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Quality Evaluationand Microbial Safetyof Soybean Powder Sold in Umuahia, Abia State, Nigeria

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Abstract: *The nutritional attributes of soybean has led to the availability of soy products particularly soybean powder of diverse qualities since its production technique is robust. This studyis aimed at evaluating the quality of soybean powder displayed in major marketslocated in Umuahia, Abia state, Nigeria. The proximate composition, vitamin and mineral content and microbial safety were analysed.The protein content of all the samples were found to be low (2.4-4.5%), which could be attributed to the poor processing methods used wherein the protein inhibitors were not properly reduced to insignificant levels.Also the soybean powders were observed to have been adulterated with cassava flour. The carbohydrate content for all samples ranged between 30.52 to 63.14 % which validates its claim as a high energy source.The vitamin C content of the soybean samples was lower than the values for soybean in literature which is likely due to the soaking process which may have resulted in the leaching out ofsoluble vitamins.The mineral content was relatively low. The growth of Staphylococcus aureus in samples obtained from Cooperative andUbani market was significantly high; (7.8x 10^5cfu/g) and (8.1x 10^5cfu/g) respectively which is attributed to poor handling and non-hygienic methods.*

Keywords: *Soybean powder,anti-nutritional factors, microbial analysis, nutrient composition*

I. Introduction

1. Soybean (*Glycinemax* (L.) Merr) is an important oil seed belonging to the family Leguminosae. It is usually cultivated as a food crop [1]. Soybean is a staple food of great nutritional value. Its importance includes milk production, oil processing, livestock feeds, industrial uses and human consumption[2]. Soybean has been recognized to be an ideal grain for meeting protein and energy requirements of both man and animal. It is probably the world's most valuable crop, used as feed by billions of livestock, as a source of dietary protein, oil and in the industrial manufacture of several products [3].
2. Soybean is such an extremely rich source of protein and fat, and such a good source of energy, vitamins and minerals with an average production cycle of 90-110 days from planting to harvesting.Soybean contains about 35 to 40% protein and has been noted as an invaluable protein source. Of all plant foods consumed globally, it is ranked numberone as the richest in food value [4]; [5].
3. There is increased research currently on plant sources of protein. Most of these plants are legumes due to the protein content of leguminous plants. Therefore, soybean is seen as an important legume not only because of its high protein content but also due to its nutritionally balanced amino acid profile [6]. Another unique quality of soybean is its reliable availability and affordable cost[7].
4. Currently, soybean is gaining more popularity as the pressing need to alleviate poverty and malnutrition and to improve the welfare of the poor increases, thereby serving as a source of high quality protein food with great income opportunities [8].
5. The household use of soybean is targeted to suit local dishes for Nigerians and communities all over the country. About 140 soybean products are now available [9]; [10]; [11]
6. It is very useful in improving the menu of malnourished children and revitalizing heart and breast cancer patients and it has no cholesterol. According to [9], soybean can be used as a nutritional supplement for pregnant women, lactating mothers and children. This importance of soybean has led to the increased number of people involved in the processing and marketing of soybean powder in Nigeria which has also resulted to the widespread of substandard and low quality soybean products in our markets.
7. A key problem associated with soybean is that it contains some anti-nutritional factors, which inhibit the availability of the desirable elements such as protein. Fortunately most of these anti-nutritional factors can be destroyed through adequate processing and boiling [12]; [9]; [10].
8. Major processing of these products includes cleaning, soaking,fermentation,dehusking, milling, sieving, boiling and toasting or oven-drying. Further processing depends on the type of products to be produced. [13].
9. With the increasing use of soybean products for human consumption, it is necessary to assess the risk to human health that may be associated with the consumption of soybean processed locally in which the trypsin inhibitors may not have been completely inactivated[14] ;[1].

