



Proximate and Metal Composition of Buckwheat Groats Cultivated in Selected Town in Enugu State, Nigeria

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ABSTRACT

The proximate and metal content of buckwheat (*Fagopyrum esculentum*) samples obtained from four different villages of Enugu State, Eastern Nigeria was analyzed. Moisture content was determined by oven dehydration method at 105°C. Crude protein was determined using Kjeldhal method, Crude fat was obtained by extraction method using sohxlet. Crude fiber was obtained by Acid and Alkali digestion methods. Ash content was determined in muffle furnace at 550°C for 6 hours. Carbohydrate content was obtained by difference, subtracting the sum of protein, fat, crude fibre and ash percentages from one hundred. Calcium, Sodium, Potassium and Magnesium were determined by flame photometric method while zinc, lead, Cadmium, Copper, Nickel and Chromium were obtained by atomic absorption spectrophotometric method. The results of the present investigation revealed that buckwheat species from the four sampling sites (Abor, Obinagu and Umuagu and Nkwere), showed considerable high concentration of protein, fat, and ash, and low nitrogen free extract and fiber. Gluten content was not detected in all the samples. Moderate amount of potassium and sodium recorded in this study reveals that buckwheat groat is a good source of food for patients with hypertension. Minerals such as calcium, zinc, phosphorus, iron, potassium and sodium were also detected in appreciable amounts. However, buckwheat can be safely eaten by people who have celiac disease as it does not contain gluten. Buckwheat can be a good substitute for wheat, oats, rye and barley in a gluten-free diet. Buckwheat's well-balanced starch, protein, fat and mineral composition has found a renewed interest, particularly among the food scientists. Additionally, its seeds compose proportionately of more starch and less fat content than fellow oil seeds hence can be handled in a similar way like any other staple grains. Being a short-season crop and sustainable characteristic of thriving under drought conditions, it can be a solution for malnutrition alleviation programs, particularly in famine-prone regions.

Keywords: Buckwheat, Composition, Groat, Enugu – Nigeria, Mineral, Nutritional Content, Proximate

INTRODUCTION

Buckwheat (*Fagopyrum esculentum*) is a dicotyledonous plant cultivated for its grain - like seeds and as a cover crop. It belongs to the Polygonaceae family; it is usually considered a cereal in agriculture and in food technology because of its usage and the cultivation techniques used (Bonafaccia *et. al.*, 1994). Despite its name, buckwheat is not related to wheat and is not a true cereal grain, but rather, it is a fruit plant (*Fagopyrum genus*) belonging to the same family as rhubarb (USDA, 2010; USDA, 2013). While it is of similar size to wheat kernels, it features a unique

triangular shape. Buckwheat groats are the raw buckwheat kernels with their inedible black hull removed. They are either white (unroasted) or brown (roasted) in colour. It originates from inland Southeast Asia, and then spread to Central Asia and Tibet, then to the Middle East and Europe (Bonafaccia *et. al.*, 1994). The agricultural features which have first and foremost encouraged its cultivation in such varied regions are primarily that buckwheat is semi wild, does not have particular soil or fertilization requirements and can, furthermore, grow at high altitudes (Faizullah *et. al.*, 2013). In Nigeria, it is processed for food in the

form of buckwheat groats, buckwheat flour, buckwheat hulls and buckwheat honey. Buckwheat is present in different variety produced locally and reproduced annually. In comparison with traditional cereals, buckwheat proteins are high in lysine, which makes it interesting from a nutritional point of view. Like soybeans, the whole grains are good sources of phytoestrogens - plant compounds that may affect blood cholesterol level, blood vessel elasticity, bone metabolism, and many other cellular metabolic processes. An interesting feature is represented by its rich supply of flavonoids, particularly rutin, plant lignans and the lack of gluten, due to the almost total absence of prolamin. It could therefore be used as a substitute for wheat in gluten - free diets for celiac patients. It was reported by Ötles and Cagindi, (2006) that buckwheat has been used as an important raw material for functional food development because of its functionalities and compounds content, such as proteins, flavonoids, phyosterols, among others. It was further reported that Rutin, a secondary metabolite present in buckwheat, has shown anti-inflammatory, anticancer, antiatherogenic, and antioxidant activity (Kreft *et al.*, 2006; Zhang *et al.*, 2012). Buckwheat protein extracts have been related to cholesterol - lowering and anticancer effects in animals (Liu *et al.*, 2001; Tomotake *et al.*, 2006). Incorporation of buckwheat into bread has proved to significantly lower postprandial blood glucose and insulin responses compared to white wheat bread (Skrabanja *et al.*, 2001). Literature reveals that *Fagopyrum esculentum* contains a variety of nutrients, due to the unpopular nature of this food in this part of the world, there is need for this study to examine the nutritional and metal composition of buckwheat groat cultivated in different villages in Enugu State, South – East Nigeria, create a link between the nutritional profile of the tested species and individuals, residence in Nigeria.

