Original Research Article

PROXIMATE AND MINERAL COMPONENTS OF FIVE IMPROVED VARIETIES OF SOYBEAN (*GLYCINE MAX*) COMMONLY CONSUMED IN SAMARU COMMUNITY ZARIA-NIGERIA

ABSTRACT

Five improved varieties of *Glycine max* (TGX 1987-62F, TGX 1485-1D, TGX 1448-2E, TGX 1987-10F and TGX 1835-10E) consumed in Samaru community, Zaria-Nigeria were analyzed for their proximate composition and mineral contents using standard methods. The results show that TGX 1835-10E has significantly ($p<0.05$) higher protein compared to the other varieties. Carbohydrates and ash contents did not differ significantly ($p>0.05$) between the varieties. The lipid and crude fiber content were significantly ($p<0.05$) high in TGX 1987-62F and TGX 1448-2E varieties respectively. Moisture content was significantly ($p<0.05$) high in TGX 1448-2E and TGX 1485-1D varieties. The mineral analysis showed no significant ($p>0.05$) difference in the Copper (Cu) content of all the varieties. Potassium (K) and Iron (Fe) contents were significantly high in TGX 1485-1D variety while Calcium (Ca), Magnesium (Mg) and Zinc (Zn) contents were significantly ($p<0.05$) high in TGX 1987-62F, TGX 1835-10E and TGX 1987-10F, respectively. The results show that none of the test varieties is outstandingly different.

Keywords: *proximate composition, mineral elements, soybean.*

INTRODUCTION

The **Soybean** (US) or **Soya bean** (UK) (*Glycine max*) is a species of legume native to East Asia, widely grown for its edible bean which has numerous health benefits. In Nigeria, it is grown extensively, mainly by small-scale farmers, which may account for its low yields [5]. Soy contains isoflavones like Genistein and Daidzein. It also contains glycitein, an O-methylated isoflavone which accounts for 5–10% of the total isoflavones in soy food products. Glycitein is a phytoestrogen [11]. For human consumption, soybeans must be cooked with "wet" heat to destroy the trypsin inhibitors (serine protease inhibitors). Raw soybeans, including the immature green form, are toxic to all monogastric animals [3]. Other valuable components found in soybeans include phospholipids, vitamins, and minerals. Furthermore, soybeans contain many minor substances like phytates and oligosaccharides. Others, such as isoflavones, are just being recognized for their powerful ability to prevent human cancers and other diseases [7].

The soybean is one of the most economical and valuable agricultural commodities because of its unique chemical composition. Among cereal and other legume species, it has the highest protein content (around 40%); other legumes have the protein content between 20% and 30%, whereas cereals have protein content in the range of 8-15%. The soybean also contains about 20% oil, the second highest content among all food legumes [10].

In Samaru, a community in Zaria metropolis, Kaduna State, Nigeria, several improved varieties of soybean are available in the market. However, little effort has been made to ascertain their nutritional advantage of different improved varieties, hence the need for this research.

Varieties of Interest

TGX 1987-10F and TGX1987-62F were developed by IITA in collaboration with Nigeria's National Cereal Research Institute (NCRI). The on-station and on-farm testing of TGX1740-2E, TGX1987-10F, and TGX1987-62F were funded by the Tropical Legumes II project. The Malawi Agricultural Technology Clearing Committee (ATCC) on 18 January 2011 officially approved the release of TGX1740-2F while the Nigeria Varietal Release Committee released TGX1987-10F and TGX1987-62F on 2 December 2010 [1].

Materials and Methods

The five varieties of soybean used were purchased at the Samaru market and identified at the Department of Agronomy and Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, Nigeria. The five varieties are improved varieties namely TGX 1987-62F, TGX 1485-1D, TGX 1448-2E, TGX 1987-10F, TGX 1835-10E. All chemicals used were of analytical grade.

Dry Matter (DM) Content Determination

Moisture in this method refers to the amount of free water and volatile substances that are lost by drying the food under controlled temperature in an air oven. It is expressed in g per 100 g sample (1).

