were determined using atomic absorption spectrophotometric method by Fashakin et al. (1991). Calcium, magnesium and manganese were determined on the Atomic Absorption Spectrophotometer (Perkin Elmer, model 402, England). Sodium and potassium were determined by flame photometry while phosphorus was determined by using the Vanodo-molybdate method.

Veggie burger evaluation

This was done according to the method of Akindele et al. (2017), a 9-point hedonic scale assessment was used.

Statistical analysis

All analyses were done in triplicate and data obtained were subjected to appropriate statistical analyses. Microsoft Excel 2010 was used for analyzing the raw data. SPSS 16.0 was used for the data grading.

RESULTS AND DISCUSSION

Proximate compositions

The results of the proximate compositions of the samples are presented in Table 2. It was observed that inclusion of vegetable flour to peanut burger reduced its moisture content, similar results had been reported (Akindele et al., 2017; Akande et al., 2018). Fortification increased the protein content of the peanuts, this is in accordance to reported works (Oluwole and Karim, 2005; Olatidoye and Sobowale, 2011; Akindele et al., 2017). Increase in protein content of the veggie peanut burgers might be due to the addition of vegetables. Energy value synonymously referred to as calorific value is the amount of calories in food, indicating the levels of utilizable energy (IFIS Publishing, 2005). Protein, fat and carbohydrate contribute to the energy value of a substance. It was calculated based on the concentration of fat, protein and carbohydrate. Energy is required for daily activities, it is an important parameter in food/drinks label. It is therefore necessary to know the amount of energy that will be derived from these vegetables and their peanut burgers.

Blanching had significant ($p > 0.5$) effect on the samples. Blanched samples had lower moisture, protein, ash, fat, fibre and carbohydrate contents than the unblanched samples. Arisa et al. (2013) suggested that the ruptured cell membrane during blanching allows for greater internal diffusion during drying. Thus, favouring greater water removal of blanched samples during drying than the unblanched samples. Oboh (2005) observed that protein content will reduce owning to protein cellular denaturation during blanching. Njoroge et al. (2015) however reported that it might be attributed to leaching out of nitrogen compound during blanching. Egbuonu and Nzewi (2016) suggested that the volatile fatty acids might have evaporated with the steam during blanching.

Drying temperature affected the moisture content of all samples. Oven-dried samples had higher moisture, protein, ash, fibre, fat and carbohydrate contents than the sun-dried counterpart. Abasi et al. (2009) observed lower moisture content for samples dried at higher temperatures and high moisture contents for samples dried at lower temperatures. It was observed that exposure of samples to high heat intensity reduced the protein content of samples. This could be explained by denaturation. According to IFIS Publishing (2005) denaturation is the structural change that occurs in proteins in response to extreme conditions of temperature, which renders the molecule incapable of performing its original function.

Mineral compositions

Table 3 shows the results of the mineral compositions. Fortification of peanut burger with vegetables increased the calcium, magnesium, sodium, potassium, phosphorus and manganese content of the peanut burgers (Fasogbon et al., 2017). These veggie peanut burgers will contribute to the recommended dietary allowance (RDA) when consumed, it could be a choice snack for sodium, calcium,

