International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 1, November-December 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Comparison of the Proximate and Anti-Nutritional Composition of Malted and Un-Malted Seeds of Three Indigenous Seeds for Use as Weaning Food

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ABSTRACT

Proximate and anti-nutritional composition of some selected seed flours; Corn (*Zea mays Everta*), Bambara nut (*Vigna subterreanea.L.Verdc*) and Soybeans (*Glycine max*) were carried out before and after malting as potential raw materials for weaning. The seeds were cleaned separately of dirt and extraneous materials. Forty grams of each seed was weighed and divided into 2 equal parts. The first part was malted by steeping and germinating then dried at 60^{O}C for 28hrs, milled and sieved into flour. The second part, raw seeds (un-malted) were also milled into flour separately and each assessed for proximate and anti-nutritional composition. The results showed that the proximate content of the on-malted seeds ranged from; carbohydrates (33.83±0.81 to 77.19±0.17%), protein (11.66±1.02 to 33.25±0.00%), crude fat (4.20±0.57 to 6.10±0.64%) and ash (2.43±0.04 to 6.63±1.24%), while the malted seeds contained 56.53±1.52 to 68.08±0.47 carbohydrates, 11.38±0.39 to 16.63±1.24% protein, 4.10±1.14 to 9.90±0.14% crude fat and 4.23±0.39 to 5.05±0.00% ash. The carbohydrate and fat content of bambara nut and soy beans reduced after malting. Soybeans contained the highest crude fat both in raw and malted flour. Malted bambara nut contained the highest protein while corn contained the highest carbohydrates. Anti-nutrients such as tannin, phytate, oxalate, trypsin inhibitor and saponnin found in un-malted seeds reduced after malting. The study showed that these seeds when malted and used or their flours combined in various proportions could yield desirable quality weaning food capable of supplying nutrients required for infant growth and development.

***KEYWORDS*:** Proximate composition, Anti-nutrients, selected seeds, malting, un-malted seeds

***How to cite this paper*:** Okafor, J. I. | Umeh, S. O. "Comparison of the Proximate and Anti-Nutritional Composition of Malted and Un-Malted Seeds of Three Indigenous Seeds for Use as Weaning Food" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-1, December 2021, pp.600-607, URL: www.ijtsrd.com/papers/ijtsrd47863.pdf

IJTSRD47863

INTRODUCTION

Weaning food (also referred to as complementary food) is the food given to children from the age of 6 to 24 months when transiting from exclusive breastfeeding to semi-solid food. Exclusive breastfeeding provides the basic and best nutrition in a child's early life but regarded as inadequate after six months to provide additional nutrition needed by the fast growing infants. These additional nutrients such as vitamin D, iron, calcium, zinc magnesium etc needed for optimal growth of children are usually obtained through the use of complementary or weaning foods. Ikujenlola, (2014) documented the use of traditional staples such as cereals and legumes as sources of weaning food for young children. Cereal grains (such as corn, millet, barley, oats, wheat, rice, millet, sorghum etc) in their natural unprocessed whole grain form are rich sources of vitamins, carbohydrates, fats and oil and proteins (mainly methionine and cysteine) (Ikujenlola, 2014). When processed, i.e. by the removal of the bran and germ, the remaining endosperm is mostly carbohydrate. Legumes are economical dietary source of good quality protein and are higher in protein than most other plant foods. They have about twice the protein content of cereal grains, generally low in fat and virtually free of saturated fats. Legumes are rich in energy-giving carbohydrates, with a low glycemic index rating for blood glucose control, good sources of B-group vitamins (especially folic), and minerals (like iron, zinc, calcium and magnesium), high in fiber, low in sodium and as well associated with health-promoting benefits, such as reducing risk for cardiovascular disease (Sharma *et al*., 2011). Legumes (such as alfalfa, beans and peas, peanuts, soybeans, broad beans, dry Bambara nut, chickpeas, lentils etc) are important component of the human diet in several areas of the world, especially in the developing countries, where they complement the lack of proteins from cereals, roots, and tubers.

The utilization of either cereal(s) or legume(s) alone does not satisfactorily supply all the necessary nutritional requirements of the fast growing infants. Legumes are regarded as plant proteins which are deficient in sulphur-containing amino acids; methionine and cysteine but rich in tryptophan and lysine (Davidson *et al*., 1980).Cereals on the other hand are deficient in lysine, which among other functions aid in effective absorption of calcium and in some cases, tryptophan (AOAC, 2005). These essential amino acids cannot be synthesized at reasonable quantity by the body (FAO, 1992). Consequently, Integrated Child Development Scheme (ICDS) and Food and Agricultural Organization (FAO) advocate the combination of cereal and legume for complementary food as alternative protein and energy sources for children (Imitiaz *et al*., 2011).