The container was placed in the drying oven at 100°C until constant weight (1 h) and was cooled in a desiccator for about 30 min and weighed (***W1***). The sampled was ground until homogenous. The dried sample was thaw to room temperature. The sample was mixed thoroughly by turning the tightly closed bottle up and down three (3) times.
3g sample was weighed accurately, in duplicate, into a pre-weighed drying container (***W2***). A container was placed with the sample in the air oven pre-heated to 100°C for 2 hours. The container with the dried sample was transferred into a desiccator, cooled for 30 minutes and weighed (***W3***). The heating procedure was repeated until constant weight.

Calculation

$$\% \text{ moisture} = \frac{\text{dry weight}}{\text{fresh weight}} \times 100$$

$$= \frac{w2 - w3}{w2 - w1} \times 100.$$

Therefore % dm = 100 - %moisture.

Total solid (%) = 100 - % moisture (w/w)

where: W1 = weight of the container or empty dish (g)

W2 = weight of container + sample before drying (g)

W2- W1 = weight of sample (g)

W3= weight of container + sample after drying (g)

W2– W3 = loss of weight (g)

Determination of Ash Content

Ash content refers to the total mineral residue left after incineration of organic matter. It has no nutritional significance per se, but the value for ash is a useful check-in summing up the proximate composition of food and a measure of its mineral content. It is expressed as g ash per 100 g sample.

The marked crucible was heated in a furnace at 550ºC for 2 hours. The crucible was transferred into a desiccator, cooled for 30 min and weighed (***W1***). The sample was weighed in duplicate into the pre-weighed crucible dish (***W2***), 2g. The dried samples were charred over a hotplate, initially at low temperature to avoid spattering. The temperature was increased gradually until smoking ceases. The sample was incinerated in a furnace at 550ºC until the residue is uniformly white or nearly white and was evaporated on a water bath and repeat heating in the muffle furnace for 30 minutes until constant weight was obtained. The temperature of the furnace was decreased to 180ºC, and the crucible was transferred into a desiccator, cooled for 30 minutes and weighed (***W3***).

Calculation

$$\% \text{ ash content} = \frac{w3 - w1}{w2 - w1} \times 100$$

where: *W1* = weight of crucible

W2 = weight of crucible + sample

W3 = weight of crucible + ash

Determination of Crude Fibre

This involves sequential digestion of the sample with dilute acid and alkaline solution. The residue obtained was ignited to obtain crude fiber.

The sample 2g (***W_1***) was weighed into a 600mL beaker; 100mL of dilute Sulphuric acid was added. The sample was heated and allowed to boil using lab con heating mantle. The sample was removed after 30 minutes and allowed to stand for 1 minute. The sample was washed thoroughly with hot water using cheese cloth. The sample was washed back into the beaker and 100mL of sodium hydroxide was added. It was allowed to boil for 30 minutes and to stand for 1 minute before filtering with hot water again using cheese cloth. It was washed thoroughly with hot water and three times with acetone. The sample was transferred into the weighed crucible (***W_2***) and dried for 1hr and weighed

again as W_3. The sample was ashed at 550^{o}C in a muffle furnace for 3hrs.The sample was removed and allowed to cool in a desiccator and weighed again as W_4.

Calculation

$$\% \text{ Crude fiber} = \frac{\text{weight of ash (g)} \times 100}{\text{Weight of sample (g)}}$$

Determination of Crude Protein

Crude protein is total nitrogen multiplied by protein factor. It is expressed in g per 100 g sample. Total nitrogen content includes nitrogen primarily from proteins and to a lesser extent from all organic nitrogen-containing non-protein substances. For practical purposes, non-protein nitrogen is assumed to be of little significance.