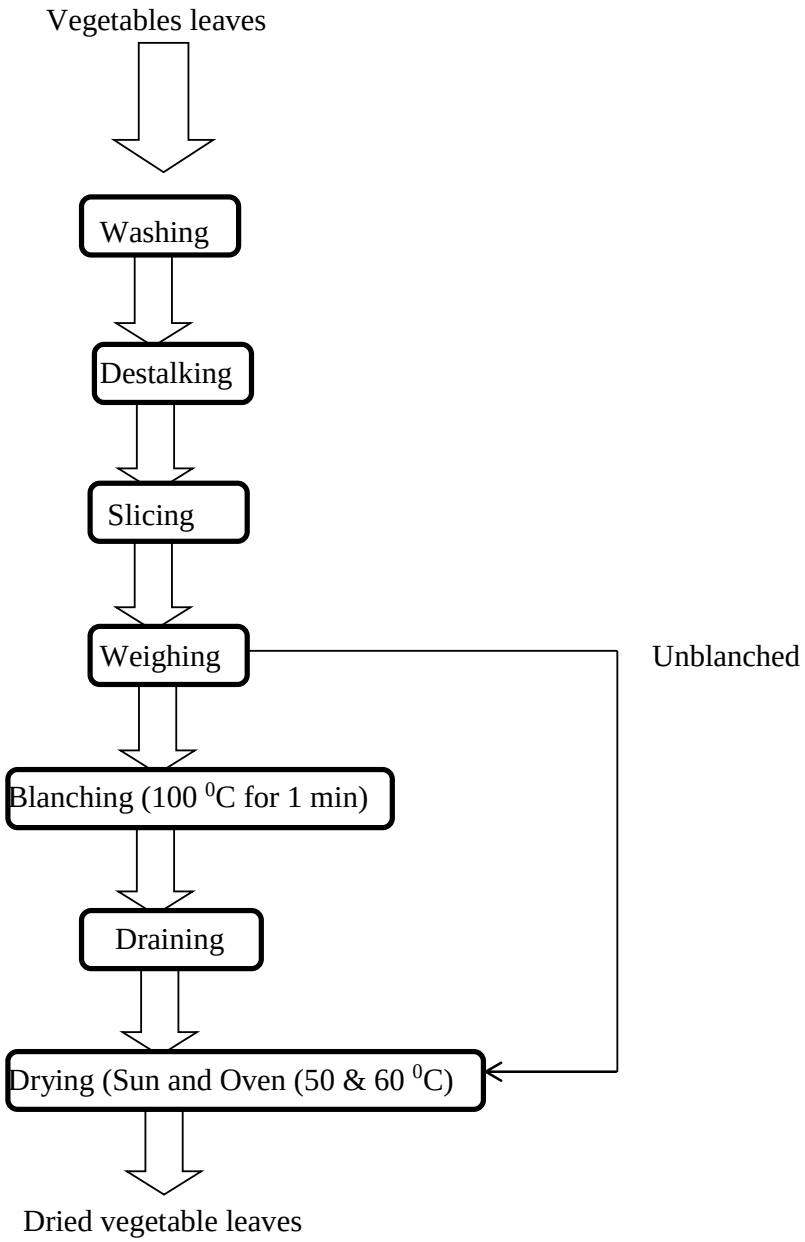

Figure 1. Flowchart for dried blanched and unblanched vegetable leaves processing modified method of Okpala and Ekechi (2014).

Table 1. Veggie peanut production recipe.

Ingredients	Quantity (g)
Peanut	100.0
Wheat flour	50.0
Sugar	20.0
Eggs	30.0
Salt	2.0
Vegetable flour	1.0

Table 2. Proximate composition (% db) and energy value (kcal/g) of veggie peanut burger from Black Nightshade and Netlespurge vegetables.

Sample	Moisture	Protein	Ash	Fat	Fibre	Carbohydrate	Energy value
USO	5.25 ± 0.09^{c}	9.10 ± 0.21^{b}	4.69 ± 0.41^{ab}	0.45 ± 0.01^{a}	14.79 ± 0.07^{b}	70.96 ± 0.63^{c}	77.54
BSO	4.20 ± 0.00^{d}	7.47 ± 0.69^{c}	4.36 ± 0.07^{ab}	0.41 ± 0.00^{b}	10.73 ± 0.01^{d}	77.03 ± 0.77^{a}	81.66
ULO	7.58 ± 0.16^{b}	11.19 ± 0.02^{a}	4.99 ± 0.82^{ab}	0.46 ± 0.00^{a}	16.65 ± 0.04^{a}	66.70 ± 1.03^{d}	75.46
BLO	5.14 ± 0.04^{c}	10.37 ± 0.08^{a}	4.09 ± 0.01^{b}	0.42 ± 0.01^{b}	12.56 ± 0.08^{c}	72.56 ± 0.05^{b}	80.18
UHO	7.50 ± 0.10^{b}	10.86 ± 0.02^{a}	4.69 ± 0.06^{ab}	0.41 ± 0.00^{b}	10.80 ± 0.07^{e}	73.24 ± 0.01^{bc}	81.28
BHO	4.28 ± 0.15^{d}	9.58 ± 0.01^{b}	4.39 ± 0.00^{ab}	0.34 ± 0.00^{c}	8.13 ± 0.01^{f}	77.55 ± 0.16^{a}	84.04
USI	5.26 ± 0.15^{d}	7.18 ± 0.01^{e}	4.17 ± 0.22^{b}	0.43 ± 0.01^{bc}	10.64 ± 0.01^{b}	77.57 ± 0.06^{c}	81.95
BSI	1.01 ± 0.01^{g}	6.87 ± 0.01^{e}	2.83 ± 0.02^{c}	0.38 ± 0.00^{d}	8.08 ± 0.00^{d}	81.84 ± 0.14^{a}	85.63
ULI	6.36 ± 0.08^{b}	11.06 ± 0.02^{a}	5.78 ± 0.23^{a}	0.49 ± 0.01^{a}	11.15 ± 0.04^{a}	71.53 ± 0.33^{e}	80.009
BLI	3.06 ± 0.04^{f}	8.94 ± 0.01^{b}	4.50 ± 0.44^{b}	0.40 ± 0.01^{d}	10.30 ± 0.01^{c}	75.86 ± 0.42^{c}	81.93
UHI	5.67 ± 0.17^{c}	7.97 ± 0.18^{c}	5.41 ± 0.17^{a}	0.41 ± 0.00^{cd}	8.49 ± 0.04^{d}	77.72 ± 0.07^{c}	82.81
BHI	4.20 ± 0.02^{e}	7.64 ±0.04^{d}	4.37 ± 0.12^{b}	0.35 ± 0.01^{e}	7.30 ± 0.01^{e}	80.34 ± 0.02^{b}	84.86
Control	8.66 ± 0.18^{a}	7.32 ± 0.00^{e}	5.52 ± 0.38^{a}	0.46 ± 0.01^{b}	7.60 ± 0.01^{e}	79.10 ± 0.55^{d}	83.61

