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Comparative nutritional analysis of the flours of finger millet (*Eleusine coracona*), fonio (*Digitaria exillis*) and their composite in federal college of education Pankshin, Pankshin local government area of Plateau state

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Abstract
Fonio (*Digitaria exillis*) locally called Acha or hungry rice, Finger millet (*Eleusine coracona*) locally referred to as Tamba are cereals cultivated in plateau state, Nigeria use for porridge, main ingredients of Alcoholic and non-alcoholic drinks and a staple food in plateau state anSd other parts of northern Nigeria; by all classes of people. Thus the aim of this study was to carry out comparative nutritional analysis of Fonio flour, Finger millet flour and their composite flours. Fonio and Finger millet grains were bought from retailer in Monday market Pankshin, thoroughly washed with distilled water sun dried and grinded with an electric blender and sieved to obtain finer flour. 100gm each of Fonio flour and Finger millet flour were mixed in a bowl and packaged as composite. The flours were used for proximate and chemical composition and Amino acid analysis. The result of the proximate chemical composition and mineral content analysis of: Fonio was; moisture (4.03±0.028), crude fiber (7.03±0.06), crude fat (2.87± 0.014), NFE (60.66±0.08), phosphorus (0.08±0.002), calcium (0.17±0.015),Finger millet proximate chemical composition and mineral content were; moisture (5.03±0.025), crude fiber (9.24±0.011), crude fat (4.90±0.08), crude protein (8.17±0.012), ash (2.55±0.014), NFE (70.20±0.011), Phosphorus (0.03±0.001) and Calcium (0.11±0.012). the composite flour proximate composition of mineral result was moisture (5.64 ±0.024, crude fiber 8.24± 0.020), crude fat (3.84±0.017), crude Protein (8.55 ± 0.024), Ash (8.91 ± 0.042), NFE (62.92±0.031), Phosphorus (0.04±0.002), Calcium (0.13±0.017). The proximate chemical composition among the cereals flour and their composite showed significant difference in Calcium content observed among the cereals and their composite flours because P> 0.05. These results indicates Fonio, Finger millet and the composite flours are rich in essential conditionals essential and non - Essential amino acids, which falls within the recommended level of world health organization (WHO). In conclusion, Finger millet, Fonio cultivated in plateau state are highly nutritious food with good storage capacity in addition the composite flour is highly nutritious and can serve as an alternative way of using Fonio and Finger millet thus increasing the level of food security. It was recommended that s that; the Federal Government and private stake holders should make available credit facilities to Fonio and Finger millet farmers, there should be in place strategically target investment in composite flour Production and lastly Finger millet, Fonio farmers and composite producers should participate in decision making towards improving and utilization of Finger millet, Fonio and their composite.

Keywords: *Digitaria exillis*, *Eleusine coracona*, nutritional value, composite flours

Introduction

A Cereal is any grass cultivated for the edible component of its grain, composed of the endosperm, germ and bran. Cereals constitute the major sources of energy, protein, vitamins and minerals for the world population (Ballogou *et al*; 2013) [2]. According to Ballogou *et al;* 2013 [2], cereals grains of economic importance include; wheat, barley, oats, rye, rice, maize, sorghum, millet and underutilized cereals like Fonio grains.

Finger millet (Eleusine coracona) known as Ragi (India), Tamba (Hausa)is an important cereals, containing high levels of fillers, minerals, vitamins, and has eight times more calcium than other cereals (Shely *et al*;2016)..Shelly *et al* (2016) [10] opines that Finger millet (Tamba) is comparable to rice and wheat with regards to protein (6-8%), fat (1-2%), but far superior to rice and wheat with respect to minerals and micro-nutrients contents. Finger millet has gained importance because of the numerous health benefits such as its low glycemic index which makes it a good suitable grain for diabetic patients, heart friendly, due to its high dietary fiber content; promoting digestive health and richness in vitamins, minerals and good antioxidants. It has excellent storage properties, reducing post-harvest lost to pest.