10. The presence of anti-nutritional factors in soybean has been observed to have a possibility of reducing the protein digestibility and consequently inhibit its amino acid availability [15]. Most of these anti-nutritional factors are naturally occurring in the food while some are formed during heat/alkaline processing of leguminous products. This reaction yields Maillard compounds, an artificial amino acid derivativeknown as lysinoalanine (LAL), and oxidized forms of sulfur amino acids. Legumes which contain high levels trypsin inhibitors such as soybeans have been found to cause up to 50% reductions in amino acid digestibility in rat and pig studies [15]. It is therefore important to note that for a plant to to be termed as a high protein source, it must have high amounts of essential amino acids accompanied with good digestibility and bioavailability [16].
11. The ease of processing of soybean flours has led to the increase of individuals involved in the processing and marketing of soybean powder in Nigeria. This has also resulted in multiple kinds of soybean flour in the market with varying qualities. Poor handling processes with poor hygienic practices has resulted in the widespread of low quality soybean products.
12. It is necessary to ensure that the thermal processing technique applied is sufficient to reduce the anti-nutritional factors to low levels[16]**.**
13. Most soybean products have been contaminated by certain microorganisms which cause food borne illness and disease to under aged children in Nigeria (6-36months) particularly in Abia State during weaning. This is as a result of poor handling or processing, use of dirty utensils, and poor storage [17].
14. Therefore it is necessary to carry out microbial safety and nutritional assessment on the soy products available in the market to determine their safety levels and thus to proffer a solution on better ways of handling and processing soybean flour, so as to reduce the risk of inherent disease caused by poor processing and packaging of soybean products in Abia State. This will go a long way to improve the nutritional status of Children within the Age of 5-36months in Abia State that are prone to underweight, stunting, food poisoning and wasting.
15. The aim of this work was toevaluate the quality and microbial safetyof soybean powder found in major markets of Umuahia, Abia State Nigeria. Specifically, the main objectives of this study were to determine the vitamin, mineral and anti-nutrient contents ofdehulled soybean powder and to evaluate their microbial safety.

II. Materials And Methods

2.1 Raw material collection

Soybean powder used for this study was obtained from the major markets in Umuahia,Abia state. The markets include Ubani international market, co-operative market, Owerri road market, Ndoro Market and Crowther/Ibeku market. All reagents used were of analytical grade.

2.2 ProximateAnalysis of Soybean Flour

2.2.1 Moisture content determination

The moisture content was determined using gravimetric method [18], where 5g of each sample was used at 105^0C for 3 hours. The weight loss was calculated and expressed as a percentage of the original sample weight.

2.2.2Ash content determination

The furnace incineration method as described by [19]; [20] was used. Accurately, 5.00g of each sample was measured into a previously weighed porcelaine dish and transferred into a pre-heated muffle furnace at 550^0C and left for 2 hours at this temperature. The heated samples were cooled in desiccators and re-weighed and moisture content was calculated using (1).

2.2.3 Crude fiber determination

This was determined using the method described by [19]. Five grams (5g) of the sample was boiled under petroleum ether. The defatted sample was boiled under reflux for 30 minutes with 200 ml of a solution containing 1.25g of tetraoxosulphate (VI) acid (H_2SO_4) per 100ml of solution. The solution was filtered through a muslin cloth on a fluted funnel. The residue was washed with boiling water until it was no longer acidic before it was transferred into a beaker and was boiled for 30 minutes with 200ml of solution containing 1.25g NaOH per 100ml. The final residue was filtered through a thin but closed pad of washed and ignited asbestos in a crucible. The residue was dried in an electric oven and weighed. It was incinerated, cooled, weighed and crude fiber was calculated using (2).

2.2.4 Fat content determination

This was determined using soxhlet fat extraction method [21].

2.2.5 Protein determination

This was done using the Kjedahl method described by [21]; [19].

2.2.6 Determination of carbohydrate

Carbohydrate was determined by difference. In this method, carbohydrate contents were obtained by subtraction, having obtained all the other fractions of proximate composition as seen in [3]and [21]; [19]. This was calculated as in (3).

