SOMALI REGIONAL PASTORAL AND AGROPASTORAL RESEARCH INSTITUTE (SORPARI)

FOOD SCIENCE AND NUTRITION RESEARCH DIRECTORATE

FINAL RESEARCH REPORT SUBMITTED TO SORPARI

PROXIMATE COMPOSITION, PHYSICOCHEMICAL, FUNCTIONAL, AND ANTI-NUTRITIONAL PROPERTIES OF SOYA BEAN

Mahamed Dol, MSc

Principal Investigator

Ass.Prof. Abdulkarim Mohamed, MSc

Hodo Mohamed, BSc

Co-Investigators

January 20, 2023
Jigjiga, Ethiopia

SOMALI REGIONAL PASTORAL AND AGROPASTORAL RESEARCH INSTITUTE (SORPARI)

FOOD SCIENCE AND NUTRITION RESEARCH DIRECTORATE



PROXIMATE COMPOSITION, PHYSICOCHEMICAL, FUNCTIONAL, AND ANTI-NUTRITIONAL PROPERTIES OF SOYA BEAN

Mahamed Dol, MSc

Principal Investigator

DG-SoRPARI

January 20, 2023
Jigjiga, Ethiopia

Acknowledgment

First, I would like to offer lots of thanks to Allah for His compassionate help in all aspects of this work and the rest of my life. Second I am deeply grateful and indebted to Ass. Prof. Abdulkarim Mohamed for his major advice during the analysis of the research results.

In addition, I would like to express my sincere appreciation and gratitude to the Somali Region Pastoral and Agro-pastoral Research Institute for granting this work. I also owe my deepest gratitude to my wife and my relatives in Jijiga town for their unreserved collaboration with their prayers and encouragement towards the successful completion of this work. Particularly, my thanks go to Mr. Abulqadir Sh. Abdirahman and Mr.Omar Hassen, who provided me with some suggestions for the data analysis. Other individuals who in one way or another other collaborated in this work deserve special thanks for their unforgettable duty during data collection.

Table of Contents

List of Tables v
List of Figure vi
1. INTRODUCTION 1
1.1. Background 1
1.2. Statement of the problem 2
1.3. Objective 5
1.3.1. General Objective 5
1.3.2. Specific Objective 5
2. **Material and Methods** 11
2.1. Structure of the experiment work 11
2.2. Sample collection and preparation 11
2.3. Determination of Proximate Composition 12
2.3.1. Moisture Content 12
2.3.2. Ash Content 12
2.3.3. Crude Lipid Content 13
2.3.4. Crude Protein Content 13
2.3.5. Carbohydrate Content 14
2.3.6. Total energy Content 14
2.4. Determination of Mineral content 14
2.4.1. Calcium 14
2.4.2. Iron 15
2.4.3. Magnesium 15
2.4.4. Zinc 15
2.5. Determination of functional properties 16
2.5.1. Water Absorption Capacity 16
2.5.2. Oil Absorption Capacity 16
2.6. Determination of Anti-Nutritional Factors 16
2.6.1. Determination of Phytate 16
2.6.2. Determination of tannin 18
3. Results 19
3.1. Proximate composition of soya bean varieties 19
3.2. Mineral contents of different soybean varieties 21

3.3. Anti-Nutritional Factors of soya bean 22
3.4. Functional Properties of Soya bean 23
3.5. Physical Properties of Soya bean.....24
4. Discussion.....25
4.1. Proximate Composition of Soya Bean.....25
4.2. Mineral Concentrations of Soya Bean.....26
5. Conclusion and Recommendation.....28
5.1. Conclusion.....28
5.2. Recommendation.....28
6. References.....30

List of Tables

Table 1. Proximate Composition of Different Soybean Varieties.....20
Table 2.Total Mineral contents of different soybean varieties.....21
Table 3. Anti-Nutritional Factors of soya bean.....22
Table 4. Functional Properties of Soya bean.....23
Table 5. Physical Properties of Soya bean.....24