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within same column are significantly ($p < 0.05$) different.
Key: USO; Unblanched sun-dried "*Odu*" (*S. nigrium*); BSO, blanched sun-dried "*Odu*" (*Solanum nigrium*); ULO, unblanched "*Odu*" (*S. nigrium*) oven-dried at 50; °CBLO, blanched "*Odu*" (*Solanum nigrium*) oven-dried at 50C; UHO, unblanched "*Odu*" (*S. nigrium*) oven-dried at 60°C; BHO, blanched "*Odu*" (*S. nigrium*) oven-dried at 60°C; USI, unblanched sun-dried "*Iyana Ipaja"* (*J. tanjorensis*); BSI, blanched sun-dried "*Iyana Ipaja"* (*J. tanjorensis*); ULI, unblanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 50°C; BLI, blanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 50°C; UHI, unblanched "*Iyana Ipaja" Jatropha tanjorensis* oven-dried at 60°C; BHI, blanched "*Iyana Ipaja"* (*Jatropha tanjorensis*) oven-dried at 60°C.

Table 3. Mineral composition (mg/100 g) of veggie peanut burger from Black Nightshade and Netlespurge vegetables.

Sample	Calcium	Magnesium	Manganese	Sodium	Potassium	Phosphorus
USO	7.60 ± 0.26^{bc}	34.13 ± 0.09^{b}	6.87 ± 0.07^{a}	1.45 ± 0.03^{c}	7.30 ± 0.23^{b}	6.94 ± 0.05^{a}
BSO	7.44 ± 0.03^{c}	33.80 ± 0.06^{d}	6.57 ± 0.08^{b}	1.23 ± 0.02^{d}	6.93 ± 0.05^{c}	6.45 ± 0.20^{c}
ULO	7.88 ± 0.07^{a}	36.62 ± 0.17^{a}	6.95 ± 0.04^{a}	1.76 ± 0.03^{a}	8.26 ± 0.08^{a}	7.10 ± 0.51^{a}
BLO	7.67 ± 0.03^{b}	33.94 ± 0.05^{cd}	6.54 ± 0.12^{b}	1.69 ± 0.03^{b}	7.06 ± 0.06^{c}	6.44 ± 0.19^{c}
UHO	7.85 ± 0.03^{a}	34.07 ± 0.05^{bc}	6.59 ± 0.23^{b}	1.68 ± 0.02^{b}	6.18 ± 0.07^{d}	6.73 ± 0.04^{b}
BHO	7.52 ± 0.02^{bc}	30.32 ± 0.10^{e}	5.87 ± 0.09^{c}	1.64 ± 0.03^{b}	5.89 ± 0.11^{e}	6.25 ± 0.07^{c}
USI	4.77 ± 0.03^{d}	24.67 ± 0.39^{b}	5.20 ± 0.20^{c}	15.40±0.12^{ab}	3.06 ± 0.05^{b}	6.06 ± 0.04^{b}
BSI	4.36 ± 0.03^{e}	19.83 ± 0.06^{f}	4.80 ± 1.17^{d}	9.32 ± 0.11^{c}	2.92 ± 0.02^{b}	5.15 ± 0.06^{d}
ULI	5.08 ± 0.04^{a}	26.60 ± 0.18^{a}	6.07 ± 0.04^{a}	16.86 ± 0.06^{a}	4.32 ± 0.16^{a}	6.41 ± 0.02^{a}
BLI	4.87 ± 0.03^{c}	22.28 ± 0.16^{d}	5.87 ± 0.11^{b}	16.43±0.10^{ab}	4.09 ± 0.04^{a}	5.25 ± 0.06^{c}
UHI	5.00 ± 0.04^{b}	23.74 ± 0.30^{c}	5.81 ± 0.16^{b}	15.8 ± 0.08^{ab}	2.47 ± 0.12^{c}	6.09 ± 0.03^{b}
BHI	4.18 ± 0.06^{f}	20.29 ± 0.17^{e}	5.23 ± 0.09^{c}	14.07± 3.43^{b}	1.96 ± 0.02^{d}	5.15 ± 0.04^{d}
Control	1.94 ± 0.02^{g}	0.43 ± 0.02^{g}	0.11 ± 0.03^{e}	0.77 ± 0.02^{d}	0.80 ± 0.03^{e}	0.77 ± 0.02^{e}

