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# Mineral and Proximate Composition of Soya Bean

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author ORE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ORE and NBC managed the analyses of the study. Author ORE managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** The aim of the research was to analyse the minerals and proximate content of soya bean in order to explore its nutritional values in human and animal diets.

**Place and Duration of Study:** This study was carried out at Edo Environmental Consults and Laboratory Limited (EECL), Benin–City and Delta State University, Abraka, between March, 2010 and January, 2011.

**Methodology:** The standard procedures were followed to analyse the proximate compositions and mineral concentrations of soya bean flour. The caloric value was calculated from crude protein, crude fat, crude fiber, carbohydrate, moisture and ash content. The Iron (Fe), Zinc (Zn), Calcium (Ca), magnesium (Mg), and cadmium (Cd) were determined by Atomic Absorption Spectrophotometer (AAS), sodium ((Na) by Flame Spectrophotometer and phosphorus (P) by Spectrophotometer.

**Results:** The result revealed that soya bean contained 37.69% of protein, 28.20% of crude fat, 4.29% of ash, 8.07% of moisture, 5.44% of fibre, 16.31% of carbohydrate. The mineral determination showed that soya bean contained 300.36 mg/100 g of Calcium, 258.24 mg/100 g of

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Magnesium, 16.4 mg/100 g of Iron, 3.0 mg/100 g of Sodium, 2.7 mg/100 g of Zinc, 695.20 mg/100 g of Phosphorus, 469.80 kCal/100 g while Cadmium was below detectable range.
**Conclusion:** This study concluded that the tested soya bean contained the highest amount of protein and lowest amount of ash. Similarly, among the minerals tested soya bean contained the highest amount of phosphorus and no cadmium at all. Considering the nutrient contents and proximate analysis of the sample, soya bean should be an inexpensive source of macronutrients that could be used in the management of protein-energy malnutrition and to improve the nutrition status of the vulnerable group of the population in developing countries. In developed countries, it could be used to improve the nutrition status of functional foods.

*Keywords: Soya bean; macronutrients; proximate nutrients; crude protein.*

## 1. INTRODUCTION

Food insufficiency and malnutrition have been the major problem of the developing countries, including Nigeria. Any approach to help fight this problem will go a long way in pushing the wheel of development in our country. Plant protein products are gaining increased interest as ingredients in food systems throughout many parts of the world; the success of utilizing plant proteins as additives depends greatly upon the favourable characteristics that they impart to food [1]. Plants proteins are now regarded as versatile functional ingredients or as biologically active components more than as essential nutrients in the developed countries [2]. Plant food diets increase the level of fibre intake which reduces the risk of bowel diseases [3]. The partial replacement of animal foods with legumes is claimed to improve overall nutritional status [4]. A large variety of oilseeds and pulses, including cowpeas, groundnuts, pigeon peas and melon seeds grow well in Nigeria. Soya bean (*Glycine max*) has recently become popular in the West African sub-region due to their high protein content. It is an annual leguminous crop and is grown to provide food for humans, feeds for animals and raw materials for industries [5]. Soya bean is an excellent source of protein (35-40%). The soya bean seed is the richest in food value of all plant foods consumed in the world [6]. It is used in the production of bread as composite flour [6,7,8]. Soya bean is used by leading infant food manufacturers in the country because of its high nutritional value. Soya bean is also processed into flour and its oil is used in local paint, cosmetics and soap making industries [9]. Soya bean is consumed in Nigeria as soya milk, the cake is used for livestock feeding and the flour is added to pap as food for infant and children.

Soya bean is a widely used, inexpensive and nutritional source of dietary protein [10]. Its protein content (40%) is higher and more economical than that of beef (19%), chicken (20%), fish (18%) and groundnut (23%) [9]. Soya bean is also of particular interest as a vegetable protein source because of its cholesterol-lowering abilities in patients with type II hyperlipoproteinamia [11]. Soya bean is also rich in minerals and vitamins such as iron, zinc, copper, thiamine, riboflavin, niacin and pantothenic acid [10]. Most of these minerals and vitamins are well-known hematinic and are essential in the formation of red blood cells [12]. The present study was, therefore, initiated to know the proximate composition and mineral content of soya bean and to evaluate its nutritional importance.