The sample was ground until it becomes homogenous. A sample was weighed in duplicate 2g sample (depending on the nitrogen content of the sample) into the digestion tube. 5g of catalyst and one glass bead was added to prevent the solution from bumping and 10mL sulfuric acid. The digestion tube was placed in the digestor. Digest mixture initially at low temperature to prevent frothing and boil briskly until the solution is clear and is free of carbon or until oxidation is complete. The sample was heated for another hour after the liquid has become clear to complete breakdown of all organic matter and was placed in a 250mL Erlenmeyer flask containing 50 mL of 4% boric acid with an indicator as a receiver on the distillation unit. 100 mL of water and 70 mL of 50% sodium hydroxide was added to the digests and start distillation. It was Distilled until all ammonia has been released was obtained. Lower the receiver flask so that the delivery tube is above the liquid surface and continue the distillation for 2 minutes. Finally, the sample was rinsed the delivery tube with water and allow the washings to drain into the flask. The distillate was titrated with the standardized 0.1 N HCl until the first appearance of the pink color. The volume of acid used to the nearest 0.05 mL was recorded.

CALCULATION

$$\text{N (g\%)} = \frac{(\text{mL 0.1N HCl sample} - \text{mL 0.1N HCl blank}) \times 0.0014 \times \text{N HCl} \times 100}{\text{Weight of sample}}$$

Protein (g per 100g) = % total nitrogen x appropriate nitrogen conversion factor.

Determination of Lipid

Fat includes fatty acids, triglycerides, esters, long chain alcohols, hydrocarbons, other glycol esters and sterols determined by this method. It is expressed as g fat per 100g sample. The method is used for the quantitative determination of total fat in foods using manual extraction.

The sample is hydrolyzed by hydrochloric acid at 70-80^{0}C. Protein, if any, can be dissolved in the acid, crude fat is then manually extracted by diethyl and petroleum ether. The solvent is removed by evaporation, and the oil residue is dried and weighed.

2 g dried sample (W_1) was placed in a 250 mL Erlenmeyer flask, two mL alcohol was added. It was stirred to moisten all particles (moistening of the sample with alcohol prevents lumping on the addition of acid). Ten mL of the diluted 4N HCl was added and mixed well. The flask was set on the heater and reflux for 30 min. The sample was stirred at frequent intervals until the sample was completely hydrolyzed (usually 30–40 min).10 mL alcohol was added and cooled. When the hydrolysis has taken place in a flask, transfer the digested mixture to extraction glassware. The flask was rinsed and poured into the extraction tube with 25 mL diethyl ether in three portions. The tubes were closed with a cork and shook vigorously for 1 min. 25 mL petroleum ether was added and again shaken vigorously for 1 min. Then allowed to stand until upper liquid is practically clear and transferred as much as possible of the ether-fat solution into a pre-weighed 125 mL flask by filtering it through a funnel containing a plug of cotton packed firmly in the stem part to allow free passage of ether into the flask before weighing the flask, dried it in drying oven at 100^0C and then let cool in a desiccator and weighed (W2). Extraction of the liquid sample remaining was repeated in tube twice using the same solvent and transferred the clear ether solutions through the same funnel into the same flask. Afterwards, the inside and outside of the funnel were rinsed into the same flask. The solvent was evaporated completely in a water bath at 80^0C and dried fat in an oven at 100^0C until constant weight was obtained. It was allowed to the flask to cool in a desiccator and weighed (W3).

Calculation

$$\text{Total Fat (g/100 g)} = \frac{W3 - W1}{W1} \times 100$$

Where: W1 = Weight of sample

W2 = Weight of dried flask before fat extraction

W3 = Weight of dried flask after fat extraction

Determination of Carbohydrate

Difference determined the total carbohydrate. The sum of %moisture, ash, crude fiber, crude protein and crude lipid was subtracted from 100 (Miller and Tobin, 1980).