Another one of the most important cereals is -Fonio (*Digitaria exillis*). Fonio, known as Achaotherwise referred to hungry rice by the indigenous people ofWest Africa who consumes this grains, is a misleading term implying it is a famine food, whereas it is a prized nutritious cereal often used as porridge, Gruel (Gwote), couscous, and

in non-alcoholic beverage (Robert *et al*;2013; Okeme *et al*; 2017) [9, 7]. It is valued as a weaning food because of its low bulk and high caloric density, good for diabetic patients, good for post natal care of woman after delivery (kwang-Ndung; 2013). Acha is rich in Sulphur containing amino acids like methionine and cysteine which are required for normal body metabolism, healthy growth of hairs, nails and skin and involved in major detoxification processes in the body (Robert *et al*; 2015).
Most cereals are consumed either as whole grains or grinded into flour which are used for pastries, and solid paste food that are swallowed like Tuwo (Hausa name) for thick paste swallowed food. However, a trendy development in cereals usage is the formulation of Composite flour which is defined, as a mixture of two or more flours, obtained from tubers, roots, cereals and legumes, with or without the addition of wheat flour (Seresh *et al;* 2015). Composite flour gives; better supply of protein for human nutrition better overall use of domestic agricultural products, emulsion stability and higher bulk density.

Materials and Methods

Location of the study: The study was conducted in Pankshin Local Government Area of Plateau State, Nigeria with its headquarters in the town of Pankshin. It has an area of 1,524 km^2 and a population of 191,685 at the 2006 census (National Population Census, 2006). The geographical co-ordinates of Pankshin are Latitude 9.3279^0 E and longitude $9,54312^0$ E, and an altitude of 1371 meters elevation above sea level. Pankshin enjoys a more temperate climate than much of the rest of the local government areas in plateau state. Average monthly temperatures range from $20\text{-}24^0$ (70-79 ^{0}F) and the annual rainfall is at average of 1150 mm (45.26 inch) of rainfall per year, or 95.8 mm (3.77 inch) per month.

Sample collection and preparation: Fonio cereals namely; Fonio, Finger millet, locally known as Acha and Tamba in Hausa language were purchased from Monday market in Pankshin town, Pankshin Local Government Area of Plateau State, and aseptically stored in labeled transparent white polythene bags according to method of (Okeme *et al*, 2017) [7] modified. The purchased cereals were transported to the Biology Department of Federal College of Education, Pankshin, for flour production. 200gm each of Fonio and Finger millet were thoroughly washed with distilled water to remove dirt particles and small stones thrice (3X). The washed cereals were put on a clean tray and allowed to sundry for 8 hours daily for three (3) days. During the period of drying, the cereals were turned to ensure uniform drying. The sun dried Fonio and Finger millet were each blended with a electric blender (model: BLFPPK-20L,Synix, USA) into a fine powder, which were each sieved by a locally made sieve of mesh size 30mm into a clean bowl to form fine flour.

Composite Formulation: 100gm each grain flour of Fonio and Finger millet, respectively were digitally weighed with weighing balance (Model: 573, Kern and Sohn, Germany), poured into a deep medium size clean plastic bowl and thoroughly mixed to form the Composite flour. 50gm each of the Composite, Fonio, Finger millet flours were packaged into air tight labeled autoclaved BAMA bottles in duplicates put into zipped bag and transported to the Biochemistry Department of National veterinary Research Institute (NVRI), Vom for proximate analysis

Proximate analysis: The nutritional composition analyses (Moisture content, protein, Crude fibre, Lipids, Ash, NFE, Phosphorus and Calcium) in the sample were determined using the method described by AOAC (2010). Crude fat was determined using the Soxlet system (Soxtecavante 2050), Crude protein and NFE were determine by Kjeldahl method using Kjeltec TM Model 2300 principle: The Soxlet equipment was used to defat the sample as in crude fat determination, Moisture content determination by the air oven drying method, the Calcium, Phosphorus and the ash content were determined using different methods.