MATERIALS AND METHODS

Sample Preparation

Four samples of common buckwheat (*Fagopyrum esculentum*) were obtained from four different villages around Enugu State, Eastern Nigeria, namely: Obinagu, Abor, Umuagu and Nkwere towns. The husks of the buckwheat samples were removed manually - the whole kernel, deprived of its external hull, was removed. A portion of the sample was milled using a Cyclotec laboratory Mill with a 1mm mesh sieve. The samples were analyzed in triplicate for their proximate composition, mineral and metal contents as per standard procedures.

Proximate composition

Proximate composition includes moisture, Crude protein, ether extract, Crude fiber, Ash, and Nitrogen free extract. Moisture content was

determined by drying 5g of the buckwheat samples to a constant weight at 60°C – 80°C in an oven, for ash, 5g of the prepared samples were placed in the ceramics crucibles that had been previously heated and cooled until a constant weight was obtained. The samples were then subjected to ashing in the muffle furnace maintained at about 550°C until a constant weight. Crude protein was determined by using Kjeldhal method, Crude fat was determined by extraction with ether. Crude fiber was determined by Acid digestion and Alkali digestion method. Analysis was carried out in triplicate in accordance with A.O.A.C. (2000). The carbohydrate content was estimated by difference, subtracting the sum of protein, fat, crude fibre and ash percentages from one hundred

Determination of mineral Contents

5g of finely powdered sample of the substance under test was weighed into a platinum crucible. The samples were moistured with 5 drops of deionized water. 5 drop of sulphuric acid was added, using plastic pipette. 5mL of hydrochloric acid (40%) (All safety precaution when handling hydrofluoric acid was considered). The fume was evaporated to dryness on a hot plate. The addition and evaporation of the sulphuric and hydrofluoric acid was repeated until the sample is completely decomposed. The residues were extracted with diluents and quantitatively transfer the solution into a 200 mL volumetric flask. The solutions were diluted to the volume with the diluents. Calcium, Sodium, Potassium and Magnesium were determined by flame photometric method using NaCl and KCl to prepare standard for Na and K respectively while zinc, iron, lead, Cadmium, Copper, Nickel and Chromium were determined by atomic absorption spectrophotometric method.

RESULTS AND DISCUSSIONS

Chemical Composition

The results of analysis of the proximate, minerals and metal composition of buckwheat samples is shown in Table 1, 2 and 3 respectively. Data on the proximate composition of the buckwheat species on percentage by weight basis in Table 1 reveals that the Ash, moisture, crude Fiber, Fat, Protein and Carbohydrate were found in the minimum and maximum range of (1.11 ± 0.03 – 1.16 ± 0.02), (14.10 ± 0.09 - 14.92 ± 0.08), (0.73 ± 0.02 – 0.83 ± 0.03), (1.68 ± 0.07 - 2.01 ± 0.06), (6.46 ± 0.03 – 8.12 ± 0.04) and (72.94 ± 0.08 - 74.84 ± 0.09) percent, respectively. Result from Table 1 reveals that buckwheat is a highly nourishing, energizing and tasty food that can be eaten instead of rice or the usual porridge. It was reported by the American College of Gastroenterology that decent fiber content can help women avoid gallstones. Fiber do not only increase the bulkiness of the food and helps prevent constipation problems by speeding up bowel