List of Figure

Figure 1. Experimental structure 11

1. INTRODUCTION

1.1. Background

The soya bean, botanically called Glycine max (L.) originated from Eastern Asia, probably in north and central China. Mature soya bean seed contains approximately 40% protein, 20% oil, and 10% water-soluble carbohydrates (Byth, 1968). Glycine max is an important legume increasingly consumed for both its nutritional and economic values (Bayero et al., 2019). High-quality protein and oil are of paramount importance to human beings. One primary source of high-quality protein and oil is the soya bean (Medic et al., 2014). The quality of soya beans is usually determined by seed protein, oil, fatty acid, and mineral contents, as such its quality is key to improving human and animal nutrition. This importance is probably related to the fact that soya bean products are excellent sources of proteins, minerals, phosphorus, and vitamins all at a very low cost (Wang et al., 2003). On another hand, soya bean products are largely known to play an important role in health and healthy living. Soya bean intake is reported to prevent heart disease, obesity, hypercholesterolemia, cancer, diabetes, kidney disease, and osteoporosis, and it is also suitable for people with allergic reactions caused by animal milk (Friedman & Brandon, 2001). Glycine max has the highest protein content (40%) among cereals and other legumes. Other legumes have a protein content of

between 20 to 30%, while cereals have a protein content in the range of 8-15% (Yohannes et al., 2020).

Soya beans' protein content (40%) is higher and more economical than that of beef (19%), chicken (20%), fish (18%), and groundnut (23%) (IITA 1990). Soya bean is also of particular interest as a vegetable protein source because of its cholesterol-lowering abilities in patients with type II hyperlipoproteinemia (Sridhar & Bhat, 2007). The soya bean also contains about 20% oil, the second highest content among all food legumes, with the highest oil content found in peanuts, which is about 48% on a dry matter basis, while the third-highest oil content is chickpea which is about 5% (Liu, 1997). Soya bean is also rich in minerals and vitamins such as iron, zinc, copper, thiamine, riboflavin, niacin, and pantothenic acid, as well as phospholipids (Bourre, 2006). Most of these vitamins and minerals are well-known hematinic and are essential in the formation of red blood cells (Joel & U, 2011). Soya bean is reported to contain flavonoids, especially isoflavones, and this is the reason why they are regarded as having a powerful ability to fight and prevent cancers in humans, as well as other diseases (Messina et al., 1994).

1.2.Statement of the problem

Soybean (Glycine max) is a grain legume that is very nutritious and contains on average 40% protein. It is gaining ground

internationally due to its multi-use use as human food, livestock feed, manufacturing purposes, and more recently, as a source of bio-energy (Argaw et al.). Currently, it also comes to be the world's most important source of vegetable oil. Unlike most other beans it contains 40% protein compared to 20% and 13% protein content in meat and egg, respectively (Muchabi et al., 2014). Moreover, it contains 20% non-cholesterol oil and its fortified foodstuffs are considerably low-soya beans than other sources of high-quality protein. It very well may be utilized directly for nourishment in the family unit or handled for soy milk, cooking oil, and a scope of different items including newborn child weaning sustenance. Also, the poultry sector industry uses soybean for feed production. Soybean grain often has good market demand. The crop residues are also wealthy in protein and are great feed for domesticated animals forming a good basis for compost manure. It is a source of edible oil (the second most consumed oil in the world after palm oil) with the highest gross output of vegetable oil among the cultivated crops with a total cultivated area of 117.7 million ha and total production of 308.4 million tons (Fentahun, 2019).

Food insecurity and malnutrition are among the urgent difficulties that creating nations confront nowadays. The significant staple food harvest of most creating Sub-Saharan African Nations, maize, contains low protein (5.2-13.7 %) (Maitra, 2018). The difficulties are particularly intense in Ethiopia and relatively more serious in the rural than urban areas, primarily due to a low level of understanding

of a balanced diet and the absence of an ability to buy animal-source proteins.

Producing and consuming more soy would enhance the circumstance (Food Security) as soy gives a nutritious mix of both calorie and protein consumption: it is the most nutritionally rich crop product, as its dry seed contains the highest protein and oil content among grain legumes (topmost rich in protein) (40 to 42% protein) with a good sense of balance of the essential amino acids and has 18-20% oil on a dry seed weight basis. It is discounted and rich source of protein for poor farmers, who have less access to animal-source protein, because of their low acquiring limit (low purchasing power). In this way, Soybean is an elective protein source for rural families and can be utilized at home in different structures and the surplus can be sold to different buyers, producers, and manufacturers for money (Fentahun, 2019).

Many other products with a soya basis are also directly used for human consumption (soymilk, tasty soya, soy yogurt, snacks, soya sauce, protein extract, and concentrates, etc.). In the major producing nations and especially in Brazil, Argentina, Paraguay, and the USA soybean contributes fundamentally to the aggregate value added by the agricultural sector. In these nations, soybeans and their sub-products also occupy an important position in total export earnings. Among minor producers, only India and Bolivia earn significant income from the exportation of soybean and derived products or by-products (Gwada et al., 2020).