## 2. EXPERIMENTAL AND MATERIALS

### 2.1 Plant Material and Sample Preparation

Soya bean seeds were bought from Oba-market, Benin-city in the Edo State of Nigeria. The seeds were handpicked to remove extraneous materials. They were soaked in water to remove shaft after which it was dried and grounded into a fine powder using an electric mill.

### 2.2 Sample Analysis

#### 2.2.1 Proximate nutrient determination

Moisture, ash, crude protein, crude fat and crude fibre were determined by standard methods [13]. Total percentage carbohydrate was determined by the difference method [14]. This method involved adding the total values of crude protein, crude fat, crude fibre, moisture and ash constituents of the sample and subtracting it from 100. The value obtained was the percentage carbohydrate constituent of the sample.

*2.2.1.1 Energy determination*

Energy content was obtained by multiplying the mean values of crude protein, crude fat and total carbohydrate by the Atwater factors of 4, 9, 4 respectively, taking the sum of the products and expressing the result in kilocalories per 100 g sample [14,15].

### 2.2.2 Minerals determination

Several methods are available in the determinations of mineral compositions of materials [16,17,18]. In this present study, mineral contents of soya bean were determined by atomic absorption spectrometry, flame photometry and spectrophotometry according to standard methods [19].

*2.2.2.1 Wet digestion of sample*

1.0 g of the powdered sample was taken in digesting glass tube. Twelve millilitres (12 ml) of $HNO_3$ was added to the food samples and the mixture was kept for overnight at room temperature. Then 4.0 ml perchloric acid ($HClO_4$) was added to this mixture and was kept in the fumes block for digestion. The temperature was increased gradually, starting from 50ºC and increasing up to 250-300ºC. The digestion completed in about 70- 85 min as indicated by the appearance of white fumes. The mixture was left to cool down and the contents of the tubes were transferred to 100 ml volumetric flasks and the volumes of the contents were made to 100 ml of distilled water. The wet digested solution was transferred to plastic bottles labelled accurately, stored and used for mineral determination.

*2.2.2.2 Determination of Iron (Fe), Zinc (Zn), Calcium (Ca), Cadmium (Cd) and Magnesium (Mg) by atomic absorption spectrometry*

The atoms of an element were vaporized and atomized in the flame. The atoms then absorbed the light at a characteristic wavelength. The source of the light was a hollow cathode lamp, which was made up of the same element to be determined. The lamp produced radiation of an appropriate wavelength, which while passing through the flame was absorbed by the free atoms of the sample. The absorbed energy was measured by a photo-detector read-out system. The amount of energy absorbed is proportional to the concentration of the element in the sample. The digested sample of soya bean was analyzed for mineral contents by Atomic Absorption Spectrophotometer (Buck Scientific model 210VGP).

The absorption measurement of the elements for soya bean was read out and is given in Table 2. Different electrode lamps were used for each mineral. The equipment was run for standard solutions of each mineral before and during determination to check that it was working properly. The dilution factor for all minerals except P and Mg was 100. For determination of Mg, further dilution of the original solution was done by using 0.5 ml of original solution and enough distilled water was added to make the volume up to 100 ml. Also for the determination of Calcium, 1.0 ml lithium oxide solution was added to the original solution to unmask Ca from Mg. The concentrations of minerals recorded in terms of “ppm” were converted to milligrams (mg) of the minerals by multiplying the ppm with dilution factor and dividing by 1000, as follows:

$$MW = \frac{\text{Absorbency (ppm) x dry weight x D}}{\text{Weight of sample x 1000}} \quad (1)$$

**Note:** Dilution factor for phosphorus was 2500, for magnesium 10000, and for other minerals including calcium, iron, potassium, sodium, zinc and cadmium was100.