movements through the gut; but also reduces the secretion of bile acids - excessive amounts contribute to gallstone formation; increases insulin sensitivity and lowers triglycerides - blood fats. Fiber also binds to toxins and aid in their excretion through the gut and, thereby help protect colon mucosa from cancers and thus, good for colon health. It was reported by Atli (2015) that its husk contains resistant starch, which is resistant to digestion and is therefore categorized as fiber. Resistant starch passes down to the colon, where it is then fermented by the local bacteria. These beneficial bacteria produce short-chain fatty acids, such as butyrate. Butyrate and other short chain fatty acids serve as nutrition for the cells lining the colon, improving colon health and decreasing the risk of colon cancer. Although, the protein content recorded in table is generally low, it was reported by Atli (2015) that the amount of buckwheat protein might be small, but it has high quality

proteins with a very good nutritional quality. But he noted that the digestibility of these proteins is relatively poor. It was reported by Umesh (2015) that buckwheat groat composes almost all of the indispensable amino acids at excellent proportions, especially lysine which is otherwise a limiting amino acid in grains like wheat, maize, rice. It was reported by Juan *et. al.*, (2015) that buckwheat protein is rich in albumin and globulin, but very poor in prolamin and gluten. The high biological value of these proteins is due to well-balanced amino acid composition, being rich in lysine and arginine. Results from Table 1 further reveals that buckwheat species under investigation contains proportionately more starch than other similar seeds like quinoa and amaranth. Its grains are moderate sources of energy. Calorie content of its seeds may be compared to that of major cereals such as wheat, maize, rice and that of pulses like chickpea, bean, cowpea (black-eye pea).

Table 1: Chemical Composition of Buckwheat Groats in four villages in Enugu State, Nigeria

Chemical Composition	Sample 1 (g) Obinagu	Sample 2 (g) Abor	Sample 3 (g) Umuagu	Sample 4 (g) Nkwere
Ash Content (%)	1.11±0.03	1.16±0.07	1.14±0.05	1.16±0.02
Moisture Content (%)	14.10±0.09	14.92±0.08	14.15±0.09	14.20±0.07
Crude Fibre (%)	0.81 ± 0.02	0.83 ± 0.03	0.82 ± 0.03	0.73 ± 0.01
Fat Content (%)	1.68 ± 0.07	2.01 ± 0.06	1.92 ± 0.05	1.93 ± 0.06
Protein Content (%)	6.46 ± 0.03	8.12 ± 0.04	7.85 ± 0.04	7.95 ± 0.02
Carbohydrate Content (%)	75.84±0.09	72.94±0.08	74.12±0.10	74.03±0.09
Gluten (%)	ND	ND	ND	ND

*Average of triplicate determinations ± SD (standard deviation)

Furthermore, results from Table 2 reveals that the minerals Mn, Mg, Ca, Cu, P, Na and K, were found in detectable amount. This is in agreement with the daily mineral and calories daily requirement for individual (Jill, 2011). Buckwheat is richer in minerals than many common cereals, such as rice, wheat and corn. Though, manganese is found in appreciable amounts in whole grains with value ranging from 0.41 ± 0.25mg/100g to 0.49 ± 0.15mg/100g; Mn is responsible for healthy bone structure, bone metabolism, and helping to create essential enzymes for building bones. It also acts as co-enzyme to assist metabolic activity in the human body, formation of connective tissues, absorption of calcium, proper functioning of the thyroid gland and sex hormones, regulation of blood sugar level, and metabolism of fat and carbohydrates. Manganese is an actual component of manganese super oxide dismutase enzyme. It is a powerful antioxidant that seeks out the free radicals in the

human body and neutralizes these damaging particles, thereby preventing many of the potential dangers they cause. Manganese deficiency result to high blood pressure, heart ailments, muscular contraction, bone malformation, high cholesterol, and poor eyesight, hearing trouble, severe memory loss, shivers and tremors (Akpogheli *et. al.*, 2015). Severe deficiency may cause infertility in women, pancreatic damage, heart ailments and osteoporosis. Magnesium plays an important role in over 300 enzymatic reactions within the body, including the metabolism of food and synthesis of fatty acids and proteins. Buckwheat has comparatively decent concentration of minerals like copper, and magnesium. While Copper is required for the production of red blood cells, and also an essential trace element that may have beneficial effects on heart health when eaten in small amounts, Magnesium is involved in neuromuscular transmission and activity and