Different research centers under the Somali region pastoral and Agro-pastoral research institute have been working on the Soya bean varieties and possible this was released and proximate analysis must check its quality. Therefore, the aim of the present study will profile the nutritional value, antinutritional value, mineral contents, and functional and physical properties of soya bean varieties adapted and released by SoRPARI. Knowing the soya bean's nutritional diversity would have a direct impact on the improvement of soya beans for quality breeding and food product development to reduce the prevalence of food insecurity, malnutrition, and mineral deficiency, especially for those low-income communities.

1.3. Objective

1.3.1. General Objective

- To Analysis of the proximate composition, physicochemical, functional, and anti-nutritional properties of soya bean

1.3.2. Specific Objective

The specific objective of the study was to;

- To analyze the Physical properties of soya bean
- To analyze the functional properties of soya bean
- To analyze the proximate composition of Soya bean
- To analyze the anti-nutritional factors of soya bean

2. LITERATURE REVIEW

2.1. Soya Bean

The Soybean (*Glycine max* L.), is one of the oldest crops of China and has been used by Chinese and other Oriental cultures for centuries in many forms as one of the most important sources of proteins and oil (Papastoitsis & Wilson, 1991). For this reason and due to manyothers (high protein yield per unit area than other crops), the soybean has caught the attention of the world and now it is seen as a crop that could help to combat world hunger. Most recently, interest in soybean has increased due to the presence of isoflavones, compounds that may play an important role in preventing and treating chronic diseases (Kennedy, 1995). Wild types of soybeans were first introduced in the United States as a hay crop. Introductions from China, Manchuria, Korea, and Japan have been important in developing cultivars for the United States. Modern breeding efforts to improve the agronomic traits, such as more erect growth, reduced lodging, and increased seed size,have been primarily responsible for the development of soybeans into a crop of worldwide importance (Yoshida et al., 2003).

2.2. Agronomic characteristics

The soybean belongs to the family Leguminosae, subfamily Papilionoidea, and genus Glycine, L. The cultivated form is called *Glycine max* (L.) Merrill, grows as a summer annual.

However, some related species are perennial in nature (Doyle & Luckow, 2003). The plant is bushy with heights ranging 0.75 to 1.25 m, branching sparsely or densely, depending on cultivar and growing conditions. The flowers are white or violet. The beans grow in pods that develop in clusters of 3 to 5 cm with each pod usually containing 2 or 3 beans. These beans are sometimes big or small, long, round, or oval. The color can also vary. Some are yellow, others are green but can also be brown and some are even black or with spots. One of the most important agronomic characteristics of soybeans is that it can take nitrogen from the air and convert it to a form usable by the soybean plant characteristic that will be explained later in more detail (Howell & Caldwell, 1978).

2.3. Seed Morphology

The soybean seed is essentially devoid of endosperm and consists of a seed coat and a large, well-developed embryo that contains two pieces of cotyledons that function as food reserve structures. The seed coat is marked with a hilum or seed scar that varies in shape from linear to oval. The coat protects the embryo from fungi and bacterial infection before and after planting. Besides cotyledons, the embryo has three other parts: radicle, hypocotyl, and epicotyl (Figure 2.1). The radicle and hypocotyl are located under the seed coat at one end of the hilum, just below the micropyle, which is a tiny hole formed by

the integuments during seed development. The third part, the epicotyl, is very small and placed between the pair of cotyledons (Figure 2.1). During germination, the radicle becomes the primary root, whereas the hypocotyl lifts the cotyledons above the soil surface. The epicotyl is the main stem and growing point (Houssard et al., 1980).

