

Original Research Article

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

Comment [U1]: The title should read 'Proximate and mineral components of five'

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 shows 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 fibre content were significantly ($p < 0.05$) higher in TGX 1987-62F and TGX 1448-2E varieties respectively. Moisture content was significantly ($p < 0.05$) higher 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 higher in TGX 1485-1D variety while Calcium (Ca), Magnesium (Mg) and Zinc (Zn) contents were significantly ($p < 0.05$) higher in TGX 1987-62F, TGX 1835-10E and TGX 1987-10F, respectively. The results show that none of the test varieties is outstandingly different.

Keyword: *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 (4). 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 (10). 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 (6).

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 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 (9).

34 Varieties of Interest

35 **TGx 1987-10F** and **TGx1987-62F** were developed by IITA in collaboration with Nigeria's National Cereal
36 Research Institute (NCRI). The on-station and on-farm testing of TGx1740-2E, **TGx1987-10F**, and **TGx1987-62F**
37 was funded by the Tropical Legumes II project. The Malawi Agricultural Technology Clearing Committee (ATCC)
38 on 18 January 2011 officially approved the release of TGx1740-2F while, the Nigeria Varietal Release Committee
39 released **TGx1987-10F** and **TGx1987-62F** on 2 December, 2010 (1).

40 Materials and Methods

41 The five varieties of soybean used were purchased at the Samaru market and identified at the Department of
42 Agronomy and Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, Nigeria. The five
43 varieties are improved varieties namely TGX 1987-62F, TGX 1485-1D, TGX 1448-2E, TGX 1987-10F, TGX 1835-
44 10E. All chemicals used were of analytical grade.

45 Dry Matter (DM) Content Determination

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

48 The container was placed in the drying oven at 100°C until constant weight (1 h) and was cooled in a desiccator for
49 about 30 min and weighed (**W1**). The sample was grinded until homogenous. The dried sample was thaw to room
50 temperature. Sample was mixed thoroughly by turning the tightly closed bottle up and down three (3) times.

51 3g sample was weighed accurately, in duplicate, into a pre-weighed drying container (**W2**). Container was placed
52 with the sample in the air oven pre-heated to 100°C for 2 hours. The container with the dried sample was transferred
53 into a desiccator, cooled for 30 minutes and weighed (**W3**). The heating procedure was repeated until constant
54 weight.

55 Calculation

56 % moisture = $\frac{\text{dry weight}}{\text{fresh weight}} \times 100$

57 = $\frac{W2 - W3}{W2 - W1} \times 100$.

58 Therefore % dm = 100 - %moisture.

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

60 Where: W1 = weight of container or empty dish (g)
61 W2 = weight of container + sample before drying (g)
62 W2- W1 = weight of sample (g)
63 W3= weight of container + sample after drying (g)
64 W2- W3 = loss of weight (g)

65 **Determination of Ash Content**

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

69 Marked crucible was heated in a furnace at 550°C for 2 hours. The crucibles was transferred into a desiccator,
70 cooled for 30 min and weighed (*W1*). The sample was weighed in duplicate into the pre-weighed crucible dish (*W2*),
71 2g. The dried samples were charred over a hotplate, initially at low temperature to avoid spattering. The
72 temperature was increased gradually until smoking ceases. The sample was incinerated in a furnace at 550°C until
73 the residue is uniformly white or nearly white and was evaporated on water bath and repeat heating in the muffle
74 furnace for 30 minutes until constant weight was obtained. The temperature of the furnace was decreased to 180°C
75 and the crucibles was transferred into a desiccator, cooled for 30 minutes and weighed (*W3*).
76

Comment [U2]: were

77 **Calculation**

78
$$\% \text{ ash content} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

79
$$= \frac{W3 - W1}{W2 - W1} \times 100$$

80 where: *W1* = weight of crucible

81 *W2* = weight of crucible + sample

82 *W3* = weight of crucible + ash

83 **Determination of Crude Fibre**

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

86 The sample 2g (*w₁*) was weighed into a 600mls beaker; 100mls of dilute Sulphuric acid was added. The sample was
87 heated and allowed to boil using lab conco heating mantle. The sample was removed after 30 minutes and allowed
88 to stand for 1 minute. The sample was washed thoroughly with hot water using cheese cloth. The sample was
89 washed back into the beaker and 100mls of sodium hydroxide was added. It was allowed to boil for 30 minutes and
90 to stand for 1 minute before filtering with hot water again using cheese cloth. It was washed thoroughly with hot
91 water and three times with acetone. The sample was transferred into weighed crucible (*w₂*) and dried for 1hr and
92 weighed again as *W₃*. The sample was ashed at 550°C in a muffle furnace for 3hrs. The sample was removed and
93 allowed to cool in a desiccator and weighed again as *W₄*.