muscle relaxation. Magnesium deficiency, especially prevalent in older populations, is linked to insulin resistance, metabolic syndrome, coronary heart disease and osteoporosis. The mineral Ca is well-known for its key role in bone health. It also helps maintain heart rhythm, muscle function. General survey reveals that Ca is recommended by doctors to control high levels of Mg, P, and K. in the blood. It was reported by (Akpogheli *et al.*, 2015; Fagbuaro *et al.*, 2006) that Calcium play important role in blood clotting. The concentration

of calcium found in this study reveals that the consumption of buckwheat groats will increase the calcium level in the blood. It was reported by Akpogheli *et al.*, (2015) that the presence of K and Na is an added advantage because while Na is essential for normal heart and muscle function, K helps in muscle contract, maintain fluid balance and maintain normal blood pressure. They further reported that potassium may also help reduce kidney stone and bone loss as you age but too much sodium has adverse effect on your heart and direct relationship with hypertension in human.

Table 2: Mineral content of buckwheat species in (mg/100g)

Mineral Composition	Sample 1	Sample 2	Sample 3	Sample 4
Ca ²⁺ %	70.14±0.04	64.36±0.02	69.47±0.05	70.71±0.03
Mg ²⁺ %	0.31 ± 0.07	0.33 ± 0.03	0.32 ± 0.04	0.34 ± 0.04
P %	0.75 ± 0.07	0.69 ± 0.02	0.84 ± 0.06	0.72 ± 0.03
Mn %	0.41 ± 0.05	0.46 ± 0.03	0.49 ± 0.05	0.46 ± 0.03
Na %	0.34 ± 0.03	0.38 ± 0.02	0.33 ± 0.01	0.39 ± 0.02
K %	1.19 ± 0.04	1.11 ± 0.02	1.13 ± 0.02	1.21 ± 0.02

Data from Table 3 further reveals that the metal under investigation were below the WHO and the International / National Standard for heavy metal in food except for Cd which is above permissible limit. Cadmium is a highly toxic metal which naturally occur in the soils, and is naturally spread in the environment due to human activity. Excess exposure to cadmium may results to renal, pulmonary, hepatic, skeletal, reproductive effects and cancer. While Zn is needed for cell growth and to boost the immune system, Cu is an essential trace element that forms enzyme systems including cytochrome, oxidase and tyrosinase (Babalola and Akinsoyinu, 2009). It was further reported that copper is associated with iron and catalyses oxidation – reduction mechanism concerned with the oxidation of tyrosine. Phosphorus is an essential mineral that plays an important role in the growth and maintenance of body tissues. When

compared to other grains, the minerals in cooked buckwheat groats are particularly well absorbed. This is because buckwheat is relatively low in phytic acid, a common inhibitor of mineral absorption found in most grains. Buckwheat is a pseudocereal, which is a type of grain that doesn't grow on grasses like other cereals yet, used in a similar way. It is gluten-free, a good source of fiber, and rich in minerals and various plant compounds, especially rutin. As a result, buckwheat consumption is linked with several health benefits, including improved blood sugar control and heart health. Thus, it is not only safe to consume buckwheat groat cultivated from these villages, it is also safe to consume farm product cultivated within the immediate environment.

Table 3: Metal Composition of buckwheat species

Metals	Sample 1	Sample 2	Sample 3	Sample 4
Pb	0.142	0.178	0.199	0.126
Cd	0.333	0.240	0.412	0.397
Zn	0.479	0.253	0.253	0.301
Cu	0.321	0.222	0.297	0.217
Ni	0.009	0.018	0.010	0.009
Cr	0.019	0.016	0.011	0.016

*Average of triplicate determinations \pm SD (standard deviation)

CONCLUSION

The results of the present investigation revealed that buckwheat samples cultivated within the Enugu communities / environs has a lot of well-balanced starch, protein, fat and mineral composition and hence, has found a renewed interest, particularly among the food scientists. Additionally, its seeds compose proportionately more starch and less fat content than fellow oil seeds, and can thus be handled in similar ways like any other staple grains. Being a short-season crop and sustainable characteristic of thriving under drought conditions, it can be an answer for malnutrition alleviation programs.

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