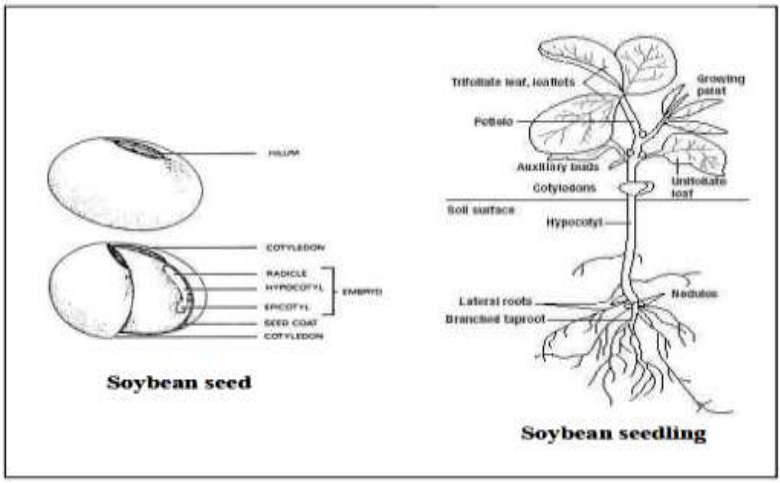


Figure 1. Structure of a soybean seed, and a soybean seedling. Source: MSU 2000, Roth and others 2003.

2.4. Proximate Composition

The composition of soybeans may vary somewhat according to cultivar and growing conditions. On average, oil and protein together constitute about 60% of dry soybeans. The remaining dry matter is composed of mainly carbohydrates (about 35%) and ash (about 5%) (Liu, 1997).

2.4.1. Lipids

During seed development, soybeans store their lipids, mainly in the form of triglycerides, in an organelle known as oil bodies. Triglycerides are neutral lipids, each consisting of three fatty acids and one glycerol that links the three acids. The functional properties, oxidative stability, as well as nutritional value of edible oils in general, and soybean oil, in particular, are all determined by their fatty acid composition, geometric configuration, and positional distribution. Most of the fatty acids in soybeans are unsaturated. The highest percentage of fatty acids in soybean oil is linoleic acid, followed in decreasing order by oleic, palmitic, linolenic, and stearic acid. Soybean also contains more minor fatty acids, including arachidic, behenic, palmitoleic, and myristic acid (Conforti & Davis, 2006).

2.4.2. Proteins

Based on biological function in plants, seed proteins are of two types: metabolic proteins and storage proteins. Metabolic proteins include enzymatic and structural and are concerned with normal cellular activities, including the synthesis of the second type. Storage proteins, together with reserves of oils, are synthesized during seed development. The majority of soybean protein is storage protein (Liu, 1997).

2.4.3. Carbohydrates

Carbohydrates are the second largest component of soybeans. However, the economic value of soy carbohydrates is considered much less important than soy protein and oil. Soybeans contain about 30% carbohydrates. These can be divided into two groups: soluble sugars (sucrose 5%, stachyose 4%, raffinose 1%), and insoluble fiber (20%) (Jideani, 2011).

3. Material and Methods

3.1. Structure of the experiment work

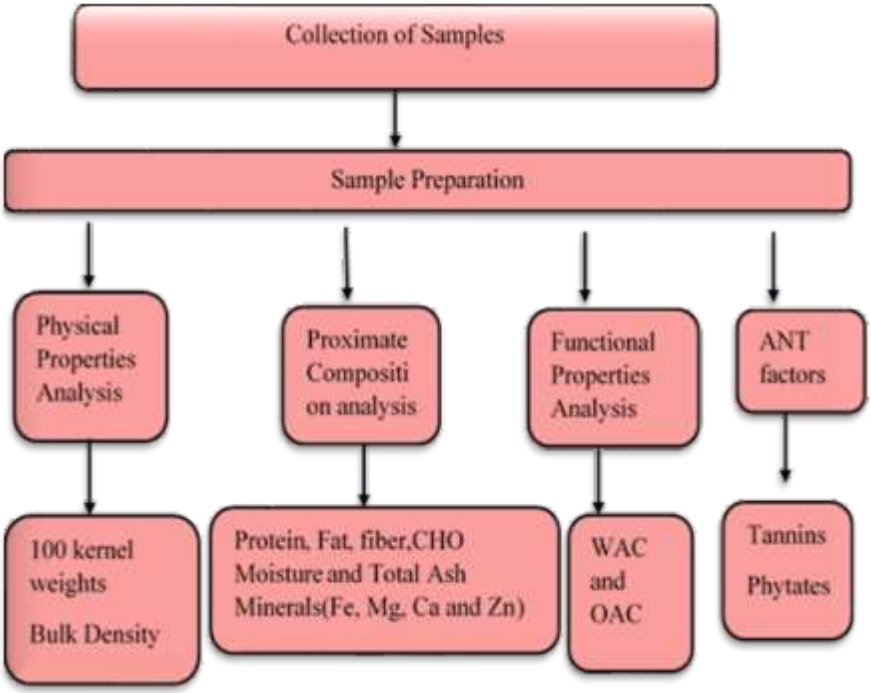


Figure 2. Experimental structure

3.2. Sample collection and preparation

Mature soya bean seeds were obtained from Kelafo, Dolo-Ado Research center, and two local varieties were bought from the local market of Gode city and Jigjiga city in Somali Regional State, Ethiopia. Then seeds were cleaned from any foreign material and removed any damaged or insect infestation seeds and then washed with tape water after that it was sundried for 8 hours to remove any moisture absorption during washing and then milled into flour