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within same column are significantly ($p < 0.05$) different.
Key: USO, Unblanched sun-dried "*Odu*" (*S. nigrium*); BSO, blanched sun-dried "*Odu*" (*S. nigrium*); ULO, unblanched "*Odu*" (*S. nigrium*) oven-dried at 50°C; BLO, blanched "*Odu*" (*S. nigrium*) oven-dried at 50°C; UHO, Unblanched "*Odu*" (*S. nigrium*) oven-dried at 60°C; BHO, blanched "*Odu*" (*S. nigrium*) oven-dried at 60°C; USI, unblanched sun-dried "*Iyana Ipaja"* (*J. tanjorensis*); BSI, blanched sun-dried "*Iyana Ipaja"* (*J. tanjorensis*); ULI, unblanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 50°C; BLI, blanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 50°C; UHI, unblanched "*Iyana Ipaja" J. tanjorensis* oven-dried at 60°C; BHI, blanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 60°C.

Table 4. Sensory evaluation of veggie peanut burger from black Nightshade and Netlespurge vegetables.

Sample	Appearance	Crunchiness	Flavour	Taste	Overall impression
USI	5.0 ± 1.91^{d}	6.8 ± 1.32^{ab}	6.4 ± 1.27^{b}	6.2 ± 1.46^{abcd}	6.3 ± 1.38^{abc}
BSI	5.5 ± 1.51^{bcd}	6.7 ± 1.57^{ab}	6.5 ± 1.45^{b}	6.5 ±1.20^{abc}	6.4 ± 1.45^{abc}
ULI	5.5 ± 1.51^{bcd}	7.2 ± 1.36^{a}	6.6 ± 0.95^{b}	6.3 ± 1.18^{abc}	6.6 ± 0.87^{abc}
BLI	6.2 ± 1.63^{abcd}	6.7 ± 1.70^{ab}	6.7 ± 1.26^{b}	6.9 ± 1.14^{ab}	6.6 ± 1.12^{abc}
UHI	6.0 ± 1.35^{bcd}	7.5 ± 0.78a	6.8 ± 1.18^{b}	6.8 ± 0.90^{ab}	6.6 ± 1.19^{abc}
BHI	5.1 ± 1.90^{cd}	7.3 ± 1.44^{a}	6.9 ± 1.17^{b}	6.8 ± 1.09^{ab}	7.2 ± 0.69^{a}
Control	7.4 ± 1.39^{bcd}	4.5 ± 1.61^{de}	5.5 ± 1.66^{b}	5.6 ± 1.56^{bcd}	6.00 ± 1.87^{abc}
USO	6.0 ± 1.78^{bcd}	5.5 ± 1.27^{b}	4.8 ± 1.52^{cde}	6.2 ± 1.14^{b}	5.6 ± 1.50^{c}
BSO	5.9 ± 1.26^{bcd}	5.9 ± 1.32^{b}	4.2 ± 1.24^{e}	6.3 ± 1.17^{b}	5.7 ± 1.44^{c}
ULO	5.5 ± 1.27^{bcd}	5.8 ± 1.24^{b}	5.8 ± 1.41^{bc}	6.2 ± 0.99^{b}	5.8 ± 1.41^{bc}
BLO	5.5 ± 1.20^{bcd}	6.5 ± 1.72^{a}	5.6 ± 1.90^{bcd}	6.8 ± 1.14^{b}	6.2 ± 1.34^{abc}
UHO	5.7 ± 1.44^{bcd}	5.8 ± 1.54^{b}	7.3 ± 1.38^{a}	6.7 ± 1.25^{b}	6.4 ± 1.71^{abc}
BHO	6.4 ± 1.04^{abc}	6.1 ± 1.44^{b}	6.5 ± 1.39^{ab}	7.1 ± 1.14^{a}	6.9 ± 0.86^{ab}
Control	6.8 ± 1.09^{ab}	6.5 ± 1.13^{b}	3.8 ± 2.03^{e}	6.3±1.25^{b}	5.6 ± 1.26^{c}