Statistical Analysis: Statistical analysis was carried out using one-way Analysis of Variance (ANOVA). Data were analysed using Graphpad Prism computer software. Data were expressed as the mean $\pm$ standard error of mean and values at $P< 0.05$ were considered significant.

Results

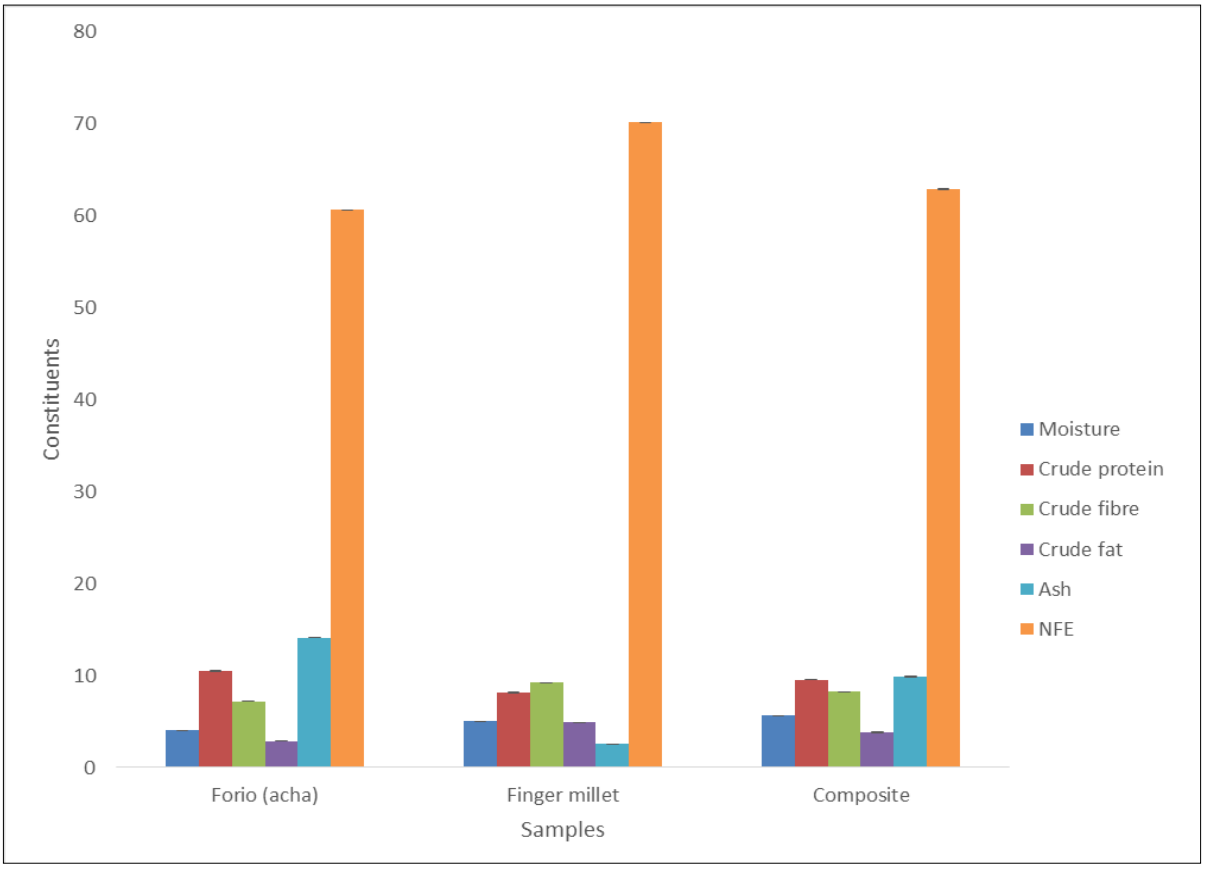
Table.1 Proximate chemical composition analysis of Fonio, flour, Finger millet, and Composite flour The results depicted in table 1, showed significant difference among the groups and the P values was 0.0001 which were less than 0.05. The moisture content of the composite was highest having value of 5.64 $\pm$ 0.024, followed by finger millet with value 5.03 $\pm$0.011 and Fonio with least value 4.03$\pm$0.025. Fonio had the highest value crude protein value of 10.50$\pm$0.012, followed by the composite with a value of 9.55 $\pm$0.005 and finger millet having a value of 8.17$\pm$ 0.012. Finger millet had highest value of nitrogen free extract of 80.66 $\pm$ 0.006, followed by the composite flour with value of 62.92$\pm$0.31, while Fonio had the least value of 60.66 $\pm$ 0.018. There was also significant difference in crude fat and ash contents of Fonio Finger millet and Composite at $P<0.005$. Finger millet had the highest crude fat value of 4.90 $\pm$0.008, followed by the composite flour with a value of, 3.84 $\pm$0.017. Fonio had the least value of 2.87 $\pm$ 0.14. Fonio recorded the highest ash value of 14.14$\pm$0.017, followed by the composite, with a value of 9.91$\pm$0.042 and the least was finger millet having a value of 2.55$\pm$0.014. In figure 1, finger millet had the highest Nitrogen free extract (NPE) crude fiber and crude fat. The moisture, protein, fiber, nitrogen free