2.3 Vitamin analysis

2.3.1 Determination of riboflavin

Accurately 10g of sample was weighed into a conical flask. 50ml of 0.2NHCl was added and boiled on a water bath for 1 hour. It was cooled and adjusted to pH5.0 using NaOHand filtered into a 100ml measuring flask then the volume was made-up to the mark. Two tubes were taken and marked 1 and 2 in order to remove interference. 1 ml of acetic acid was added to each tube and mixed. 5ml of 3% $KMnO_4$ solution was added and kept away for 2 min and 0.5ml of 3% H_2O_2 was added. The florimeter was adjusted to excitation wave length of 470nm and emission wavelength of 525nm. 20mg of Sodium Hydrogen Sulphate was added to both tubes and the fluorescence were measured [22].

2.3.2Determination of thiamin

The method described by [22] was adopted where5g of the sample was taken and 75ml of 0.2NHCL was added and heated to boiling for 30min on a water bath. It was cooled and 5ml of enzyme solution was added and incubated at 37^0C over light. The material was then placed in 100ml flask and filled to 100ml with water. The residue was filtered and purified by passing it through silicate calcium 5ml of acidic KCl reagent was taken in conical flask and 3ml of alkaline Ferricanide solution and 15ml of iso-butanol was added and shaken for 2min. it was allowed to separate and the alcohol layer was taken. 3g of anhydrous Na_2SO_4 was added to iso-butanol extract. Oxidation and extraction of thiochrone in the case of sample as described above was carried out using 5ml each. Another sample and standard blank were prepared. 3ml of 15NaOH was added. The florimeter was set up to excitement wave length of 360nm and emissive wavelength 435nm. The instruction was adjusted to zero deflection with $0.1NH_2SO_4$ and 100 against the standard. The florimeter reading with the sample and the blank was taken then calculated in (4)

2.3.3Determination of niacin

This was determined by the method describedin [18]

2.3.4Vitamin A and Cdetermination

The vitamin A and C content of the samples were analysed using the method described in [23].

2.4 Mineral content determination

2.4.1 Determination of calcium and magnesium by complexiometric titration

The EDTA titrimetric method of[24] was employed. 20ml portion of the extract as dispersed into flask and treated with pinches of the masking agents (hydroxylamine hydrochloride, sodium Cyanide and sodium potassium ferrocyanide). The flask was shaken and the mixture dissolved. 20ml of amino buffer was added to it to raise the pH to 10.00 (a point at which both calcium and magnesium form complex with EDTA). The mixture was titrated against 0.02NEDTA solution using Eriochrome Black T as indicator. A reagent blank was also titrated and titration in each case was done from deep red to a paramount blue end point. The titration value represents both Ca^{2+} and Mg^{2+} in the test sample. A repeat titration was done to determine $Ca2^{+}$ alone in the test samples.Titration of calcium alone was done in similarity with the above titration. However, 10% NaOH was used in place of the ammonia buffer and sole chrome Dark blue indicator in place of Eriochrome Black T. From the titer values obtained, the Ca^{2+} content were calculated as in (5).

2.4.2 Potassium determination

This was determined by flame photometry as describedby [22]. The instrument, Jaway digital flame photometer, was set up according to the manufacturer's instruction. It was switched on and allowed about 10 to 15 minutes to equilibrate. Meanwhile standard sodium and potassium solution were prepared separately and diluted in series to contain 10, 8, 6, 4 and 2 pp of Na and K respectively.

After calibration, 1ml of each standard was aspirated into it and sprayed over the non-luminous flame. The optical density of the resulting emission from each standard solution was recorded. Before flaming, the appropriate element filter (Na or K) was put in place with the standards measured, the test sample extracts were measured in time and were plotted into a standard curve which was used to extrapolate the content of each test element and calculated as in (6).

2.4.3 Determination of phosphorus

Phosphorus in the test samples was determined by the molybdo vanadate colorimetric method [19].

2.5Anti-nutrient determination

2.5.1 Phytatedetermination

This was carried out by quantitative method described in [25]

2.5.2 Determination of tannins

The Folin- Denis spectrophotometric method was usedas described by [21].

2.5.3Trypsin inhibitor assay

The trypsin inhibitor activity (TIS) assay used spectrophotometric method described by [26].