Cereals and legumes are usually bulky and toxic in its natural form, and as such require the application of one or more processing methods of which malting are included. Malting however is controlled germination of grains during which biochemical reactions take place (Ikujenlola, 2014). During the process of malting, inherent enzymes are activated which help to break down polymers, reduce dietary bulk and improve the nutritional quality of malted flours (Ocheme *et al*., 2008). The enzyme alpha amylase which converts insoluble starch to soluble sugars, resulting in thinning effect is an important nutritional effect of malting (Murugka *et al*., 2013, Ikujenlora and Eduratoye, 2014). The process enhances native phytase activity in plants and thus resulting to decrease in phytic acid content of the plant food. Malting plant foods facilitate its digestibility as well as reducing its viscosity at elevated concentrations to increase the caloric density of foods. This research is hence undertaken to assess the proximate and anti-nutritional compositions of selected malted seeds and their um-malted counterparts like corn, bambara nut and soybeans for use as weaning food.

MATERIAL AND METHODS

Sample collection

The seeds, corn (*Zea mays* Everta), Bambara nut (*Vigna subteranea.* L. Verdt) and Soybeans (*Glycine max*), were purchased from Eke-Awka market, Anambra State, Nigeria using sterile bags.

Sample identification

The seeds were identified by Mrs Philomena Okeke of Botany Department in Nnamdi Azikiwe University, Awka.

Sample processing/ malting

The sample processing method adopted in this research was the method of Ijarotimi and Keshinro (2012). The flow chart below was used to prepare the malted seed flours.

