e-ISSN :3027-2068:Print ISSN:3026-9830

https://www.ijbsmr

***Int. J.Bio. Sc. Mol. Res. , September, 2023* Vol.1 (3) 181-193**

Comparative evaluation of the proximate, mineral nutrients and anti-nutrient composition of couscous and semolina consumed in Nigeria, and their relevance to health.

Dike, O.C [1], Akanu-Ibiam, A.C[2]., Akpa,S.O[3]., Nwaru,E.,C[4]., Onwe, E.N[5]., Nwosu, S.C[6] and *Ibiam,O.F.A[7].

[1]Department of Applied Biology, Faculty of Science. Ebonyi State University, Abakaliki. Ebonyi State.
[2,] OFRAKIB Digital Academy 26, Sir Edward Igwe Crescent, Ntezi Abba, Ebonyi LGA. Ebonyi State.
[3]Department of Industrial Chemistry, Faculty of Science Ebonyi State University, Abakaliki. Ebonyi State.
[4]Department of Plant Science and Biotechnology, Faculty of Biological Sciences, Abia State University, Uturu .Abia State.
[5]Department of Biotechnology, Faculty of Biological Sciences, Evangel University, Akaeze, Ebonyi State.
[6] Department of Public Health, School of Public and Allied Health. Babcock University, Ilesan.Ogun. State.
[7]Department of Biology, Faculty of Biological Sciences Alex –Ekwueme Federal University, Ndufu-Alike.. Ebonyi State.

***Corresponding author e-mail drakanuibiamjr@yahoo.com**

Abstract

Background: Families in Nigeria enjoy eating semolina and couscous with soup , as these wheat products are said to have extremely little or no carbohydrates. Many doctors recommend them to their patients , particularly the diabetics. T For a better advice, this effort aims at investigating the proximate, mineral nutrients and anti-nutrient composition of these wheat products.**Methodology:**The standard Association of Analytical Chemists (A.O.A.C.) and atomic absorption spectrophotometric procedures, with minor modifications, were used to analyze their proximate, mineral-nutrient and anti-nutrient compositions.Chemicals of analytic grades were utilized. **Result:** Based on proximate analysis, the percentage composition of couscous was higher than that of semolina in terms of carbohydrates, protein , and moisture , while semolina had higher levels of ash , lipid , and fiber compared to couscous which had higher ash , lipid , and fibre contents.The two wheat products contained the following anti-nutrients, measured in mg/100g: saponin, alkaloid, flavonoid, tannin, and cyanogenic glycosides, and mineral nutrients calcium, magnesium, iron, zinc, copper, manganese, and phosphorus. While cyanogenic glycoside in couscous was higher than in semolina (p<0.05), the mineral nutrients and anti-nutrient levels of semolina were significantly higher than those of couscous. Nonetheless, a noteworthy distinction was seen in the compositions of proximate, mineral, and anti-nutrients between semolina and couscous (p<0.05). **Conclusion: C**ouscous had higher carbohydrate, cyanogenic glycoside, ash, lipid and fibre contents than semolina, while, semolina had higher mineral nutrient and anti-nutrient contents than couscous. Consumers' choice , and doctors' recommendation to patients, of the two wheat products, especially, those who are diabetic are advised.

Key words: Comparative, Couscous, Human-health, Nutrient, Semolina

1. Introduction

Semolina and couscous have excellent nutritional qualities. Flour is one of the primary ingredients used to make couscous, but it lacks some essential amino acids (lysine, tyrosine, and methionine), and by adding legume flour, which has a good amino acid balance and a high