Calculation

%Available Carbohydrate = 100-(%Moisture + %Ash + % fibre + % Protein+ %Lipid)

RESULTS AND DISCUSSION

Table 1. The Proximate Composition of Improved *Glycine max* Varieties (%)

Varieties*	*CP*	Lipid	CHO*	Moisture	Ash	CF*
1D	37.17±0.22[a]	16.74±0.48[b]	30.03±0.47[a]	5.65±0.29[c]	4.60±0.13[a]	5.80±0.25[ab]

2E	37.29±0.37^{ab}	16.60±0.07^{b}	29.55±0.92^{a}	5.63±0.30^{c}	4.84±0.47^{a}	6.09±0.19^{b}
62F	36.59±0.70^{a}	17.86±0.23^{c}	30.41±0.77^{a}	5.39±0.03^{ab}	4.40±0.48^{a}	5.42±0.49^{a}
10E	37.99±0.14^{b}	15.98±0.11^{a}	29.69±0.63^{a}	5.54±0.04^{bc}	4.89±0.17^{a}	5.91±0.26^{ab}
10F	37.09±0.31^{a}	17.02±0.15^{b}	30.64±0.18^{a}	5.24±0.22^{a}	4.65±0.06^{a}	5.35±0.36^{a}

Values are expressed as mean±SD (n = 3); Values with different superscripts down the column are significantly different from each other at p<0.05; *CF: crude fibre; CP: crude protein; CHO: carbohydrate; **1D: TGX 1485-1D; 10E: TGX 1835-10E; 2E: TGX 1448-2E; 10F: TGX 1987-10F; 62F: TGX 1987-62F

Table 2. Mineral Composition of Improved *Glycine max* Varieties (mg/100g)

Varieties**	**K**	**Ca**	**Mg**	**Cu**	**Zn**	**Fe**
1D	1.39±0.01^{d}	99.98±6.93^{a}	88.20±0.40^{a}	1.12±0.08^{a}	8.78±0.62^{a}	18.01±0.54^{d}
2E	1.26±0.01^{b}	120.80±0.00^{b}	88.60±0.00^{a}	1.08±0.01^{a}	8.61±0.51^{a}	1.13±0.02^{a}
62F	1.31±0.02^{c}	141.63±6.95^{c}	94.10±0.40^{b}	1.13±0.07^{a}	11.08±0.56^{b}	6.03±0.67^{b}
10E	1.18±0.01^{a}	113.83±6.95^{b}	95.40±0.00^{c}	1.13±0.07^{a}	14.18±0.06^{c}	12.44±0.15^{c}
10F	1.48±0.00^{e}	99.97±6.95^{a}	93.70±0.00^{b}	1.09±0.01^{a}	22.25±0.82^{d}	6.61±0.20^{b}

Values are expressed as mean±SD (n = 3); Values with different superscripts down the column are significantly different from each other at p<0.05;**1D: TGX 1485-1D; 10E: TGX 1835-10E; 2E: TGX 1448-2E; 10F: TGX 1987-10F; 62F: TGX 1987-62F

Proximate compositions of the five different varieties of Soya bean are presented in Table 1. The variety TGX 1835-10E shows a significantly (p<0.05) high amount of Crude protein (37.99±0.14%) than other varieties. The lowest crude protein composition was obtained in TGX 1987-10F (36.59±0.70%) with a significant difference at p<0.05. All across the varieties, there was no significant difference in the Carbohydrate composition (P>0.05). Variety TGX 1987-10F shows significantly (p<0.05) high level of Lipid (17.86±0.23%). Moisture content is significantly lower in TGX 1835-10E (5.24±0.22%) and significantly high in TGX 1485-1D (5.65±0.29%) at P<0.05. TGX 1987-62F has significantly more Crude fiber (p<0.05); lowest Crude fiber was obtained from TGX 1835-10E.