2.5.4Determination of hemagglutininby spectrophotometric method

In this method, 0.5g of the simple was weighed into a test-tube and dispersed in a 10ml normal Saline solution buffered at pH 6.4 with a 0.01M phosphate buffer solution. It was allowed to obtain the extract 0.1ml of the extract diluents in a test tube and 1m of the trypsinized rabbit blood were added. A control was mounted with the test tube containing only the blood cells. It was then allowed to stand for 4 hours at room temperature. Another I ml of normal saline was added to all the test tubes and allowed to stand for 10 minutes after which the absorbance was read at 62 nm. The test tube containing only the blood cells and normal saline served as the blank. The result was expressed as hemagglutinin units per milligram of the sample (9).

2.6 Microbial analysis of soybean powder

The method of the international commission on microbiological specification for food [27] was used. Following sterilization of equipments, each sample was swirled and 10ml aseptically introduced into 90ml of sterile peptone water and was homogenized; further decimal dilutions to 10^{-6} concentration were done. 1ml of appropriately diluted sample was used to inoculate freshly prepared media by spread plate method. Media employed for the isolation and enumeration of organism include: Baird parker for *staphylococcus aureus*, RBC Agar for fungal enumeration, MacConky Broth for *E. coli*, Buffered peptone water for pre-enrichment. Media were sterilized by autoclaving at 121^{o}C for 15minutes. In all cases, the resulting colonies following inoculation and incubation were counted.Data obtained were statistically analysedby analysis of variance and means were separated using Duncan multiple range test.

III. Discussion

3.1 Proximate composition of the soybean powder samples

TABLE 1 shows the result of the proximate analysis carried out on the soybean powders obtained from Umuahiamajor markets. The protein content of soybean powders ranged from 2.4-4.45%. This is in similar range with the findings of[28] but in contrast with the protein content of soybean powder as reported by [29] and[17]. These low values could be attributed to the presence of protein inhibitors in the samples [6]. Studies have suggested ways of removing these protein inhibitors such as the method which entails the use of immobilized metal affinity chromatography (IMAC) for binding the protease inhibitors and the soybean lectins from an aqueous extract of the flour [30];[31]; [6]. The low protein contents of the samples could also be as a result of the presence of cassava flours that were added to the soybean as seen in their sealed containers. Cassava flours are high in carbohydrate with negligible protein content, therefore adulteration of soybean powders with cassava results in low protein values.

The samples (Or and Nm) are not significantly different ($p>0.05$) in there protein contents. There was a significant difference between samples Ci, Um andCp ($p<0.05$)in their protein, moisture, Ash, crude fiber and carbohydrate content. These variations might be due to the difference in cultivars and processing methods used [1]. The Ash content of soy powders ranged from 4.86-5.92%. The significant difference between the samples could be attributed to varying charring effect on the samples during processing. The fiber content of the samples ranged from 3.20-3.72% which defers from the fiber content of soy powder (2.1%) as reported by [32]. The Fat content ranged from 20.22-23.60% which falls in line with other research findings[33]. The Carbohydrate content ranged from 30.52-63.14%. The composition of soy beans carbohydrates varies according to the geographical locations where the soybean is grown, harvesting conditions and post-harvestprocesses[34].

3.2 Vitamins composition of the soybean powder samples

TABLE 2 shows the vitamin content of the soy powders. Vitamin A content of the samples arewithin 24.56µg/g to 32.72µg/g. There is a significant difference among the samples ($p<0.05$), with the sample collected from Ndoro market (Nm) having the highest value (32.72µg/g). Vitamin A is often high in soybean due to its existence as a provitamin (β-carotene). It is an essential fat soluble vitamin with functions that include growth maintenance, maintaining the structure and functioning of the cells of the skin and mucous membrane as well as proper eye maintenance [35]. There was no significant difference in the vitamin C content of soy samples

($p>0.05$). The vitamin C content of the samples is seen to be lower than values reported by[33].This loss in vitamin C may be as a result of treatment of the bean (soaking, heating) since vitamin C is water soluble and could be leached. Significant differences were observed ($p<0.05$) in vitamin B1 contents of the samples with co-operative market sample being the highest (1.05µg/g). The B-vitamins level of the samples are lower than those reported by [1]. This might be as a result of the uncontrolled processing treatments since these products were locally produced in homes and brought to the market. Because the soaking and toasting processes have the capacity to leach these vitamins, if not properly done, it can lead to undesired an uncontrolled losses [37].