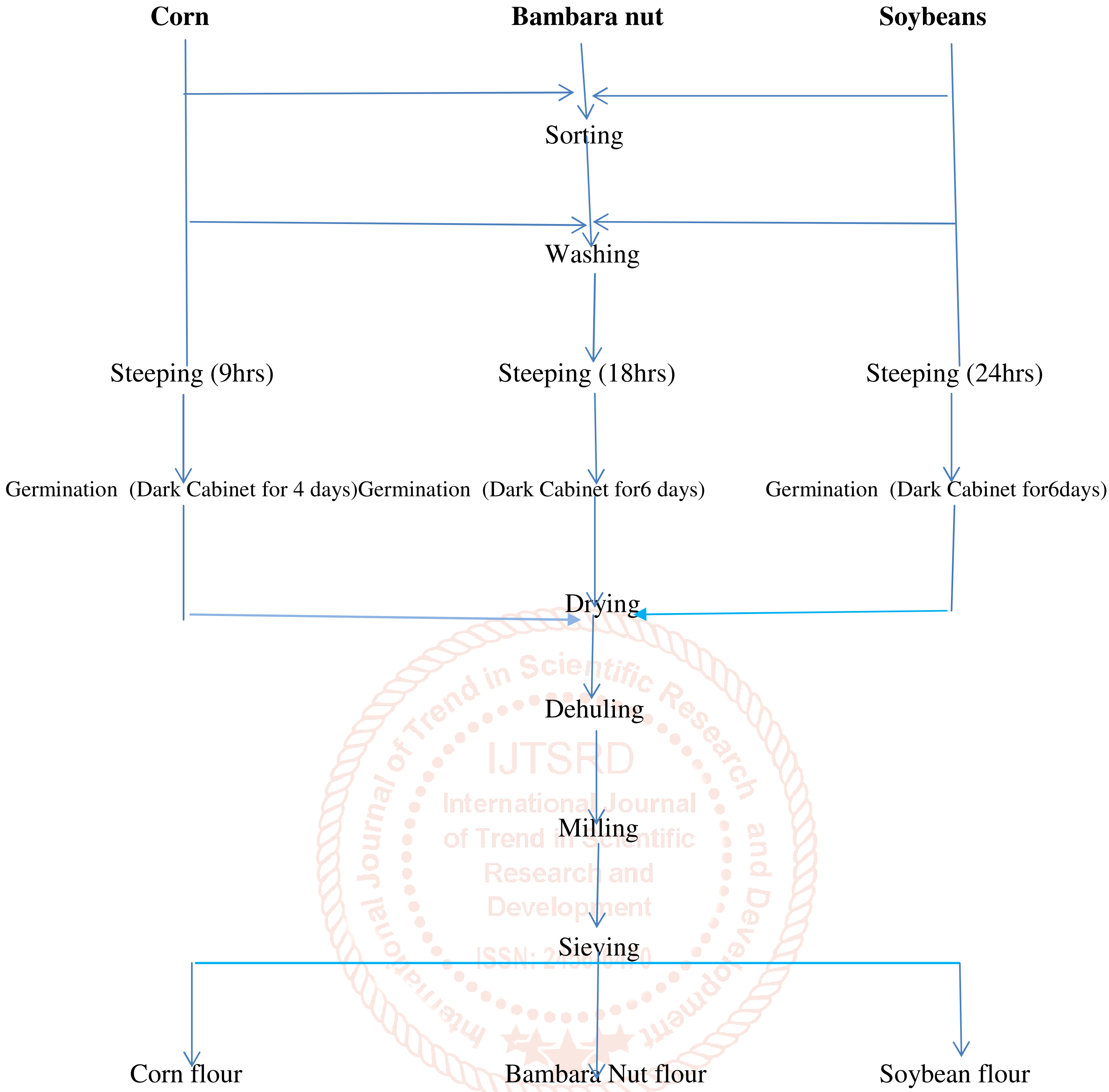

Figure 1: Modified flow chart for processing of Corn, Bambara nut and Soybean Flours (Ijarotimi and Keshinro, 2012)

Proximate Analysis

Proximate compositions (crude protein, fat, fiber, ash and total carbohydrates) were determined on the um-malted and malted seed flours using the method of AOAC, (2004).

Determination of Anti-nutritional Factors

Anti-nutritional factors (saponins and tannin) were determined using the method of AOAC, (2005).

Phytate

Phytate contents were determined using the method of Young and Greaves (1940) as adopted by Enemor *et al.*, 2013.

Oxalate Determination (by Titration Method)

This was determined according to Osagie (1998).

Quantization of Trypsin Inhibitor

Trypsin activity of the samples was first determined using the reaction: tyrpsin produces tyrosine in the presence of casein substrate as outlined by Jayaraman, (1981).

Data Analysis

Data generated were analyzed using one way Analysis of Variance (ANOVA) with statistical package for social sciences (SPSS) version 20 to compare mean and standard deviation. The result were considered significantly different at $p<0.05$.

RESULTS

Proximate composition of the un-malted seeds.

The proximate compositions of raw (un-malted) seeds are as shown in Table 1. Ash and fat contents of un-malted soybean are higher and significantly different from that of corn and bambara nut. Protein content of the seeds ranged from 11.66 ± 1.02 to 33.25 ± 0.00 and is found least in un-malted corn. Carbohydrate was found highest in un-malted corn which inversely showed the least value in other parameters like ash, protein, fat, moisture and fiber, while soybean had the least value for carbohydrates. Moisture value was found to be least in un-malted corn (2.48 ± 0.04) and highest in un-malted Bambara nut (9.10 ± 0.64).

Table 1: Proximate composition of the un-malted seeds

Parameter (%)	Corn	Bambara	Soybean
Ash	2.43^{b}±0.04	3.70^{b}±0.71	6.36^{a}±1.24
Moisture	2.48^{c}±0.04	9.10^{a}±0.64	5.25^{b}±0.07
Fat	4.20^{b}±0.57	6.10^{b}±0.71	14.20^{a}±0.57
Crude Fibre	2.05^{c}±0.21	4.10^{b}±0.71	7.10^{a}±0.07
Crude Protein	11.66^{c}±1.02	17.51^{b}±1.24	33.25^{a}±0.00
Carbohydrate	77.19^{a}±0.17	59.51^{b}±1.29	33.83^{c}±0.81

^{abc}Means with different superscripts on the same row are significantly different at $p\leq0.05$.

Proximate composition of malted seeds

Table 2 presented the proximate composition of the malted seeds. Ash content of the malted seeds ranged from 4.23 ± 0.09 to 5.05± 0.00 with no significant difference at $p\leq0.05$. Malted soybean contained the highest value for fat (9.90 ± 0.14) with significant difference while malted corn contained the least value for fat (4.10 ±0.14) and moisture (9.53 ±0.66), but had the lowest value in protein, ash (mineral), fat and fiber. Malted bambara nut had the highest protein value of 16.63 ± 1.24) followed by malted soybeans (16.25 ± 0.71) without significant difference at $p\leq0.05$.