protein content, couscous could be improved (Lee *et al.,* 1998). The word "semolina" came from the Italian "semola", and the French word "semoule," according to Donnelly and Ponte (2000). It is defined as the refined middlings of durum wheat (*Triticum durum*), ground so that all of the products pass through a No. 22 U.S. sieve, and no more than 3% must pass through a No. 100 U.S. sieve, while on the other hand, couscous is a grain food that is processed from a fine and coarse grain of semolina. According to Connell *et al*. (2004), durum wheat endosperm is sufficiently tough to maintain its cohesiveness during milling, preventing the endosperm from disintegrating into a fine, powdery flour. The end product is a granular substance known as semolina, which is ground fermented wheat. and is the coarse, grittier wheat particles that remain after the finer flour is removed. Semolina is used to manufacture spaghetti and other pasta products (Connell *et al*., 2004). Different names for couscous are used in different countries: seksu in Berber, kusksi in Libya, keskesu in Tuareg, kuskus in Turkey, couscous in Morocco, maftoul, moghrabieh in Lebanon, and kouskousaki in Greece.(Clifford, 2004). Connell *et al*. (2004) defined it as husked and crushed, but unground semolina of hard wheat (*Triticum durum*), which could also be made with barley, millet, sorghum, or corn. Produced since ancient times,while couscous is made from a fine and coarse grain of semolina, the fine grain affixes to the coarse grain by hand (although mechanization is used for mass production), the grains being rolled and rubbed with the palms and fingers, until the desired size is formed (Connell *et al*., 2004). Semolina is the hard part of the hard wheat grain that resists millstone grinding. Certain researchers have claimed that couscous and semolina are excellent providers of food nutrients. Protein, fiber, carbohydrate, fat, sodium, potassium, iron, and calcium are found in couscous (Celik *et al.,* 2004), while semolina, according to (USDA, 2013) contains water, protein, lipid, ash, carbohydrates, fiber, calcium, iron, magnesium, phosphorus, potassium, sodium, zinc, copper, and manganese. Manthey and Hareland (2001), stated that three distinct factors affect semolina's moisture content, which is crucial for processing into pasta, and these include: necessity to add as much water as possible to the mill to maximize mill gain; the ideal moisture content for best milling results and product handling; and the paramount safety precaution of not exceeding a moisture level where mold growth or other microbiological organisms won't affect the product. Both contain fiber for a healthy bowel movement, and carbohydrates, which the body breaks down to produce energy (Weickert and Pfeiffer, 2007).

Instead of the customary cassava (foofoo), garri, or even pounded yam, many families in Nigeria prefer to eat semolina and couscous grains with soup. As these wheat products are said to have extremely little or no carbohydrates, many doctors recommend them to their patients, particularly, those who have diabetes. One diabetic patient mentioned that his doctor suggested couscous as a product without carbohydrates, hence, his choice of it. Although there is little information available on the proximate, mineral nutrient and anti-nutrient composition of the two wheat products produced and consumed in Nigeria, this assumption piqued our interest in researching the food value. Additionally, there is no literature on the anti-nutrient composition of these two sample wheat products, hence, the aim of this work is to compare the proximate, mineral nutrient and anti-nutrient contents of the two products to provide consumers, especially, the diabetics , desirable options.

2. Materials and Methods

Samples of semolina and couscous were gathered from supermarkets of state capitals in Nigeria, and mixed together to create a composite sample. Representative samples of the two wheat sample products were brought to the University of Port-Harcourt's Plant Anatomy and Physiology Research Laboratory, Rivers State, Nigeria for analysis. This project was completed between January and February of 2022.

2.1. Determination of the proximate, mineral nutrient, and anti-nutrient compositions of couscous and semolina .

This was carried out following the method in A.O.A.C (2010)/Atomic absorption spectrophotometer with some modifications.

2.1.1 Proximate analysis

2.1.1.1 Determination of carbohydrate

Two distinct, clean, 250 mL conical flasks were filled with 0.1 g of each sample—couscous and semolina. Each sample was heated to digest, after 3g of digestion catalyst and 20 ml of concentrated sulfuric acid were added to the flasks. Using the Cleg Anthrone method, 0.1g of semolina and couscous were weighed into two separate volumetric flasks,and 1.3 mL of 62% perchloric acid and 1 mL of distilled water respectively, were added and the mixtures were agitated, and left to homogenize thoroughly for 20 minutes. Each of the sample mixtures was made up to 25 mL with distilled water. After each sample mixture solidified, it was passed through glass filter paper, left to sediment, and then decanted . 0.1 mL of each sample filtrate was put in two different test tubes, and made up to 1mL with distilled water respectively. To each, 5 mL of Anthrone reagent was added. 1mL of distilled water and 5mL of Anthrone reagent were mixed in another test tube. The mixture was read at 630nm wave length on a Spectrophotometre, using the 1ml distilled water and the 5m of anthrone reagent mixture prepared as blank for each sample. A 0.1mL solution of glucose was also prepared and treated as the sample, with Anthrone reagent. Absorbance of the standard glucose was read, and carbohydrate content calculated as the values of glucose, using the formula below for each of the samples.The above experiments were replicated three times for each of the samples.

% CHO as glucose = 25 x absorbance of sample x 100/Absorbance of standard glucose.

.