*2.2.2.3 Determination of sodium by flame spectrophotometry*

Sodium was analyzed by flame spectrophotometer (Jenway model PFP7/C). The flame photometer measures the emission of radiant energy when atoms of an element return to their ground state after their excitation by the high temperature of the flame. The degree of emission is related to the concentration of the element in the solution. The same wet digested food sample solutions as used in AAS were used for the determination of Na. Standard solutions of 20, 40, 60, 80 and 100 milli equivalent/L were used. The calculations for the total mineral intake involved the same procedure as given in AAS.

*2.2.2.4 Determination of phosphorus (P) by spectrophotometry*

The calorimetric determination is based upon the principle that certain elements or compounds on reaction with suitable reagent develop color. The intensity of the color is measured with colorimeter or spectrophotometer. The inorganic phosphorus reacts with ammonium molybdate. Ammonium phosphomolybdate is formed, which in reaction produces molybdenum blue. The blue color of the solution is measured and the amount of the phosphorus is determined.

12 g of the ammonium molybdate was taken and mixed with 250 ml distilled water in a beaker (solution A). 0.2908 g antimony potassium tartarate was taken and dissolved in 500 ml $H_2SO_4$ (5N) solution in a volumetric flask. Enough distilled water was added to make the solution up to 1000 ml (solution B). The two solutions (A and B) were mixed in a 2000 ml volumetric flask to get mix reagent. The volume of the mixed reagent was made up to 2000 ml by adding distilled water. 0.739 g of ascorbic acid was mixed with 140 ml of the mixed reagent in a beaker and left until dissolved to make color reagent. One millilitre of wet digested duplicate food sample was taken in a plastic bottle labelled properly and to it was added 4.0 ml distilled water to make a diluted volume of 5.0 ml. Five millilitres (5.0ml) of color reagent was added to this volume and the total volume of this mixture (final solution) was made up to 25.0 ml. The dilution factor of this solution was 2500 (100 x 25). After some time, the color of this final solution turned blue.

Sample from final blue solution was taken in a cuvette and introduced in the spectrophotometer. The readings of the phosphorus were recorded in ppm and the calculations for the total mineral intake involved the same procedure as given in AAS.

## 3. RESULTS

### 3.1 Proximate Nutrients and Energy Composition of Soya Bean

Table 1 shows the proximate composition of the soya bean seed. The result shows that the soya bean seed is rich in nutrient especially protein 37.69%, crude fat 28.2% and carbohydrate 16.31%. The moisture content was found to be different from 1.02% -1.80% reported [20] and 6.11% [21]. The difference in value may be due to the processing methods. The ash content of 4.08% was higher than the 1.01% -1.67% range reported [20]. The difference in value may be due to the different areas of cultivation. The crude protein of 37.69% obtained compared favourably with the value of 36% [21] and 36.94% - 40.10% [20]. The crude fat of 28.2% obtained was not consistent with the reported 16.82% - 19.30% range [20]. The 5.44% crude fibre was also higher than the values 2.97%, 2.98% and 3.01% found in the literature [20]. The carbohydrate value of 16.31% was lower than the range given as 34.97% - 39.86% [20] and 40.67% [21]. The energy content of 469.80kCal/100g compared favorably with the values of 473. 62 kCal/100 g, 465.21 kCal/100 g and 458.58 kCal/100 g previously reported [17].

### 3.2 Mineral Concentrations of the Flour Sample of Soya Bean

The mineral (calcium, magnesium, iron, zinc, sodium, cadmium and phosphorus) concentrations (mg/100 g) of the flour sample of the soya bean were presented in Table 2. Phosphorus had the highest (695. 20 mg/100 g) followed by calcium 300.36 mg/100 g, zinc had the lowest value of 2.7 mg/100 g of mineral while cadmium was not detected. Calcium content of 300.36 mg/100 g obtained was far higher than range of values 62.93 mg/100 g - 217.38 mg/100 g reported [20]. The magnesium content 258.24 mg/100 g was also found higher than the range of values 8.39 mg/100 g -8.53 mg/100 g reported [20]. The iron content of 16.4 mg/100 g was found higher than the values 3.86 mg/100 g - 11.51 mg/100 g reported [20]. The phosphorus content of 695.20 mg/100 g was far more than that of the three varieties of soya beans reported as 0.88 mg/100 g - 2.33 mg/100 g [20]. The variation in results may be due to the difference in specie used and the dictates of environmental conditions. The zinc and sodium contents of 2.7 mg/100 g and 3.0 mg/100 g obtained respectively were fairly in agreement with the values previously reported [20]. The absence of cadmium may be that there was no industry close to where the soya bean was cultivated and there were non-anthropogenic activities around the areas.