Table 2: Proximate composition of malted seeds

Proximate (%)	Corn	Bambara	Soybean
Ash	4.23^{a}±0.39	4.58^{a}±0.60	5.05^{a}±0.00
Moisture	9.53^{a}±0.66	9.05^{a}±1.06	6.13^{b}±0.18
Fat	4.10^{c}±0.14	5.60^{b}±0.28	9.90^{a}±0.14
Crude Fibre	2.70^{c}±0.14	4.88^{b}±0.32	6.15^{a}±0.49
Crude Protein	11.38^{b}±1.24	16.63^{a}±1.24	16.25^{a}±0.71
Carbohydrate	68.08^{a}±0.47	59.28^{b}±1.38	56.53^{b}±1.52

^{abc}Means with different superscripts on the same row are significantly different at $p\leq0.05$

Figure 2 below compares the proximate composition of both un-malted and malted seeds. Carbohydrate content of malted soybeans greatly increased after malting while that of corn reduced after malting. There was slight decrease for that of bambara nut. There was remarkable reduction in protein values for malted bambara nut and soybeans, while the reduction for corn was very slight. Fiber value increases in corn and bambara nut after malting while that of soybeans reduced. All the food samples showed decrease in fat content after malting. While the moisture values of corn and soybeans increased after malting, the change in moisture content of bambara nut remain un-noticed after its malting. The ash content of corn and bambara nut increased while that of soybean decreased after malting.