2.1.1.2 Determination of protein

Stage 1 Digestion

Couscous and semolina samples (0.1g each) were weighed using the Kjeldahl method, and placed into two distinct spotless 250 mL conical flasks. To each sample, 3g of digestion catalyst and 20 mL of concentrated sulfuric acid were added to the flasks, and the samples were heated to facilitate digestion. The color of the contents changed from black to sky blue. The digests were cooled to room temperature and diluted to 100mL with distilled water for the two samples.

Stage 2 Distillation

20 mL of diluted digest was measured into a distillation flask and the flask was held in place on the electro-thermal heater. The distillation flask was attached to a liebig condenser connected to a receiver containing 10mls of 2% boric acid indicator. 40m of 40% sodium hydroxide was injected into the digest via a syringe attached to the mono-arm steel head, until the digest became strongly alkaline. The mixture was heated to boiling, and ammonia gas distilled via the condenser into the receiver beaker. The color of the boric acid changed from purple to greenish, as ammonia distillate was introduced into the boric acid. These were done for each of the samples in three replicates..

Stage 3 Titration

The distillate was titrated with standard 0.1N Hydrochloric acid solution back from greenish to purple. The Hydrochloric acid was added to effect this change as titer value. The above experiments were replicated three times for each of the samples.

Calculation= % organic Nitrogen =Titer value x 1.4 x 100 x100/ 1000 x 20 x 0.1.

Where titer value = the volume of HCL used in titrating the ammonium distillate. 1.4 =Nitrogen equivalent to the normality of HCL used in the titration 0.1N.100=percentage factor;1000=Conversion factor from gram to milligram ;20=integral volume of digits analyzed or distilled ; 6.25 =% Nitrogen .

2.1.1.3. Determination of lipid

By Soxhlet extraction method, 2g of each sample, couscous and semolina was inserted into filter papers and placed into a soxhlet extractor. The extractor was placed into a pre-weighed dried distillation flask.The solvent (acetone) was introduced into the distillation flask via the condenser end attached to the soxhlet extractor. The set up was a condenser, and the heated solvent was refluxed as a result. The lipid in the solvent chamber was extracted by process of continuous refluxing. When the lipid was observably extracted completely from the sample, the condenser and the extractor were disconnected and the solvent evaporated to concentrate the lipid. The flask was then dried in the air oven to constant weight, and reweighed to obtain the weight of lipid. These were done for each of the samples in three replicate .

Calculation =% Lipid =Weight of flask and extract - Weight of empty flask x 100/ Weight of sample extracted

2.1.1.4 Determination of moisture

By the air oven method ,1g each of couscous and semolina were weighed into separate clean dried porcelain evaporating dishes. They were placed in an oven to maintain a temperature of 105^{o}C for six hours. The evaporating dishes were cooled in a desiccator to room temperature, reweighed and the value recorded. These were replicated three times. Calculation =% moisture =Weight of Fresh Sample- Weight of dried Sample x 100/ Weight of sample used.

2.1.1.5 Determination of ash

Using the furnace method, 1g of semolina and couscous were each weighed into porcelain crucibles that had been preheated and reweighed. After being placed inside a muffle furnace and heated to 630 degrees Celsius for three hours, the crucibles were allowed to cool to ambient temperature before being re-weighed. These were done for each of the samples in three replicates. Calculation of % Ash=Weight of Crucible + Ash Sample - Weight of Crucible x 100/Weight of Sample

2.2. Mineral analysis

For this experiment, analytic grades of chemicals were utilized exclusively. Metal concentrations were determined using an AST Atomic Absorption Spectrophhotometer.

2.2.1 Determination of metal ions

Samples (0.1g) of couscous and semolina each, were converted to ash in a Muffle furnace at a temperature of 630^0C for 3hours.The ash for each sample was dissolved separately in 10ml of concentrated hydrochloric acid and heated on electro-thermal heater hot plate. The solution of ash of each sample was diluted to 50mL with distilled water. The solutions were analyzed for different metal ions by AAS at different wavelengths as shown in the table below. The wavelength selected with a narrow slit width, air and acetylene gas flow, and other settings, were adjusted as recommended for the instrument employed, and regulated. Hollow lamp cathode was given adequate time to stabilize before aspirating solution for calibration of the equipment, after which ,with standard metal concentration, the system was flushed with distilled water severally before aspirating each sample's solution, at the sample experimental condition used for the standard. The concentration of metal ion in the sample was extrapolated from the standard graph of that metal ion plotted. This was replicated three times for each of the sample.