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within same column are significantly ($p < 0.05$) different.
Key: USI, Unblanched sun-dried "*Iyana Ipaja"* (*J. tanjorensis*); BSI, blanched sun-dried "*Iyana Ipaja"* (*Jatropha tanjorensis*); ULI, unblanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 50°C; BLI, blanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 50°C; UHI, unblanched "*Iyana Ipaja"* (*J. tanjorensis)* oven-dried at 60°C; BHI, blanched "*Iyana Ipaja"* (*J. tanjorensis*) oven-dried at 60°C; USO, Unblanched sun-dried "*Odu*" (*S. nigrium*); BSO, blanched sun-dried "*Odu*" (*S. nigrium*); ULO, unblanched "*Odu*" (*S. nigrium*) oven-dried at 50°C; BLO, blanched "*Odu*" (*S. nigrium*) oven-dried at 50°C; UHO, unblanched "*Odu*" (*S. nigrium*) oven-dried at 60°C; BHO, blanched "*Odu*" (*S. nigrium*) oven-dried at 60°C.

magnesium, manganese, sodium, potassium and phosphorus deficiencies.

Sensory evaluation

Table 4 shows the results of the sensory evaluation of veggie peanut burger. All samples scored above 4 (dislike slightly) on a 9-point hedonic scale. Blanching and drying temperature affected the acceptability of the veggie peanut burgers. It was observed that veggie peanut burgers from blanched vegetable samples were preferred to veggie peanut burger from unblanched vegetable samples. This might be because the colour of blanched samples was better preserved while those of the unblanched samples were not preserved. Drying temperature affected the appearance acceptability of the veggie peanut burgers, oven-dried samples were preferred to sun-dried samples that is, 50°C > 60°C > sun. This might be the effect of sun exposure on the vegetable leaves. The control samples were best preferred in appearance for both vegetables while veggie peanut burgers' crispiness and flavor were preferred.

Conclusion

It is concluded that the inclusion of vegetables to peanut burgers increased their proximate and mineral concentration as exemplified by increased calcium, magnesium, sodium, potassium, phosphorus and manganese content of the peanut burgers compared to the control. It also enhances their sensorial acceptability with respect to taste, crunchiness, flavor and overall acceptability of the peanut burger to which the two vegetables have been added.

REFERENCES

Abasi S., Mousavi M., Mohebi M. & Kiani S. (2009). Effect of time and temperature on moisture content, shrinkage and rehydration of dried onion. Iran. J. Chem. Eng. 6(3):57-70.

Abuajah C. I., Ogbonna A. C. & Osuji C. M. (2015). Functional components and medicinal properties of food: A review. J. Food Sci. Technol. 52(5):2522-2529.

Ajala L. (2009). The effect of boiling in the nutrient and ant-nutrient in two non-conventional vegetables. Pak. J. Nutr. 8(9):1430-1433.

Akande O. A., Jolayemi O. S., Familusi A. & Idowu B. (2018). Nutritional, antioxidant and sensory properties of rice-based *Masa* enriched with grain amaranth and carrot powder. Ann. Food Sci. Technol. 19(4):645-656.

Akindele O., Gbadamosi O. & Taiwo K. (2017). Proximate, mineral, sensory evaluations and shelf stability of *Chinchin* enriched with *Ugu* and Indian spinach vegetables. Int. J. Biochem. Res. Rev. 18(4):1-14.

Aliyu H. M. (2006). Proximate analysis of some leafy vegetables' (Roselle Jute and Bitter Leaf). Int. J. Food Agric. Resour. 3(1):112.