3.3Mineral composition of soybean samples

TABLE 3 shows the mineral content of the soy powders obtained from the listed markets. The phosphorus contents of the soy samples ranged from 4.71-4.70(mg/100g) which are higher than values obtained in [28] The calcium content of the soy samples are on average 0.31(mg/100g). The magnesium contents are 0.10(mg/100g) on average, having no significant difference between samples except with samples from Crowther market (Ci). These minerals are lower when compared with the mineral content of dehulled soybean powder although some studies have also foundthe availability of calcium in soybean to be low [1].

3.4Antinutritional compositions of the soybean samples

TABLE 4 shows the anti-nutrient contents of the soybean sample. The Trypsin inhibitor and tannins of the samples ranged from 1.49-1.57(mg/g) and 1.49-1.57(mg/g) respectively with trypsin inhibitor being the highest (1.57mg/g). This could be as a result of dry heat treatment given to the soybean during processing. Dry heat treatment which is mostly practiced locally has little effect on the reduction of trypsin inhibitor[1]. Tannins are polyphenols and polyphenolic compounds are water soluble in nature. The reduction of tannins during autoclaving may be attributed to leaching out of phenols into the water used during autoclaving [38]. The hemagglutinin and phytase ranged from 0.56-0.60(mg/g) and 0.13-0.26(mg/g) respectively. Soaking and steaming can be used to remove soluble anti- nutritional factors which can be eliminated with the discarded soaking solution if adequately carried out giving proper consideration to time and temperature [15].

3.5Microbial count of soybean samples

TABLE 5 shows the result of microbial analysis of the soy samples. There was much growth of *Staphyloccocusaureus*in co-operetive(Cp)and Ubani market (Um) samples; this may be as a result of poor handling by the soybean processors as this organism exists mostly in human skin, hand and nose[39]. If these soybean powder samples are used for weaning, it could lead to diarrhea in infants. *Staphylococcus. Aureus*was absent in Owerriroad (Or) and Ndoro (Nm) samples; this shows the extent of hygiene practiced by the processors in that location as this is one of the major criteria of inhibiting *S. aureus*[39].Fungal growth in samples ranged from $1.9x10^5$ to $3.8x10^5$cfu/g with sample(Or)being the highest ($3.8x10^5$cfu/g). Thisleads to short shelf life of the soy products[40]. *E.coli*occured higher in Crowther (Ci)samples which can be attributed to feacal contamination either from raw materials, water or through flies that perch on the food during processing, storage and transportation if not carried out in standard hygienic environments[41]. Its absence in other soybean samples may be as a result of proper hygienic practices, prevention of cross contamination of finished product and the level of heat treatment given to the soybean since *E. coli* is heat sensitive and can be readily destroyed by pasteurization [41]. Its occurrence in foods especially weaning foods causes vomiting, shock, watery diarrhea which can result to wasting and death in infants [39].

IV. Equations

1. Ash content determination:

$$\% \text{ Ash} = \frac{\text{Weight of ash}}{\text{Weight of original sample}} \times \frac{100}{1}$$

2. Crude fiber equation:

$$\text{The crude fibre} = \frac{W1 - W2}{\text{Weight of sample}} \times \frac{100}{1}$$

Where;
W2 = weight of crucible + sample after washing and dried in oven.
W3 = weight of crucible + sample as ash.

3. Carbohydrate**:**

Percentage available carbohydrate = 100 – (% moisture % ash + % protein + % fibre + % fat).