Table I. Maximium absorption band for specific metal ions in nm

Metal ion	Wavelength (nm)
Phosphorus(P)	213.6
Copper (Cu)	324.8
Zinc (Zn)	213.8
Manganese (M)	279.5
Calcium (Ca)	422.7
Magnesium (Mg)	285.2
Potassium (K)	766.0
Sodium (Na)	589.0
Iron(Fe)	510 .0

2.3 Anti-nutrient Analysis

2.3.1 Determination of saponin

Sample, (10g) of couscous and semolina each were dispersed in 100 mL of 20% ethanol. The suspensions were heated over hot water bath for 4 hours with continuous stirring. The mixtures were filtered, and the residues re-extracted with another 100mL of 20% ethanol for the two samples respectively. The combined extracts were reduced to 20 mL over water bath at about

90^{o}C. The concentrates were transferred into a 250 mL separator funnel, and 20 mL of diethyl-ether was added and shaken vigorously. The aqueous layer was recovered, while the ether layer was discarded. The purification process was repeated. 60mls of n-butanol was added, and the combined n-butanol extracts was washed twice with 10 mL of aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation, the samples were dried in oven to a constant weight. The saponin content in percentage was calculated. This was replicated three times for each of the sample.

Calculation=(%) Saponin = weight of flask with residues – weight of empty flask x 100/ Weight of residues.

2.3.2 Determination of flavonoid

By Bohm and Kocipal-Abyazan mod,5g each of couscous and semolina were weighed into two separate conical flasks. 40 mL of 80% aqueous methanol and 10 mL of distilled water were added to extract the flavonoid. The conical flasks were cocked with foil to prevent evaporation. The set-up was left for 1 hour. Beakers were collected, washed, cleaned, dried and fire polished with electro-thermal heater, and put in a desiccator to cool at room temperature. The beakers were weighed to determine their initial weight. The mixtures were filtered into the beakers, weighed to determine their weight, and put in an air oven. They were reweighed later to determine their termed the final weight . Thereafter, the initial weight of beakers were subtracted from the final weight to obtain the weight of the flavonoid. This was replicated three times for each of the sample.
Calculation =% Flavonoid=Weight of flask and sample residue- weight of empty flask x100/Weight of sample used

2.3.2 Determination of Alkaloid

Samples (2.5g) of couscous and semolina, were weighed into two weighed beakers, using the Harborne method. After adding 95 ml of 10% ethanol and 5 ml of glacial acetic acid in each, the mixture was left to stand for four hours. The mixture was boiled for 20minutes, and concentrated ammonia was added until precipitate was formed. Filter paper was weighed, and it was termed its initial weight, and was used to filter the solution. After the filter paper was dried in an air oven, it was reweighed, and this was termed the final weight of the filter paper. The initial weight of the filter paper was subtracted from the final weight to obtain the weight of the alkaloid. This was replicated three times for each of the sample.

Calculation of Alkaloid=Weight of filter paper and residue-weight of empty filter paper x 100/Weight of sample used

2.3.4 Determination of Tannin

Couscous and semolina samples(0.1g) each, were weighed into two different conical flasks and 50 mL of water were added. They were boiled gently on hot plate for 1 hour and allowed to cool. Tannic acid standard was prepared. 1 mL of the solution was put into a test tube, and 1 mL of

water into another test tube respectively for the two samples. 1ml of 17% sodium carbonate (Na_2C0_3) ,was added to the solution and water. 0.25ml of folin denis reagent was added to both solution and water, and allowed to stand for 30minutes. They were determined in a Spectrophotometer at 520nm wave lengths. This was replicated three times for each of the sample.
Calculation, If C =mg tannic acid obtained for the Samples;Soluble Tannins (%) = C (mg) x extract volume 10 (ml) x aliquot (ml) x sample wt (g)

2.3.5 Determination of cyanogenic glycoside

Sample, (5g) each of couscous and semolina, were weighed into two different clean distillation flasks. 20 mL of distilled water was added and allowed to stand for 24hours or 48hours to obtain proper hydrolysis . The flasks were attached to the condenser and the samples distilled into 20 mL of 0.5molar sodium hydroxide. The distillates were titrated with 0.02m silver nitrate ($AgN0_3$) in the presence of 1ml of 6molar Ammonia (NH_3), and 0.2ml of potassium iodide (Ki) till it turned turbid for the separate samples. The titer value was recorded for each sample. This was replicated three times for each of the samples. Calculation=(%) Cyanogenic glycoside = Titer value x 2 x 100/1; where titer value = the volume of $AgNO_3$ used to titrate the distillate to turbidity.