94 **Calculation**

95
$$\% \text{ Crude fiber} = \frac{\text{weight of ash (g)}}{\text{Weight of sample (g)}} \times 100$$

96

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 grinded until it becomes homogenous. Sample was weighed in duplicate 2g sample (depending on the nitrogen content of the sample) into the digestion tube. 5g of catalyst and 1 glass bead was added to prevent solution from bumping and 10mL sulfuric acid. The digestion tube was placed in the digester. 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. 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 indicator as 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 colour. The volume of acid used to the nearest 0.05 mL was recorded.

CALCULATION

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

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 hydrolised by hydrochloric acid at 70-80°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 (**WI**) was placed in a 250 mL Erlenmeyer flask, 2 mL alcohol was added. It was Stirred to moisten all particles (moistening of sample with alcohol prevents lumping on addition of acid). 10 mL of the diluted 4N HCl was added and mixed well. The flask was set on the heater and reflux for 30 min. sample stirred at frequent intervals until sample was completely hydrolysed (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 flasks was rinsed and pour into the extraction tube with 25 mL diethyl ether in three portions. The tubes was closed with a cork and shake vigorously for 1 min. Add 25 mL petroleum ether and again shake vigorously for 1 min. Let 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 and Allow free passage of ether into the flask before weighing the flask, dry it in drying oven at 100°C and then let cool in a desiccator and weigh (W2). Repeat extraction of the liquid sample remaining in tube twice using the same solvent. Each time, transfer the clear ether solutions through the same funnel into the same flask. When finished, rinse inside and outside of the funnel into the same flask. Evaporate solvents completely on a water bath at 80°C and dried fat in an oven at 100°C until constant weight is obtained. It was allowed to the flask to cool in a desiccator and weigh (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

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

Calculation

$$\% \text{Available Carbohydrate} = 100 - (\% \text{Moisture} + \% \text{Ash} + \% \text{fibre} + \% \text{Protein} + \% \text{Lipid})$$

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:

155 carbohydrate; **1D: TGX 1485-1D; 10E: TGX 1835-10E; 2E: TGX 1448-2E; 10F: TGX 1987-10F; 62F:
156 TGX 1987-62F

157

158 **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 ^c	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

159 Values are expressed as mean±SD (n = 3); Values with different superscripts down the column are
160 significantly different from each other at p<0.05; **1D: TGX 1485-1D; 10E: TGX 1835-10E; 2E: TGX
161 1448-2E; 10F: TGX 1987-10F; 62F: TGX 1987-62F

162

163

164 Proximate compositions of the five different varieties of Soya bean are presented in Table 1. The variety TGX 1835-
165 10E shows a significantly (p<0.05) high amount of Crude protein (37.99±0.14%) than other varieties. The lowest
166 crude protein composition was obtained in TGX 1987-10F (36.59±0.70%) with a significant difference at p<0.05.
167 All across the varieties, there was no significant difference in the Carbohydrate composition (P>0.05). Variety TGX
168 1987-10F shows significantly (p<0.05) higher level of Lipid (17.86±0.23%). Moisture content is significantly lower
169 in TGX 1835-10E (5.24±0.22%) and significantly higher in TGX 1485-1D (5.65±0.29%) at P<0.05. TGX 1987-62F
170 has significantly more Crude fibre (p<0.05); lowest Crude fibre was obtained from TGX 1835-10E.

171 Data on the mineral composition of the five improved varieties of Soya bean are presented on Table 2. There were
172 significant differences across the varieties at p<0.05 in mineral composition. Calcium is highest in TGX 1485-62F
173 (141.63±6.95mg/100g) and lowest in (99.97±6.95mg/100g). Magnesium is highest in TGX 1835-10E
174 (95.40mg/100g) and lowest in TGX 1485-1D (88.20±0.40mg/100g). TGX 1448-2E showed significantly low level
175 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.
176 Generally, the varieties have significantly (0<0.05) high levels of Calcium and Magnesium and very low level of
177 Potassium and Copper.

Comment [U3]: In what?

Comment [U4]: ??

178 Discussion

179 The results shows that the varieties analysed have high levels of Crude Proteins; but the Solvent extracted soybean
180 SES have higher Crude proteins ($48.9 \pm 0.6\%$) (9). In soybean grains, the amount of sucrose, the main carbohydrate,
181 can range from 15 to 102 g kg⁻¹, while glucose is found in trace quantities as reported by (9). This, in humans,
182 contributes to the growth of beneficial colon bacteria (11). These varieties have less Carbohydrates compared to the
183 35% Carbohydrate as reported by (8).

Comment [U5]: You can provide the name(s) of the author(s) without the year of publication before the numbering.