extracts values recorded second highest values when compared to Fonio. Fonio recorded the highest crude protein and ash content and the least of moisture and crude fat values.

Table 1

Sample	Moisture	Crude protein	Crude fibre	Crude fat	Ash	NFE
Fonio (Acha)	4.03±0.025	10.50±0.012	7.23±0.006	2.87±0.014	14.14±0.017	60.66±0.008
Finger millet	5.03±0.011	8.17±0.012	9.24±0.011	4.90±0.008	2.55±0.014	70.20±0.011
Composite	5.64±0.024	9.55±0.008	8.24±0.020	3.84±0.017	9.91±0.042	62.92±0.031
p-values	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Values are expressed as mean ± SEM, n = 5.
If p value is less than 0.05, there is significant difference in mean values



Legend: Chemical contents in Fonio flour, Finger millet flour and the Composite flour

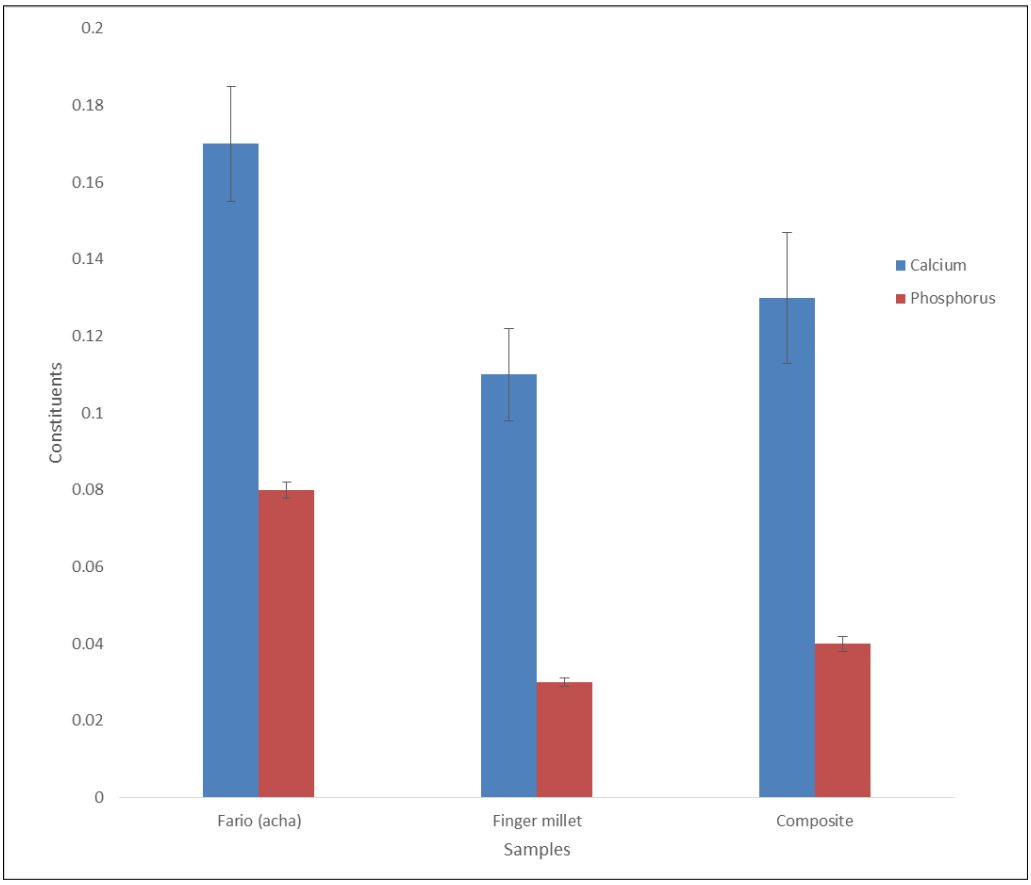
Fig 1: Bar chart showing the Proximate chemical composition analysis of Fonio, flour, Finger millet flour and Composite flour