Statistical analysis

For every sample, three duplicates of each experiment were conducted. SPSS version 20.0 was used to analyze the data. The independent sample t-test was used to compare the mean values of the minerals, proximate, and anti-nutrients of semolina and couscous. The analysis of variance (ANOVA), standard deviation, and significance threshold were all set at $p<0.05$.

2.Result

3.1 Proximate analysis

Based on proximate analysis, the percentage composition of couscous was higher than that of semolina in terms of carbohydrates (82.10±0.10), protein (9.20±0.10), and moisture (5.90±0.05), while on the other hand, semolina had higher levels of ash (1.00±0.50), lipid (1.40±0.20), and fiber (2.68±0.01) compared to couscous which had ash (0.20±0.10), lipid (0.40±0.20), and fibre (2.20±0.20) as shown in Table 2..

2:The Proximate Composition Of Semolina And Couscous in Percentage Mean ± Standard Deviation (SD).

Proximate	Semolina	Couscous
Protein	5.20±0.10	9.20±0.10
Carbohydrate	60.00±0.20	82.10±0.10
Lipid	1.40±0.20	0.40±0.20
Ash	1.00±0.50	0.20±0.10
Fibre	2.68±0.01	2.20±0.20
Moisture	5.70±0.26	5.90±0.05

$p<0.05$

3.2 Mineral nutrients analysis

The mineral nutrients potassium, sodium, calcium, magnesium, iron, zinc, copper, manganese, and phosphorus were all higher in semolina than in couscous, and Table 3 shows that these differences were statistically significant (p<0.05).

Table 3: The Mineral Composition Of Semolina And Couscous in mg/100g Mean ± Standard Deviation (S.D).

Mineral nutrients	Semolina	Couscous
Potassium	7.36±0.25	6.74±0.17
Sodium	6.21±0.26	5.66±0.34
Calcium	7.32±0.14	5.68±0.36
Magnesium	5.82±0.40	5.51±0.31
Iron	0.42±0.28	0.35±0.27
Zinc	2.37±0.33	1.81±0.52
Copper	0.66±05	0.52±0.80
Manganese	1.20±0.21	0.72±0.25
Phosphorus	4.52±0.12	3.27±0.33

P<0.05

3.3 Anti-nutrients analysis

Anti-nutrients, saponin, alkaloid, flavonoid, tannin, and cyanogenic glycoside were found to be present in both semolina and couscous; the values of these components varied significantly (p<0.5) between the two wheat products; table 4 shows that couscous had a higher cyanogenic glycoside value than semolina.

Table 4: The Anti-nutrient Composition Of Semolina And Couscous in Mean ± Standard Deviation (SD).

Anti-nutrients	Semolina	Couscous
Saponin	1.80±0.10	0.50±0.20
Alkaloid	5.20±0.20	4.00±0.50
Flavonoid	3.40±0.20	0.20±0.10
Tannin	0.25±0.05	0.01±0.00
Cyanogenic glycoside	12.00±2.00	52.00±1.00

p<0.05

4. **Discussion**

The values of protein, carbohydrate, lipid, ash, fiber, and moisture obtained from semolina and couscous in this work showed that there was a very significant difference between the two wheat products p<0.5, though the values of Protein, carbohydrate, and moisture were higher in

couscous than in semolina as shown in table 2. Celik *et al.*(2004), reported the proximate value of couscous as–protein(11.27%), Fibre(90.6%), Carbohydrate(71.80%), and Fat (2.58%), whereas the proximate values of semolina reported by USDA(2013) were-Water(12.67), Protein(12.65%), Lipid(1.05%), Ash(0.77%), Carbohydrate (72.83 %), Fibre(3.1 %). These values are higher than those obtained in this work, except the value of carbohydrate in couscous which was lower than that obtained in this work.

The proximate (food nutrients) in semolina and couscous have their different functions. According to Manthey and Hareland (2001), the moisture content in semolina is an important factor in processing it into pasta, as it results from three different influences: the need to maximize mill gain by incorporating as much water as possible; the ideal moisture content for optimal milling performance and handling of product; the overriding safety requirement not to exceed a moisture level where mold growth or other microbiological organisms will not affect the product. This should form one of the reasons it should be given preference against couscous, which has a higher moisture content, from the result of this work. Protein contains essential amino acids which help to repair and build the tissues of the body. Proteins are the chief actors within the cell, said to be carrying out the duties specified by the information encoded in genes (Bruckdorfer *et al*, 2004). Except for certain types of RNA, most other biological molecules are relatively inert elements upon which proteins act (Sleator, 2012). A carbohydrate breakdown provides the body with the energy it requires for performing daily activities (Flitsch *et al*, 2003). Carbohydrate which break down to release energy, is a good source of energy for man, and both contain fibre for healthy bowel movement (Weickert and Pfeiffer, 2007).