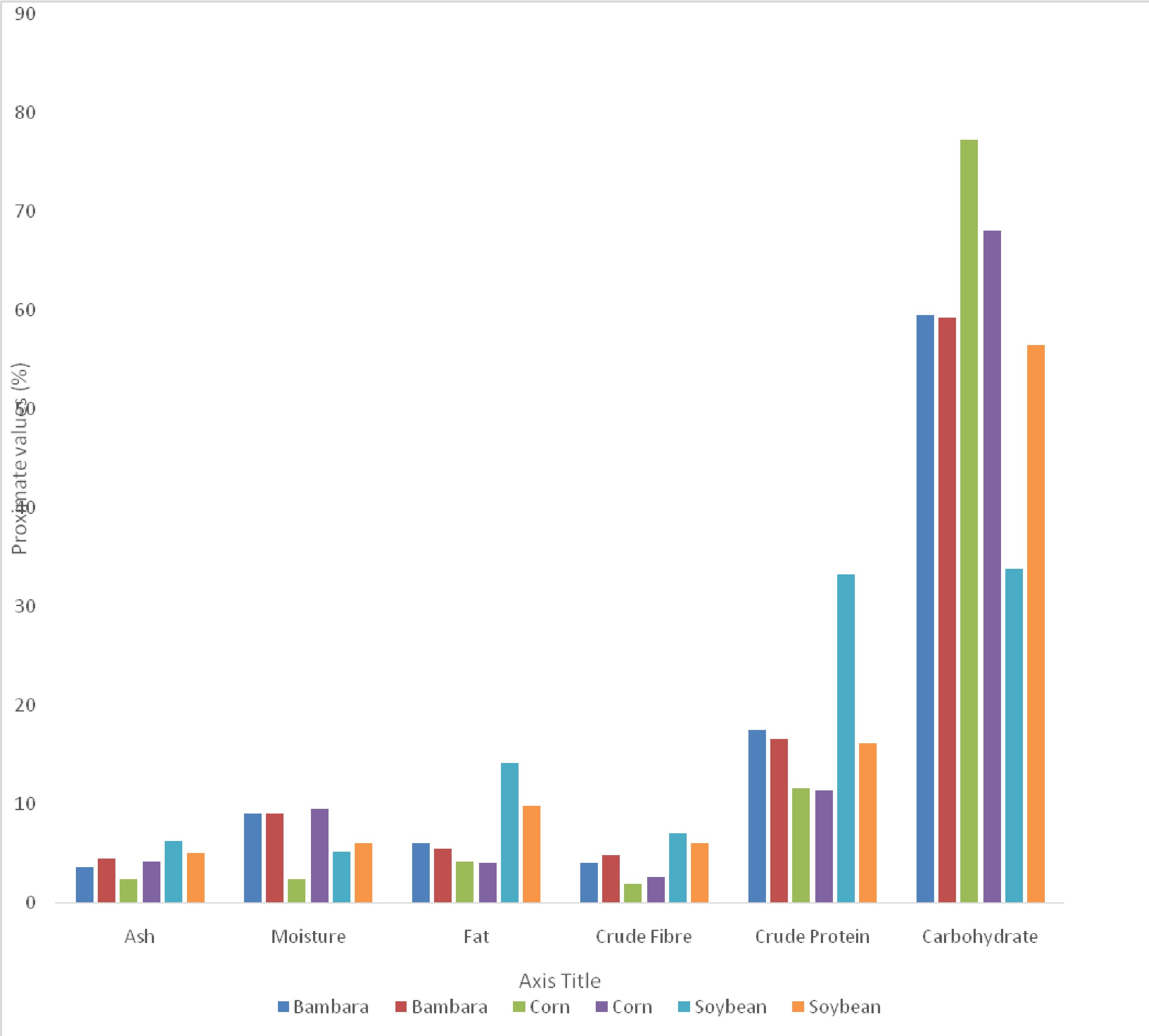

Figure 2: Comparison of proximate composition of un-malted and malted seeds

Anti- nutritional composition of un-malted seeds

Anti-nutritional compositions of the un-malted are presented in Table 3 below. The results indicated that generally un-malted corn did not contain saponine while insignificant vale was found in bambara nut. Very small amount of tannin which ranged from 0.09 ± 0.oo to 0.44 ± 0.01 was present in the un-malted seeds. Un-malted soybean contained the highest calcium oxalate while the least value was found in bambara nut with no significant difference among the values. It was observed that trypsin inhibitor was found in abundant in all the seeds analyzed with bambara nut showing the highest value of 26.21±0.25, and corn with least value (7.76 ± 0.66). The phytate content was found to range from 0.62 ±0.02 to 1.40 ±0.02 with soybean having the highest value.

Table 3: Anti- nutritional composition of the un-malted seeds

Parameters	Corn	Bambara nut	Soybean
Tannin (mg/g)	0.09^{c}±0.00	0.44^{a}±0.01	0.13^{b}±0.00
Phytate (%)	0.93^{b}±0.00	0.62^{c}±0.02	1.48^{a}±0.02
Oxalate (mg/g)	3.24^{a}±0.76	3.78^{a}±0.38	4.59^{a}±0.19
Trypsin inhibitor (mg/g)	7.76^{c}±0.66	26.21^{a}±0.25	12.62^{b}±0.01
Saponin (%)	0.00^{c}±0.00	0.70^{b}±0.00	4.79^{a}±0.21

^{abc}Means with different superscripts on the same row are significantly different at p≤0.05.

Anti-nutritional composition of malted seeds

Anti-nutritional compositions of malted seeds are represented in Table 4 below. From the Table, it was observed that the value of tannin in the malted corn, Bambara nut and soybean were very low. Corn contained no saponin soybean contained saponin (2.42±0.03). Trypsin inhibitor value was found to be high in all the malted seeds, with highest value (21.95 ±0.45) found in Bambara nut while the least value (6.23 ± 0.52) found in corn. Corn contained the highest calcium oxalate (3-24±0.76), while soybean showed the least value (1.23±0.19). The phytate content of the malted seeds significantly differ from one another with values ranging from 0.36±0.01 to 0.71 ± 0.05.

Table 4: Anti- nutritional composition of the malted seeds

Parameter	Corn	Bambara nut	Soybean
Tannin (mg/g)	$0.03^{b}\pm0.01$	$0.03^{b}\pm0.00$	$0.09^{a}\pm0.00$
Phytate (%)	$0.48^{b}\pm0.02$	$0.36^{c}\pm0.01$	$0.71^{a}\pm0.05$
Oxalate (mg/g)	$3.24^{a}\pm0.76$	$1.49^{b}\pm0.19$	$1.23^{b}\pm0.19$
Trypsin inhibitor (mg/g)	$6.23^{c}\pm0.52$	$21.95^{a}\pm0.45$	$10.81^{b}\pm0.76$
Saponin (%)	$0.00^{c}\pm0.00$	$0.42^{b}\pm0.00$	$2.42^{a}\pm0.03$

^{abc}Means with different superscripts on the same row are significantly different at $p\leq0.05$.