4. Thiamin:
   Calculation
   Suppose Z = (reading of sample solution)–(reading of blank)
   Y = (reading of sample + standard tube)–(reading of sample +standard blank)
   W = weight of sample
   Thiamine = (Mp/g of sample) = Z/Y-Z x 1/w.

5. Calcium and Magnesium:

$$Ca/Mg \quad Mg/Mg = 100 \; X \; \frac{T}{W} - B(N \times Ca/Mg) \times Vt/Va$$

   Where W = weight of sample
   T = Titre value of sample
   B = Titre value of Black
   C = Calcium equivalence
   Mg =Magnesium equivalence
   N= Normality of titrant (0.02NEDTA).

6. Potassium Determination

$$Na \text{ or } K\ (Mg/100g) = \frac{X}{100} \times \frac{Vt}{Va} \times D \times \frac{100}{W}$$

   Where X is the concentration of the test element from the curve.

7. Hemagglutinin:
   Hemagglutinin unit/ mg = (b-a) x F
   Where b = absorbance of test sample
   a = absorbance of blank control
   F = experimental factor given by
   F = 1/w xVf /Va) D
   Where w = weight of sample
   Vf = total volume of extract
   Va = volume of extract used in the assay
   D = dilution factor

V. Tables

Table 1: Proximate Composition of Soybean Powder Samples

Parameters (%)	CP	Or	Nm	Ub	Ci
Protein	$2.48^{d}\pm0.01$	$4.54^{a}\pm0.01$	$4.54^{a}\pm0.01$	$3.01^{c}\pm0.02$	$4.50^{b}\pm0.01$
Moisture	$6.26^{a}\pm0.01$	$3.36^{e}\pm0.00$	$5.34^{b}\pm0.00$	$4.86^{c}\pm0.02$	$4.06^{c}\pm0.00$
Ash	$5.32^{b}\pm0.03$	$5.26^{c}\pm0.01$	$4.92^{d}\pm0.01$	$5.92^{a}\pm0.04$	$4.86^{e}\pm0.00$
Fat/oil	$20.80^{c}\pm0.00$	$22.92^{b}\pm0.00$	$20.08^{c}\pm0.04$	$23.60^{a}\pm0.00$	$20.22^{c}\pm0.00$
Crude fibre	$3.20^{d}\pm0.02$	$3.40^{b}\pm0.03$	$3.30^{c}\pm0.02$	$3.72^{a}\pm0.03$	$3.22^{d}\pm0.00$
carbohydrates	$61.95^{b}\pm0.01$	$60.52^{d}\pm0.03$	$61.82^{b}\pm0.02$	$58.88^{c}\pm0.00$	$63.14^{a}\pm0.00$

1. ^{abc} ..... means with the same superscripts in the same rows are not sig. diff($p>0.05$)
2. Key: Cp= co-operative; Or = Owerri Road; Nm = Ndoru Market; Ub = Ubani Market; Ci = Crowther/ Ibeku

Table 2: Vitamins Composition of the Soybean Powder Samples

Vitamins (µg/g)	Cp	Or	Nm	Ub	Ci
Vitamin A	$24.56^{c}\pm0.00$	$22.11^{d}\pm0.01$	$32.72^{a}\pm0.01$	$21.75^{e}\pm0.01$	$31.92^{b}\pm0.01$
Vitamin C	$0.06^{a}\pm0.00$	$0.06^{a}\pm0.00$	$0.06^{a}\pm0.00$	$0.06^{a}\pm0.00$	$0.06^{a}\pm0.00$
Riboflavin(B_2)	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$
Thiamin(B_1)	$1.05^{a}\pm0.01$	$0.22^{e}\pm0.00$	$0.31^{d}\pm0.00$	$0.63^{b}\pm0.01$	$0.34^{c}\pm0.00$
Niacin(B_3)	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$	$0.02^{a}\pm0.00$

1. ^{abc}..... means with the same superscript in the same row are not sig. diff.($p>0.05$).
2. Key: Cp = Co-operative; Or = Owerri Road; Nm = Ndoru Market; Ub = Ubani Market; Ci = Co – operative