According to Weickert and Pfeiffer(2007), ash includes trace minerals that are required for unique molecules, such as chlorophyll and hemoglobin, and is the name given to all non-aqueous residue that remains after a sample is burned, which consists mostly of metal oxides. It is also one of the components in the proximate analysis of biological materials, consisting mainly of salty, inorganic constituents, and includes metal salts which are important for processes requiring ions such as Na^+ (Sodium), K^+ (Potassium), and Ca^{2+}(Calcium), and also includes trace minerals which are required for unique molecules, such as chlorophyll and hemoglobin (Weickert and Pfeiffer, 2007).

McKee and Latner(2000); Philippee (2006); Weickert and Pfeiffer(2007), and Rave *et al.* (2008) have demonstrated the beneficial effects of fibre consumption in protection against heart disease and cancer, normalization of blood lipids, regulation of glucose absorption and insulin secretion, and prevention of constipation and diverticular disease in humans; and those components that are insoluble in water includes cellulose, hemicellulose and lignin. As reported by Philippe (2006), whole grains are good sources of insoluble fiber, and butyrate at high concentrations in the colon is hypothesized to improve bowel health and lower cancer risk by several possible mechanisms. A high-fiber diet has the drawback of possibly producing a lot of intestinal gas, and bloating constipation may result from consuming too little fluids (Kritchevsky and Eastwood 2005). Another significant energy source is fats. Their primary biological roles include energy storage, signaling, and functioning as structural elements of cell membranes (Fahy *et al*., 2009). Additionally, they are the building blocks of steroid hormones (Mashagh *et al.,* 2013).

From the above functions of the food nutrients, as asserted by various researchers, it is necessary to note that in as much as we show a preference for whichever of the two products, consumers should take cognizance of the maximum benefits they would derive from any of the two. Secondly, the moisture level of each product, and the amount of water consumed regularly, will help the metabolic functions of the body, and the activity of different organs in the body. The values of mineral nutrients potassium, sodium, calcium, magnesium, iron, zinc, copper, manganese, and phosphorus in semolina were significantly higher than those in couscous $p<0.5$. The values of mineral nutrients as reported by previous researchers- sodium(42.25mg), potassium (365.62mg), iron (2.73mg), calcium(48.30mg) Celik *et al*.(2004) in couscous, and calcium (17.0mg), iron (1.23mg), magnesium (47.0 mg), phosphorus (136 mg), potassium(186 mg), sodium (1.0mg), zinc(1.05mg), copper(0.18mg), and manganese (0.61 mg)USDA(2013) in semolina, are lower than those obtained in this work. The anti-nutrients, saponins, alkaloid, flavonoid, tannin, and cyanogenic glycoside were observed in semolina and couscous, and there was a significant difference between the values of the anti-nutrients of the two wheat products $p<0.5$, with the values of saponins, alkaloid, flavonoid, tannin observed in semolina, higher than those observed in couscous. The value of cyanogenic glycosides was higher in couscous than in semolina, as shown in Table 4. No literature exists on previous research on the anti-nutrients in semolina and couscous in the direction of this work.

All the phytochemicals (mineral nutrients and anti-nutrients) in semolina and couscous offer benefits to man as well as negative effects. The presence of anti-nutrients hinders the activity of some of the nutrients in the body. Iron is a vital mineral that aids in the production of red blood cells which carry oxygen throughout the body, and the provision of oxygen to all parts of the body ensures healthy muscle contraction and brain function (Walter, 1997).