The calcium content result seen in table 2 and fig 1, did not show significant difference among the different cereals flours at p= 0.115 value higher than p≤0.05. The value of calcium content was 0.17±0.015, 0.011±0.012 and 0.13±0.017 in Fonio, finger millet and the composite flours respectively. However the phosphorus content recorded in table 4.2 and fig 4.3 showed significant differences at P<0.05, among the cereal flours and their flour composite. Fonio, Finger millet flour and the Composite flour, Phosphorus content was; 0.08±0.002, 0.03 ± 0.0001, and 0.04 ±0.002 respectively.

Table 2: mineral composition of fonio flour, finger millet flour and their composite flour

Sample	Calcium	Phosphorus
Fonio (Acha)	0.17±0.015	0.08±0.002
Finger millet	0.11±0.012	0.03±0.001
Composite	0.13±0.017	0.04±0.002
p-values	0.115	<0.0001

Values are expressed as mean ± SEM, n = 5.
If p value is less than 0.05, there is significant difference



Legend: The Mineral content in Fonio flour, Finger millet flour and the Composite flour

Fig 2: Bar chart showing mineral contents of fonio flour, finger millet flour and the composite flours.

Discussions

Finger millet, Fonio are cereals grains commonly cultivated in Plateau State, Bauchi, Kaduna and other parts of Northern Nigeria which are used as staple foods, main ingredients in local non- alcoholic and alcoholic Drinks like Pap, Kunun zaki (a non- alcoholic drink), Burukutu (an alcoholic drink), Porridge called (Gwote) by diabetic patients, children, people with liver conditions, the aged and healthy individuals, depending on choice. Significant differences of p values (P< 0.005) were observed in the overall proximate composition of the cereals flours (Table 4.1 and figure 1 respectively).

The moisture content of the foods indicates their freshness and shelf life until consumption. The moisture content of the composite was 5.4± 0.02, finger millet (5.03±0.01), and Fonio (4.63± 0.025). This means the shelf life of the composite is very short and can easily be subject to spoilage than finger millet and Fonio (Acha). The low moisture content of Acha impacts on it longer period of storage without spoilage. The findings agrees to an extent with the work of Robert *et al;* (2013) [9], Okeme *et al*; (2017) [7], and shelly *et al*; (2016) [10] but deviated from their work because of the inclusion of composite flour in this research work.