Table 3: Mineral Composition of Soybean Samples

Minerals(Mg/100g)	**Cp**	**Or**	**Nm**	**Um**	**Ci**
Phosphorus	$4.90^{a}\pm0.01$	$4.52^{e}\pm0.00$	$4.81^{b}\pm0.00$	$4.75^{c}\pm0.00$	$4.71^{d}\pm0.00$
Potassium	$0.21^{b}\pm0.00$	$0.22^{a}\pm0.00$	$0.21^{b}\pm0.00$	$0.22^{a}\pm0.00$	$0.15^{c}\pm0.00$
Calcium	$0.31^{b}\pm0.00$	$0.32^{a}\pm0.00$	$0.31^{b}\pm0.00$	$0.31^{b}\pm0.00$	$0.31^{b}\pm0.00$
Magnesium	$0.10^{a}\pm0.00$	$0.10^{a}\pm0.00$	$0.10^{a}\pm0.00$	$0.10^{a}\pm0.00$	$0.09^{b}\pm0.00$

1. $^{abc\cdots}$ means with the same superscript in the same row are not sig. diff.($p>0.05$)

2. Key: Cp = co-operative; Or = Owerri Road; Nm = Ndoru Market; Um = UbaniMarket ;Ci = crowther/Ibeku.

Table 4.Anti-nutritional Compositions of the Soybean Samples

Anti-nutritional factors (mg/g)	**Cp**	**Or**	**Nm**	**Um**	**Ci**
Tannins	$1.49^{b}\pm0.01$	$1.49^{b}\pm0.00$	$1.49^{b}\pm0.00$	$1.50^{a}\pm0.00$	$1.51^{a}\pm0.01$
Haemaglutin	$0.56^{d}\pm0.00$	$0.57^{d}\pm0.00$	$0.58^{c}\pm0.00$	$0.59^{b}\pm0.01$	$0.60^{a}\pm0.00$
Trypsin inhibitors	$1.49^{d}\pm0.01$	$1.51^{c}\pm0.01$	$1.52^{b}\pm0.00$	$1.57^{a}\pm0.01$	$1.57^{a}\pm0.01$
Phytates	$0.13^{d}\pm0.00$	$0.14^{d}\pm0.00$	$0.26^{a}\pm0.00$	$0.20^{b}\pm0.01$	$0.18^{c}\pm0.01$

1. $^{abc\ \cdots\cdots}$ Means with the same superscript in the same row are not sig. diff.($p>0.05$)

2. Key: Cp = Co-operactive; Or = Owerri Road; Nm = Ndoro Market; Um = Ubani Market; Crowther/ Ibeku

Table 5. Microbial count of soybean samples

Microorganism	Cp	Or	Nm	Um	Ci
S. aureus(cfu/g)	$7.8x\ 10^5$	ND	ND	$8.1x\ 10^5$	$3.4x10^5$
Yeast and Mould(cfu/g)	$2.3x10^5$	$3.8x10^5$	$3.5x10^5$	$1.9x10^5$	$2.4x10^5$
E. coli (cfu/g)	ND	ND	$2.0x10^5$	ND	$5.3x10^5$

Key: Cp = Co-operative; Or = Owerri Road; Nm = Ndoru market; Um = Ubani market; Ci = Crowther/ Ibeku. ND = Not Detected.

VI. Conclusion

Since the key problem associated with the consumption of soybean powder as seen in this paper is the presence of anti-nutritional factors, it is necessary for these anti-nutritional factors to be reduced to low levels that will not inhibit the bioavailability of the protein inherent in the beans for which it is desired. In order to ensure this, sufficient heat treatment should be applied. It has been suggested that wet heat treatment has more effect in the reduction of anti-nutritional factors than dry heat[37].

Also, from observations made in this work, it can be concluded that soybean should be purchased from known registered brands to ensure quality and safetywhile the unbranded ones should be avoided since they are not traceable. Regulatory bodies such as the National Agency for Food and Drug Administration and Control (NAFDAC) can take actions with decisions based on the findings of this studyin order to protect the health of consumers especially the vulnerable group who consume soybean products often.

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