AOAC (2000). Association of Official Analytical Chemists. Official Methods of Analysis. 17th edition.

Arisa N. U., Adelekan A. O., Alamu A. E. & Ogunfowora E. J. (2013). The effect of pretreatment of plantain (*Musa parasidiaca*) flour on the pasting and sensory characteristics of biscuit. Int. J. Food Nutr. 2(1):2165-5316.

Arya S. S., Chauhan S. & Salve A. (2015). Peanuts as functional food: a review. (*Euphorbiaceae*), Syst. Bot. 9:467-478.

Atanu F. O., Ebiloma U. G. & Ajayi E. L. (2011). A review of the pharmacological aspects of *Solanum nigrum* Linn. Biotechnol. Mole. Biol. Rev. 6(1):1-7.

Christina (2016). Nigerian peanut burger snack recipe and peanut production as business venture. Glitters, twinkles and sparkles blog. Worldpress.com.

Egbuonu A. C. C. & Nzewi D. C. (2016). Influence of blanching on some nutrient and anti-nutrient compositions of bitter yam (*Dioscorea dumetorum*). Brit. J. Appl. Sci. Technol. 16(2):1-8.

FAO/WHO (2004). United Nations Food and Agriculture Organization/World Health Organization: Fruits and vegetables for health. Report of a joint FAO/WHO Workshop, Kobe, Japan.

Fashakin J. B., Ilori M. O. & Olarewaju I. (1991). Cost and quality optimization of a complementary diet from plant protein and corn flour using a computer aided linear programming model. Nig. Food J. 9:123-126.

Fasogbon B. M., Taiwo K. A. & Oyedele D. J. (2017). Nutritional assessment and consumer acceptability of snacks (Chinchin and cookies) enriched with underutilized indigenous vegetables. Int. J. Food Nutr. Sci. 6(3):2320-7876.

Fasuyi A. O. (2006). Nutritional potentials of some tropical vegetable leaf meals: Chemical characterization and functional properties. Afr. J. Biotechnol. 5:49-53.

Han J., Bourgeois S. & Lacroix M. (2009). Protein-based coatings on peanut to minimize oil migration. Food Chem. 115:462-468.

International Food Information Service (IFIS) (2005). The dictionary of food science and technology. Published by Blackwell, ISBN 10:1-4051-2505-5. ISBN 13:978-14051-2505-5.

Mohammed M. I. & Sharif N. (2011). Mineral composition of some leafy vegetables consume in Kano Nigeria. Nig. J. Basic*Appl. Sci. 19:208-211.

Njoroge E. W., Matofari J. W., Mulwa R. M. & Anyango J. O. (2015). Effects of blanching time/temperature combination coupled with solar-drying on the nutritional and microbial quality of indigenous leafy vegetables in Kenya. Afr. J. Food Sci. Technol. 5(2):168-173.

Oboh G. (2005). Hepatoprotective property of ethanolic and aqueous extracts of *Telfairia occidentalis* (Fluted Pumpkin) leaves against garlic-induced oxidative stress. J. Med. Food 8:560-563.

Okpala L. C. & Ekechi C. A. (2014). Rehydration characteristics of dehydrated West African pepper (*Piper guineense*) leaves. Food Sci. Nutr. J. 2(6):664-668.

Olatidoye O. P. & Sobowale S. S. (2011). Effect of full-fat soy-bean flour on the nutritional, physicochemical properties and acceptability of cassava flour. Elect. J. Environ. Agric. Food Chem. 10(3):1994-1997.

Olayinka O. O., Kareem A. M., Ariyo I. B., Omotugba S. K. & Oyebanji A. O. (2012). Antioxidant contents (Vitamin C) of raw and blanched different fresh vegetable samples. Food Nutr. Sci. 3:18-21.

Oluwole O. B. & Karim O. R. (2005). Production of biscuits from Bambara, Cassava and wheat flour blends. J. Raw Mater. Resour. 2(1):34-38.

Onunogbu I. C. (2002). Lipids in human existence, 1st ed.; AP Express Publishing Company: Nsukka, Nigeria.

Vinothini K., Sasikala S., Anjana B. & Sandra A. M. (2015). Storage studies of Indian Fried Snack Food Incorporated with Ivy Gourd. IJLTEMAS. 4(4):2278-2540.

Watt J. M. & Breyer–Brandwijk M G. (1992). The medicinal and the poisonous plant of Southern and Eastern Africa. 2nd, Ed. S. Livingstone Ltd Edinburgh, London.