Data on the mineral composition of the five improved varieties of Soya bean are presented in Table 2. There were significant differences across the varieties at $p<0.05$ in mineral composition. Calcium is highest in TGX 1485-62F (141.63±6.95mg/100g) and lowest in TGX 1987-62F (99.97±6.95mg/100g). Magnesium is highest in TGX 1835-10E (95.40mg/100g) and lowest in TGX 1485-1D (88.20±0.40mg/100g). TGX 1448-2E showed the significantly low level of Iron (1.13±0.02%mg/100g) compared to the highest level in TGX 1485-1D (18.01±0.54mg/100g) at $p<0.05$. The varieties have significantly high ($p<0.05$) levels of Calcium and Magnesium and very low level of Potassium and Copper.

Statistical analysis: The analysis was carried out in triplicates for all determinations, and the results of the triplicate were expressed as mean±SEM. The SPSS 20.0 for Windows Computer Software Package was used for the Analysis of Variance (ANOVA). The significance of the differences was defined as $p<0.05$ for ANOVA. The difference in mean was compared using Duncan's new Multiple Range test [4].

Discussion

The results show that the varieties analyzed have high levels of Crude Proteins, but the Solvent extracted soybean SES have higher Crude proteins (48.9±0.6%) [10]. In soybean grains, the amount of sucrose, the main carbohydrate, can range from 15 to 102 g kg-1, while glucose is found in trace quantities as reported by Song TT, Hendrich S and Murphy PA [9]. This, in humans, contributes to the growth of beneficial colon bacteria [12]. These varieties have fewer Carbohydrates compared to the 35% Carbohydrate as reported by Oshodi [9].

Variety TGX 1987-10F shows significantly ($p<0.05$) higher level of Lipid (17.86±0.23%). This is a comparative advantage over the other varieties analyzed as more Soy Oil for local, laboratory and industrial use is to be generated from this variety. Soya oil has a low concentration of polyunsaturated linolenic fatty acids and higher oleic acid content which increase oil stability and prevent oxidation and production of off-flavors during food processing [2]. Moisture content is significantly lower in TGX 1835-10E (5.24±0.22%) and significantly higher in TGX 1485-1D (5.65±0.29%) at $P<0.05$. El-Shemy *et al.*, [ ] reported that the moisture content of local varieties is significantly higher than on improved varieties; hence would have a longer shelf life. The result also shows that TGX 1987-62F has significantly ($p<0.05$) more Crude fiber. The lowest Crude fiber was obtained from TGX 1835-10E. This level of fiber **(**6.09 ± 0.19^{b} %) would enhance intestinal motility thereby combating constipation and also colon cancer [12].

Generally, the varieties have significantly high ($p<0.05$) levels of calcium and magnesium and very low level of potassium and copper. Lower levels in potassium in these varieties as seen in the results contradicts [8] who states that potassium is found in the Soya Bean in a very high concentration, followed by phosphorus, magnesium, sulfur, calcium, chloride, and sodium in that order.

Low levels of potassium are encountered mostly on the light. Usually, acid soils with a low cation exchange capacity or on soils with a high content of three-layered clay minerals often loose soils with illite clay [2]. Potassium

deficiency is as a result of strong K fixation and high levels of available magnesium (Mg) and very strong anti-coagulating factor in blood clothing [2]. Calcium is high because lack of calcium in legumes prevents the development of the nodule bacteria, thus affecting Nitrogen fixation. Under appropriate soil pH availability of nutrients such as N and P and microbial breakdown of crop residues are favourable. Calcium deficiency is unlikely if soil pH is maintained above [1]. Copper, Zinc and Fe were relatively low because they are micro nutrients. Calcium, zinc and phytate in soy foods interact to form a highly insoluble complex, which reduces zinc absorption to a greater extent than phytate alone [10]. These low levels of Zinc would affect its bioavailability for that complex formation.

CONCLUSION

This research shows that all the target nutritional parameters (Proximate and Minerals) are presented in significant amounts. These varieties of Soya bean are very rich in Crude Protein, Carbohydrate, Lipids, Calcium, and Magnesium. Some varieties show more or less difference in the above parameters. There is no single variety among the five that is of ultimate advantage; they all share certain peculiarities as the results revealed.

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