powder and then packed in airtight polyethylene plastic bags and stored in 4° for further analysis.

3.3. Determination of Proximate Composition

The proximate compositions of the soya bean varieties were determined using standard analytical methods. All measurements were done in triplicates and values were presented in percentages.

3.3.1. Moisture Content

10 grams of the grounded soya bean seed was oven-dried in a crucible at 105 °C overnight. The dried sample was then cooled in a desiccator for 1 hour and weighed to a constant weight, and the percentage loss in weight was expressed as percentage moisture content (AOAC, 2000).

$$Moisture\ content(\%) = \frac{W2-W3}{W2-W1}X100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eq.1$$

Where,

W1 = Initial weight of the empty crucible

W2 = weight of dish + sample before drying

W3 = weight of dish + sample after drying.

3.3.2. Ash Content

Ash content was carried out using 2.5 g of dried milled soya bean seeds in a muffle furnace at 550 °C for 6 hours. The residual ash in the crucible was cooled in a desiccator and weighed. The percentage of residue weighed was expressed as ash content (AOAC, 2000).

$$\textbf{Ash content}\ (\%)\ \frac{\textbf{Weight of ash}}{\textbf{Weight of sample used}}\ \boldsymbol{x100}\ \ldots\ldots\ldots\ldots\ \boldsymbol{eq.2}$$

3.3.3. Crude Lipid Content

Continuous extraction of lipid was done for 5 hours with petroleum ether in a Soxhlet extractor using 2.00 g of the sample to determine the crude lipid content percentage expressed using following the procedures of (AOAC, 2000).

$$Crude\ Fat\ (\%) = \frac{weight\ of\ fat}{weight\ of\ sample} x100\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.3$$

3.3.4. Crude Protein Content

The protein content was determined using the micro-Kjeldahl method (AOAC, 2006). Here 1 g of the sample was placed into a filter paper and introduced into a Kjeldahl flask, and 10 ml of concentrated H2SO4 was added and digested in a fume cupboard until the solution becomes colorless. The distillation was carried out with 15 ml of 50% of NaOH. The tip of the condenser was dipped into a conical flask containing 6 ml of 4% boric acid in a mixed indicator until a green coloration was observed. Titration was done in the receiver flask with 0.01 M HCl until the solution turned red (AOAC, 2000).

$$\%\ \text{Nitrogen} = \frac{T \times 14.01 \times 0.01 \times 20 \times 100}{1.0 \times 100}$$

Where T = Titre value

1 .0g = Weight of the sample

20 = Dilution factor (i.e. from 10015)

0.01 = Normality of HCl

14.01 = Atomic mass of nitrogen

% Protein = %Nitrogen x 6.25 (where: 6.25 => Conversion factor of protein).

3.3.5. Carbohydrate Content

The total carbohydrate content was estimated as the difference between 100 and the total sum of moisture, fat, protein, crude fiber, and ash as described by (AOAC, 2000).

3.3.6. Total energy Content

The total energy was determined by the method described by (Kanu et al., 2009). The total energy or caloric values was estimated by calculation using the water quantification factors of 4, 9, and 4kcal/100g respectively for protein, fat, and carbohydrate.

3.4. Determination of Mineral content

The selected mineral elements (Ca, Fe, Mg, and Zn) concentrations were determined in a solution obtained from wet digestion of sample ash with a mixture of HCl solution and nitric acid (1:1 v/v) using atomic absorption spectrophotometer (AACC, 2000).

3.4.1. Calcium

The calcium content was determined by atomic absorption spectrophotometer (AACC, 2000). Calcium content was calculated with the following formula:

$$Ca\ (ppm) = \frac{C \times 100}{S} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.5$$

Where: **C** is the concentration of the sample from a plot of absorption in µg/ml and **S** sample mass (g).