Figure 3 below compares the anti-nutritional composition of the un-malted and malted seeds. It showed that both un-malted and malted corn (popcorn variety) used for the research work did not contain saponin. Bambara nut and soybeans contain some quantities of saponin which reduced drastically after malting. There was great reduction on oxalate content of bambara nut and soybeans while that of corn remained unchanged. The low level of tannin found in un-malted seeds was reduced to insignificant levels after malting. From the chart therefore, it is pertinent to deduce that malting is an effective way to reduce anti-nutrients on seeds, hence, increased the bioavailability of nutrients like zinc, magnesium, calcium, iron etc which are usually bound by those anti-nutrients. Malting also increased the safety of those foods to humans by reducing toxicity caused by anti-nutrients in those foods.

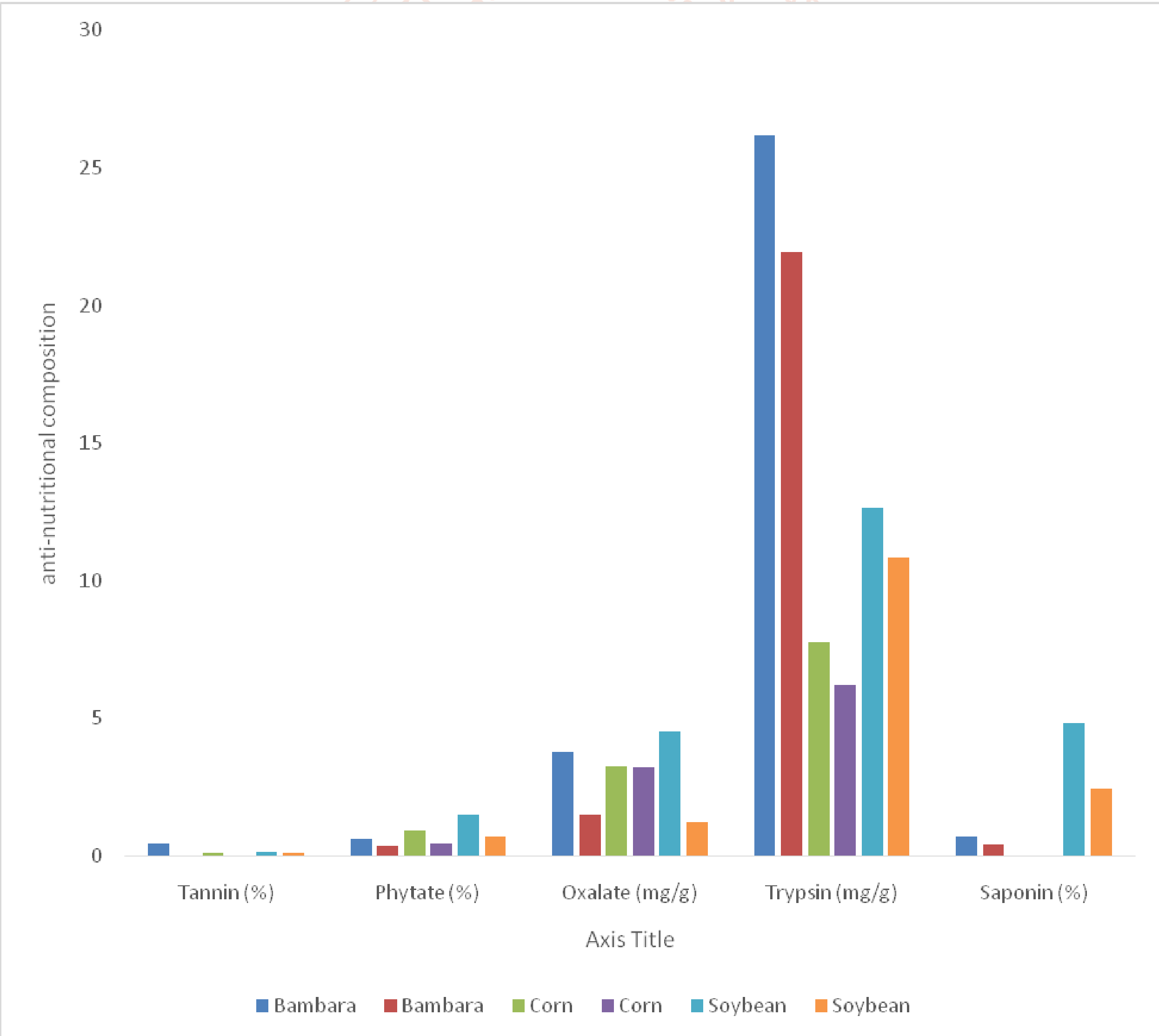

Figure 3.comparison of anti-nutritional components of un-malted and malted seeds

DISCUSSION

Formulation of weaning food for children requires the use of high nutrient substrates that are high in protein. The three seeds in this study are high protein seed that naturally contain some anti-nutrients. Malting of the seeds was employed to check its effect on the proximate and anti-nutrient compositions of the seeds.