The crude protein contents (table 1, figure 1) of Fonio, Finger millet and the Composite flours showed significant differences statistically at (P < 0.005). Fonio crude protein content (10.50 ±0.12) was highest followed by the composite flour with a protein content of (9.55±0.008), while the least crude protein content was recorded in finger millet with a value of 8.17±0.012. this findings means that Fonio Can serve as good source of plant protein in human nutrition, which agrees with Robert *et al*; (2013) [9]. The protein content of the composite flour indicates that a formulation of a composite from Fonio flour and Finger millet flour provides an alternative way of using the in human nutrition cereals to improve global food security challenge.

Crude fiber is an integral valuable nutrient for healthy probiotics normalizes bowel movement, lowers blood cholesterol and blood sugar levels and prevents colorectal cancers. Its content in Fonio flour, Finger millet flour and the Composite was found to be significantly different at p< 0.051. Finger millet Crude Fiber recorded 9.24±0.011 was highest followed by the composite with a value of 8.24 ± 0.020 and Fonio with a value of 7.23±0.006. This work deviated from shelly *et al*; (2016) [10] and agrees with Suresh *et al*; (2015) [11] in that the composite formulated in this study contains a healthy dietary fiber content which can be used in variety of ways to promote healthy nutrition.

Crude fat is an important energy sources as well as sources of essential fatty acids and fat soluble vitamins. It also confers safety, flavor and palatability to the food. There was significant difference in the crude fiber contents of the cereals grain flours since p value was less than 0.05. Finger millet recorded highest crude fat content of (4.90±0.008) followed by the Composite flour with a value of (3.84± 0.017) and Fonio had least value of (2.87±0.14). Fonio like most whitened cereals does not contain very much fat (table 1) which agrees with

Robert *et al*; (2013) [9]. In addition the higher the Crude fat content in the composite than the Finger millet makes the composite to be adventegeous I n respect to human nutrition.

The ash content of Fonio flour in table 4.1 and figure 4.1 was (14. 41±0.017) significantly higher since P< 0.05 when compared to the ash content of finger millet with a value of (2.55±0.014). However the ash content of the composite which was (9.91±0.042) makes it better Mineral containing flour than using only Finger millet flour; since the P value was less than 0.05. This finding makes thus work deviate from Robert *et al*; (2013) [9]. Also the composite offers an additional way of using Fonio and Finger millet to improve human diet due to the mineral content rather than using only Finger millet flour singly as food.

The Nitrogen free extracts of Fonio, Finger millet and the Composite flours were significantly different since (P< 0.05), in all the groups as seen in table 4.1 and figure 4.1. Finger millet flour recorded the highest value of (70.20±0.011), followed by the composite with avalue of (62.92 ±0.031) and Fonio flour having a value of 60.66±0.008. This means that the composite flour can serve the energy need of human nutrition as well as Finger millet and Fonio. This result deviated from Shelly *et al*; (2016) [10] and Robert *et al*; (2013) [9].

Calcium and phosphorus are essential minerals for a healthy diet. Calcium helps in formation of strong bones, teeth, muscle contraction, while phosphorus is essential for the maintenance of cells, formation and support of healthy bones and teeth. In the flours was significantly different since P < 0.05 (table 2, figure 2) Fonio phosphorus content was (0.08 ±0,002), Finger millet (0.03±0.001) and composite was (0.04±0.02). The higher phosphorus content of Fonio makes it a better source of phosphorus than Finger millet, but when Fonio and Finger millet are combined as a composite, the Phosphorus content level is compensated for.

The calcium contents of Fonio, finger millet and composite flours in table 2 and figure 2 did not show any significant difference since P value was greater than 0.05

Conclusion

Fonio (Acha) flour, Finger millet (Tamba) flour and their composite flour have been found to contain healthy amounts of crude fiber, ash, carbohydrate, protein, calcium and phosphorus, which makes them good food for all classes of people to beef up the nutritional needs and food security level of the society especially in the developing countries like Nigeria.

Conflict of Interests

The authors declare that there is no conflict of interest.

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