184 Variety TGX 1987-10F shows significantly ($p < 0.05$) higher level of Lipid ($17.86 \pm 0.23\%$). This is a comparative
185 advantage over the other varieties analysed as more Soy Oil for local, laboratory and industrial use are to be
186 generated from this variety. Soya oil have low concentration of polyunsaturated linolenic fatty acids and higher
187 oleic acid content which increase oil stability and prevent oxidation and production of off flavors during food
188 processing (2). Moisture content is significantly lower in TGX 1835-10E ($5.24 \pm 0.22\%$) and significantly higher in
189 TGX 1485-1D ($5.65 \pm 0.29\%$) at $P < 0.05$. El-Shemy, *et al.*, (12) reported that the moisture content of local varieties is
190 significantly higher than on improved varieties; hence would have a longer shelf life. The result also shows that
191 TGX 1987-62F has significantly ($p < 0.05$) more Crude fibre. The lowest Crude fibre was obtained from TGX 1835-
192 10E. This level of fibre ($6.09 \pm 0.19\%$) would enhance intestinal motility thereby combating constipation and also
193 colon cancer.

194 Generally, the varieties have significantly ($0 < 0.05$) high levels of calcium and Magnesium and very low level of
195 Potassium and Copper. Low levels in potassium in these varieties as seen in the results contradicts (7) who states
196 that Potassium is found in the Soya Bean in a very high concentration, followed by phosphorus, magnesium,
197 sulphur, calcium, chloride and sodium in that order.

Comment [U6]: ??

Comment [U7]: Incomplete phrase

198 Low levels in Potassium is encountered mostly on light, usually acid soils with a low cation exchange capacity or on
199 soils with a high content of three-layered clay minerals often loose soils with illite clay (2). Potassium deficiency is
200 as a result of strong K fixation and high levels of available magnesium (Mg) and very strong anti-coagulating factor
201 in blood clotting (2). Calcium is high because Lack of Calcium in legumes prevents the development of the nodule
202 bacteria, thus affecting Nitrogen fixation. Under appropriate soil pH availability of nutrients such as N and P and
203 microbial breakdown of crop residues are favorable. Calcium deficiency is unlikely if soil pH is maintained above
204 5.5 (1). Copper, Zinc and Fe were relatively low because they are micro nutrients. Calcium, zinc and phytate in soy
205 foods interact to form a highly insoluble complex, which reduces zinc absorption to a greater extent than
206 phytate alone(9). These low levels of Zinc would affect its bioavailability for that complex formation.

207 CONCLUSION

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

212

REFERENCES

- 213 1. AOAC (Association of Official Analytical Chemist) (1990) Official Methods of Analysis,
214 Association of Official Analytical Chemists. 15th Ed. Gaithersburg, USA: AOAC Press.
- 215 2. Blackman, S. A.; Obendorf, R. L.; Leopold, A. C. (1992). "Maturation Proteins and Sugars in
216 Desiccation Tolerance of Developing Soybean Seeds". *Plant Physiology* (American Society
217 of Plant Biologists) 100 (1): 225–30.
- 218 3. Circle, S J; Smith, A. H. (1972). *Soybeans: Chemistry and Technology*. Westport, CT: Avi
219 Publishing. pp. 104, 163.
- 220 4. Karr-Lilienthal LK, Kadzere CT, Grieshop CM and GC Fahley Jr (2005). Chemical and nutritional
221 properties of soybean carbohydrates as related to non ruminants: A review. *Livestock Production*
222 *Science*; 97(1): 1-12. 30. Passm
- 223 5. Lui, K. (2000). "Expanding Soybean Food Utilization". *Food Technology* 54(7): 46-47. National
224 workshop on small scale and industrial level processing of soybeans, held at IITA,
225 Ibadan, 27th-29th July. Nigeria. Pages 151–156
- 226 6. Messina, M., Messina, V., and Setchell, K.D.R. (1994). *The Simple Soybean and Your Health*. Avery
227 Publishing Group, Garden City Park, New York.
- 228 7. O'Dell B.L (1979). Effect of soy protein on trace mineral availability. In: Wilcke HL,
- 229 8. Oshodi AA. (1992) Proximate composition, nutritionally valuable minerals and functional
230 properties of *Adenopus breviflorus* seed flour and protein concentrate. *Food*
231 *Chemistry*. 45:79–83.
- 232 9. Salunkhe, D.K., Sathe, S.K., and Reddy, N.R. (2014). Legume lipids. In *Chemistry and Biochemistry of*
233 *Legumes*, S.K. Arora (Ed.) Edward Arnold Pub. Ltd., London.
- 234 10. Song TT, Hendrich S, Murphy PA (1999). "Estrogenic activity of glycitein, a soy isoflavone". *Journal*
235 *of Agricultural and Food Chemistry* 47 (4): 1607–1610. doi:10.1021/jf981054j. PM ID 10564025.

236