Ash contents of corn and bambara nut increased after malting while that of soybean decreased after malting (Tables 1 and 2). The increase in ash content of bambara nut after malting is comparable with the findings of Omoikhoje, (2008) in his research, 'assessment of the nutritive value of Bambara nut as influenced by cooking time'. The ash values did not differ significantly ($p \leq 0.05$) from one another. Ash is directly related to mineral (Ijarotimi and Keshinro, 2012). Moisture contents of corn and soybean increased after malting and fiber values for bambara nut decreased after malting (Tables 1 and 2). Soybean protein was the highest (33.25±0.00%) while corn has the least vale (11.66±1.02%). For carbohydrate, corn exhibited the highest value (77.19±0.17%), which is significantly higher than bambara nut (59.51±1.29%) and soybeans (33.83±0.81%) at $p \leq 0.05$. The carbohydrate, protein and fat values of bambara nut is similar to that reported by Brough and Azam-Ali, 1992 and Omoikhoje (2008), while the carbohydrate, protein, fat, ash and water content of soybeans are comparable to the report published by United States Department of Agriculture, (2005).

The higher fat values of soybean (9.90± 0.14%) and bambara nut (5.60±0.28%) are desirable phenomena since fat supplies the highest energy to the body and also assists in the absorption of vitamins and development of tissues (Udedi, *et al*., 2013). Legumes are very good sources of dietary fiber than cereals (Tharanathan and Mahadevamma, 2003). According to Satter *et al*., 2013, fiber aids in digestion, preventing over weight, constipation and cardiovascular disease.

The protein values of bambara nut and soybean are of close value and higher than that of corn with significant difference ($p \leq 0.05$). This is in agreement with the findings by Conde, (2015) that legumes contain more protein than cereals. Ikujenlola, (2014) also documented that legumes and oil seeds contain protein of high quality (high essential amino acids) which is essential for infants and growing children in order to prevent the occurrence of protein malnutrition, which is responsible for stunted growth. Corn contains most carbohydrate value (68.08± 0.47%) and differs from that of bambara nut (59.28± 1.38%) and soybean (56.53±1.52) with significant difference. Cereals are starchy food and could be the reason why corn (cereal) contained more carbohydrates than Bambara nut and soybeans (legumes).

Plant minerals like calcium, magnesium, iron, zinc, and phosphorus are usually bound by anti-nutrients present in that food (Ijarotimi and Keshinro, 2012). Malting enable the breakdown of those plant substances and hence increases mineral availability to the body. Soaking and germination/malting reduce anti-nutrients and increase the digestibility of protein and carbohydrates (Yasmine, *et al*., 2008, Alozie *et al.,* 2009).

The anti-nutritional compositions of un-malted and malted seeds are as represented in Tables 3 and 4. They were compared in Figure 3. The figure shows that corn (popcorn variety) used for the research work did not contain saponin hence remained unchanged after malting. The saponin value reduced after malting in both bambara nut and soybeans. There was great reduction on oxalate content of bambara nut and soybeans while that of corn remained unchanged. The low level of tannin found in sampled raw seeds was reduced to insignificant levels after malting. From the Figure therefore, it is pertinent to deduce that soaking and malting is an effective way to reduce anti-nutrients on the sampled grains, hence, increased the bioavailability of nutrients like zinc, magnesium, calcium, iron etc which are usually bound by those anti-nutrients. This observation is in line with the report of Ocheme *et al*., 2008), who stated that during the process of malting, inherent enzymes are activated and these enzymes has been associated with the reduction in the dietary bulk (which includes degrading anti-nutritional factors) and improvement in nutritional quality of flours from malted grains. This process also improved the safety of those foods to humans by reducing toxicity caused by anti-nutrients in those foods. From the results obtained from this study, using malted seeds for the formulation of infant weaning food will give a good food source that will enhance growth and development of weaned children.

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