Flavonoids have been shown to have a wide range of biological and pharmacological activities in vitro studies, example-anti-allergy (Yamamoto and Gaynor, 2001); anti-microbial, antibacterial, antifungal, and antiviral (Cushnie and Lamb, 2005);anti-cancer, and anti-diarrheal activities (Friedman, 2007); anti-inflammatory, antioxidant (Cazarolli *et al*., 2008). Tannin has been reported to hasten the healing of wounds and has anti-spasmodic and antianxiety effects in humans (Ayoka, 2005); phytochemicals which can be found in most vegetables, beans, and herbs, and the best-known sources of saponins are peas, soybeans, and some herbs with names indicating foaming properties such as soapwort, soaproot, soapbark and soapberry(Bruckdorfer *et al*., 2004). Alkaloids have a wide range of pharmacological activities including vasodilatory (e.g. vincamine), antiarrhythmic (e.g. quinidine), analgesic (e.g. morphine),(Raymond *et al*.,2010); cholinomimetic (e.g. galantamine), (Russo *et al*.,2013); antimalarial (e.g. quinine), antiasthma (e.g. ephedrine), anticancer (e.g. homoharringtonine), (Kittakoop *et al.,* 2014); antibacterial (e.g. chelerythrine), (Cushnie *et al*., 2014); antihyperglycemic activities (e.g. piperine) (Qiu *et al*., 2014. In the two sample wheat products, semolina and couscous, all the above anti-nutrients were present, including cyanogenic glycosides, a precursor to cyanide. The potential toxicity of cyanogenic glycosides arises from enzymatic degradation to produce hydrogen cyanide, resulting in acute cyanide poisoning (Haque and Bradbury, 2002). Humans may be fatally exposed to cyanide, with an acute dosage of about 1 mg/kg body weight, according to Davis (1991).

It is pertinent that the food nutrients, minerals, and anti-nutrients present in these wheat products are necessary for our growth, metabolic, protective, and general well-being, however, consumers have to exercise caution on their choice of consumption, with regards to their mode of processing and the quantity of nutrients in them that will give them the maximum health benefits.

Conclusion

From the result of the analysis of the proximate, mineral nutrients and antinutrient compositions of semolina and couscous, the values of carbohydrate, protein, and moisture contents of couscous were higher than those of semolina, while the fiber, lipid, ash, and all the mineral nutrients and anti-nutrient compositions of semolina were higher than those of couscous except cyanogenic glycoside. However, there was a significant difference between the proximate compositions of the semolina and couscous, as well as the mineral and anti-nutrients of the two. Couscous and semolina are being recommended to patients, especially, diabetics by their Medical Doctors, in the belief that they contain little or no carbohydrates. The result of this research will guide their further prescriptions, and their choice of the two wheat products by consumers.

References

Association of Official Analytical Chemists (AOAC),(2010).(18th Edition). Washington, D.C.U.S.A.

Ayoka,AO, Akomolafe1, R. O. Iwalewa,E. O. and Ukponmwan,O E.(2005) Studies On The Anxiolytic Effect Of *Spondias mombin* L. (Anacardiaceae) Extracts .*African Journal of Traditional*. CAM 2 (2): 153 - 165.

Bruckdorfer, T., Marder, O. and Albericio, F. (2004).From production of peptides in milligram amounts for research to multi-tons quantities for drugs of the future.Current Pharmaceutical Biotechnology. San Diego. Academic Press.

Cazarolli, L., Zanatta, L., Alberton, E. andFigueiredo, M. (2008). Flavonoids Prospective Drug Candidate. *Mini-Reviews in Medicinal Chemistry.* 8 (13):1429–1440.

Celik, I., Isik, F., and Gursoy, O. (2004). Couscous, a traditional Turkish food product: Production method and some applications for enrichment of nutritional value. *International Journal of Food Science Technology*. 39: 263-269.

Clifford, A. (2004). Production of couscous which is among the traditional delights of Turkey. *Journal of Traditional Foods.* 9: 15-17.

Connel, P., Lawrance, L., and Nelson, R. (2004). Durum wheat: Australia's role in world markets. *Journal of Australian Commodities. 11:* 319-324.

Cushnie, T. and Lamb, A. (2005). Antimicrobial activity of flavonoids. *International Journal of Antimicrobial Agents.* 26 (5): 343–356.

Cushnie, T., Cushnie, B. and Lamb, A. (2014).Alkaloids, An overview of their antibacterial, antibiotic enhancing and antivirulence activities.International *Journal of Antimicrobial Agents*.44 (5): 377–386.

Davis, R.H. (1991). *Cyanogens*. *In* D'Mello, J.P., Duffus,C.M. and Duffus, J.H. (eds). Toxic Substances in Crop Plants. Cambridge, The Royal Society of Chemistry pp 21-32.

Donnelly, B. J., and Ponte, J. G. (2000). Pasta Raw materials and processing. *In*:Kulp, K. and Ponte, J. G. (Eds.), Handbook of cereal science and technology (2nd ed.) Marcel Dekker, Inc. U.S.A pp. 647-665.