3.4.2. Iron

Iron content was determined by Atomic Absorption Spectrophotometer (AACC, 2000). iron content was calculated with the following formula:

$$\text{Fe (ppm)} = \frac{\left(\mu \frac{\text{g}}{\text{mL}}\right) \text{x } 100}{\text{Sample mass(db)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{eq. } 6$$

Where: µg/mL is the absorbance reading concentration

3.4.3. Magnesium

Magnesium content was determined by Atomic Absorption Spectrophotometer (AACC, 2000). iron content was calculated with the following formula:

$$\text{Mg (ppm)} = \frac{\left(\mu \frac{\text{g}}{\text{mL}}\right) \text{x } 100}{\text{Sample mass(db)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{eq. } 7$$

Where: µg/mL is the absorbance reading concentration

3.4.4. Zinc

Zinc content was determined by Atomic Absorption Spectrophotometer (AACC, 2000). iron content was calculated with the following formula:

$$\text{Zn (ppm)} = \frac{\left(\mu \frac{\text{g}}{\text{mL}}\right) \text{x } 100}{\text{Sample mass(db)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{eq. } 8$$

Where: µg/mL is the absorbance reading concentration

3.5. Determination of functional properties

Water absorption capacity and oil absorption capacity were determined at 25˚C according to the method of Yamazaki (1953) as modified by Medcalf and Gilles (1965).

3.5.1. Water Absorption Capacity

The water absorption capacity was determined according to (Guzmán et al., 2015) Water absorption capacity (WAC) was calculated with the following formula:

$$WAC\ (\%) = \frac{weight\ oF\ water\ bound}{weight\ of\ sample\ (dry\ basis)} x100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.3$$

3.5.2. Oil Absorption Capacity

The water absorption capacity was determined according to (Guzmán et al., 2015) Water absorption capacity (WAC) was calculated with the following formula:

$$OAC\ (\%) = \frac{weight\ oF\ water\ bound}{weight\ of\ sample\ (dry\ basis)} x100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.4$$

3.6. Determination of Anti-Nutritional Factors

3.6.1. Determination of Phytate

Phytic acid content was determined by the method described by Wheeler and Ferrel. Two grams of milled dried sample was weighed in a 125ml conical flask with 50ml of 3% trichloroacetic acid (TCA) for 3 hrs with mechanical shaking. The suspension was centrifuged for 5 min. Ten milliliters of an aliquot of the supernatant was

transferred to a 50ml boiling tube; 4ml of FeCl3 solution (made to contain 2 mg ferric ion per ml in 3% TCA) was added to the aliquot. The tube was heated in a boiling water bath for 45min. One or two drops of 3% sodium sulfate 3% TCA) were added. Then the tube was cooled and centrifuged for 10-15 min at 2500 r.p.m. The clear supernatant was carefully decanted. The precipitate was washed twice by dispersing well in 25 ml 3% TCA, heated for 10 -15 min in a boiling water bath, then centrifuged again. Washing was repeated once more with water. The washed precipitate was dispersed in a few ml of water and 3 ml of 1.5N NaOH was added and the volume completed to 30 ml with water. The tube was heated in a boiling water bath for 30 min and hot-filtered using Whatman No. 1; the precipitate was washed with 60ml hot water, and the washings were decanted. The precipitate was dissolved from the filter paper with 40 ml 3.2N HNO3(hot) into a 100 ml volumetric flask. The paper was washed with hot water. The washing was collected in the same flask and then completed to the volume. A standard curve of different Fe(NO3)2 concentrations was plotted to calculate the ferric ion concentration assuming a 4:6 iron: phosphorus molar ratio.

$$\text{Phytate(mg/100g)} = \frac{6}{4}\left[\frac{A \times C \times 20 \times 10 \times 50}{1000 \times 2}\right] \text{mg/100g sample}$$

Where:

A = optical density , C = concentration corresponding to optical density , 10 = volume of extract taken from supernatant , 1000 = to convert from g to mg , 4:6 = iron to phosphorus molar

20 = dilution factor , 50 = volume of T.C.A

3.6.2. Determination of tannin

Quantitative estimation of tannin was carried out using the modified vanillin-HCl method according to soya bean . The vanillin HCl reagent was prepared by mixing equal volumes of 8% concentrated HCl in methanol and 1% vanillin in methanol. The two solvents of the reagent were mixed just before use, it was discarded if a trace of color appeared. Catechin was used to prepare the standard curve, this was done by adding 100mg of catching to 50 ml of 1% HCl in methanol.