**Table 1. Proximate composition of the seed (%)**

| Composition | Value (%) |
|---|---|
| Protein | 37.69% |
| Crude fat/oil | 28.2% |
| Ash | 4.29% |
| Moisture | 8.07% |
| Crude fibre | 5.44% |
| Carbohydrate | 16.31% |
| Energy | 469.80 kcal/100 g |

**Table 2. Mineral composition of the seed (Mg/l00 g)**

| Composition | Value (mg/l00 g) |
|---|---|
| Calcium | 300.36 mg/100 g |
| Magnesium | 258.24 mg/100 g |
| Iron | 16.4 mg/100 g |
| Cadmium | ND (not detected) |
| Sodium | 3.0 mg/100 g |
| Zinc | 2.7 mg/100 g |
| Phosphorus | 695.20 mg/100 g |

## 4. DISCUSSION

### 4.1 Proximate Nutrients and Energy Composition of Soya Bean

The low moisture content of 8.07% implies that it can be stored for a very long time since moisture which is an important medium for multiplication of microorganisms is very low in the flour sample. The ash content 4.29% is indicative that the flour sample could be important sources of minerals. The high protein content 37.69% of the sample suggests that it could be used in the management of protein deficiency cases such as Kwashiorkor. This means the sample could be used in improving the palatability of foods in which they are incorporated. The high crude fat content of 28.2% suggests that soya bean may be a viable source of oil, going by their crude fat contents. Most legumes contain 1.5% crude fat. Soya bean crude fat is very high compared to most legumes because it is an oilseed. The sample contained 5.44% fibre though relatively low, but the presence of fibre in foods is known to be beneficial. Fibre has some physiological effects in the gastrointestinal, tract. These effects include variation in faecal water, faecal bulk and transit time and elimination of bile acids and neutral steroids which lower the body cholesterol pool. The high carbohydrate contents16.31% of the sample suggests that the flour sample could be used in managing protein-energy malnutrition since there is enough quantity of carbohydrate to derive energy from in order to spare protein so that protein can be used for its primary function of building the body and repairing worn out tissues rather than as a source of energy.

### 4.2 Mineral Concentrations of the Flour Sample of Soya Bean

The high calcium content of 300.36 mg/100 g suggests that the flour sample could be used in complementary foods to help build the bones and teeth since calcium is one of the main components of teeth and bones. Calcium also plays a role in blood clotting [22]. Magnesium is involved in making proteins and releasing energy and helps hold calcium in the enamel of the teeth [22]. Iron is used in the management of iron-deficiency anaemia since iron is a vital part of red blood cells that carry and release oxygen [22]. Phosphorus is closely linked with calcium. The two minerals combine to form calcium phosphate, which gives bones their rigid structure [22]. Sodium is needed in the body in a small amount to help maintain normal blood pressure and normal function of muscles and nerves. Zinc helps the immune system fight off invading bacteria and viruses. The body needs zinc to make proteins and DNA, the genetic material in all cells and also helps in wound healing and the breakdown of carbohydrates. Also, zinc is below the permissible level of 50 and 100mcg/g in grains and beans [23]. Cadmium was not detected in the soya bean flour sample.

## 5. CONCLUSION

The study has established the proximate nutrients and mineral (calcium, sodium, zinc, cadmium, magnesium, iron and phosphorus) concentrations of soya bean. The results of this study indicate that the flour sample is rich in proteins, fats and carbohydrates and are therefore inexpensive source of macronutrients which can be used in intervention programme aimed at alleviating protein-energy malnutrition. The flour has good protein contents and could be used to fortify flours with low protein content such as maize and rice. The mineral contents indicate that the flour sample could be important sources of minerals for humans and farm animals.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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