Kristchevsky, D and Eastwood,M (2005). Dietary fiber.*Annual Review of Nutrition* 25:1-8

Fahy,E.,Subramaniam,S.,Murphy,R.,Nishijima,M.and Raetz, C.(2009).Update of the Lipid Maps comprehensive classification system for lipids. *Journal of Lipid Research.* 50: 9–14.

Flitsch,Sabine,L.and Rein,V. (2003). Sugars tied to the spot. .*Journal of Nature*. 421: 219–20.

Friedman,M.(2007).Overview of antibacterial, antitoxin, antiviral, and antifungal activities of tea flavoids and teas.*Molecular Nutrition and Food Research.* 51 (1):116– 134.

Haque, M.R. and Bradbury, J.H. (2002) Total cyanide determination of plants and foods using the picrate and acid hydrolysis methods.*Journal of Food Chemistry.* 77(1):107-114.

Kittakoop, P., Mahidol, C. and Ruchirawat, S. (2014). Alkaloids as important scaffolds intherapeutic drugs for the treatments of cancer, tuberculosis, and smoking cessation. *Journal of Medical Chemistry*.14 (2): 239–252.

Lee, L., Baik, B.K. and Czuchajowska, Z. (1998). Garbanzo bean flour usage in biological roles and future perspectives.*Chinese Journal of Natural Medical.*12 (6): 401–406.

Mashaghi, S., Jadidi, T. and Koenderink , G. (2013). Lipid Nanotechnology.*International Journal of Molecular science.* 14: 4242–4282.

Manthey,F. A., and Hareland, G. A.(2001).Effects of break–roll differential on semolina and spaghetti quality. *Journal of Cereal Chemistry.* 78: 368–371.

McKee,C. J. and Latner,V.(2000).Chemical Composition and Nutritional Quality of Wheat Grain. *Journal Of Nutrition*.78*:*228-241.

Philippee,S. L. (2006).Chemical Composition and Nutritional Quality of Wheat Grain. *Journal Of Nutrition*.98*:*282-301.

Qiu,S.,Sun,H,Zhang,A.,and Xu,H.(2014).Natural alkaloids, basic aspects, biological roles and future perspectives. *Chinese Journal of Natural Medical*.12 (6):401–406.

Rave,K.,Roggen,K and Dellweg, S.(2008).Nutrient content in the Durum Wheat. *Journal of ,Nutrient*. 98:929-936.

Raymond,S.,Jonathan,S.Jahr,J. and Watkins-Pitchford,M.(2010).The Essence of Analgesia and Analgesics. Cambridge University Press.

Russo,P.,Frustaci,A.,Del Bufalo,A. and Fini, M., (2013). Multitarget drugs of plants origin acting on Alzheimer's disease. *Journal of Current Medical Chemistry*.20(13): 1686–93.

Sleator,R.D.(2012).Prediction of protein functions. Methods in Molecular Biology.Boston:Academic Press.

Turnbull,K.(2001).Basic semolina requirements. *In*: Kil,R.C. and Turnbull,K(Eds.)Pasta and semolina technology Blackwell Science Ltd, pp. 43-45.

United State Department of Agriculture(USDA),(2013) Couscous Cooked. *Food Information.*The National Agricultural Library.NDB NO: 20029.

Viteri, F.E. (1998). *In* : Howson, C. P. and Kennedy, E. T. (eds) Prevention of Micronutrient Deficiencies. National Academy Press, Washington DC, pp 45-102.

Walter,T (1997).Trace elements in man and animals *In*: Fischer,P.W. and Cockell,K.A.(eds). Proceedings of the Ninth International Symposium on Trace Elements in Man and Animals. *National Research Council of Canada*, Ottawa , pp 217-219

Weickert,M.O. and Pfeiffer,A.F.(2007).Chemical Composition and Nutritional Quality of Wheat Grain. *Journal Of Nutrition.*138*:*439-449.

Yamamoto,Y. and Gaynor,R.(2001).Therapeutic potential of inhibition of the NF-κB pathway in the treatment of inflammation and cancer. *Journal of Clinical Investigation.*107(2):135–42.

Funding

The project was jointly funded the authors

Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethical issues

The authors declare that there were no ethical issues involved.

Author Contributions

Ibiam O. F A Conceptualized, supervised the project and wrote the work
Dike, O.C and Akpa, S. O conducted the experiment
Akanu-Ibiam, A. C. and Nwosu, S.C -Procured the samples and did the interrogation of the users of the two wheat products.
Nwaru, E. C Carried out the proof-reading, plagiarism and grammar check
Onwe, E.N Carried out the statistical analysis
All the authors read the work and approved it before publication.