From this solution, a series of dilutions was prepared. Five milliliters of vanillin/HCl reagent were added to 1 ml of each dilution. The absorption was read using a spectrophotometer at 500nm after 20 min from the addition of the reagent at 300C. The absorbance was plotted against catechin concentration. A 0.2g of the sample was placed in a test tube, then 10 ml of 1% HCl/ methanol are added. Absorbance was read at 500nm and the concentration of condensed tannin was determined from the standard curve. Tannin concentration was expressed as % as follows:

$$CE\ (\%) = \frac{C \times 10 \times 100}{200}$$

Where: CE = Concentration corresponding to the optical density,

C = Concentration , 10 = Volume of extract (ml) , 200 = Sample weight (mg)

4. Results

4.1. Proximate composition of soya bean varieties

The samples of the soya bean varieties were analyzed for different proximate compositions including ash content, moisture content, crude fat content, crude fiber content, crude protein content, carbohydrate content, and energy content using different standard techniques, and the results are presented in Table 1. K-Pawa 1 was the highest moisture content of all other varieties but it was not significantly different from K-Pawa 2 whereas the lowest moisture content was in L-Jigjiga but also it was significantly different from L-Gode. Variety D-Pawa 1 indicated the highest ash content compared to the varieties however, except K-Gezale and Local varieties there is no significant difference between the other varieties. Table 1 shows that the D-Gezale has the highest crude fat content compared to other varieties however, variety K-Pawa 3 indicated no significantly different from G-Gezale but local varieties indicated the lowest crude fat content. the result indicated that the local varieties have a higher amount of fiber compared to the varieties. As seen in the result, D-Pawa 3 contained a significantly higher amount of protein, and the lowest protein content had seen in local varieties. The carbohydrate content was higher in the local varieties and there was a significant difference among the local varieties whereas the K-Pawa 1 indicated the lowest carbohydrate content. About the energy content, D-Gezale shows the highest significant amount compared to verities and there was no significant difference between variety D-Pawa 1, D-Pawa 2, K-Gizo, K-Pawa 1, K-Pawa 2, and K-Pawa 3.

Table 1. Proximate Composition of Different Soybean Varieties

Varieties	Parameters						
	Moisture (%)	Ash (%)	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)	Carbohydrate (%)	Energy (%)
D-Gezale	5.09±0.04^{c}	5.62±0.07^{ab}	21.61±0.03^{a}	28.92±0.03^{c}	3.75± 0.13^{d}	45.73±0.18^{ef}	493.0±0.32^{a}
D-Gizo	5.51±0.02^{abc}	5.76±0.03^{ab}	13.04±0.02^{h}	28.68±0.03^{d}	5.04± 0.03^{b}	53.25±0.04^{c}	445.0±0.23^{e}
D-Pawa 1	5.53±0.03^{abc}	6.30±0.48^{a}	21.47±0.01^{b}	28.73±0.02^{d}	4.45± 0.09^{bc}	45.35±0.05^{efg}	489.5±0.39^{b}
D-Pawa 2	5.17±0.01^{bc}	5.75±0.19^{ab}	20.83±0.01^{e}	27.96±0.02^{f}	4.14± 0.05^{cd}	47.07±0.00^{d}	487.6±0.26^{b}
D-Pawa 3	5.81±0.11^{abc}	5.77±0.08^{ab}	20.02±0.00^{f}	30.35±0.02^{a}	4.57± 0.05^{bc}	45.06±0.52^{fg}	481.8±2.00^{c}
K-Gezale	6.25±0.02^{abc}	5.22±0.07^{b}	16.56±0.01^{g}	26.35±03^{g}	4.32± 0.24^{bcd}	52.77±0.22^{c}	465.6±0.88^{d}
K-Gizo	6.52±1.68^{abc}	5.34±0.09^{ab}	21.27±0.00^{c}	26.35±0.03^{g}	4.92± 0.30^{b}	47.45±0.32^{d}	486.7±1.26^{b}
K-Pawa 1	7.34±0.61^{a}	5.64±0.55^{ab}	21.13±0.05^{d}	29.52±0.02^{b}	4.62± 0.02^{bc}	44.73±0.06^{g}	487.2±0.17^{b}
K-Pawa 2	7.17±0.42^{a}	5.84±0.50^{ab}	21.12±0.00^{d}	28.49±0.01^{e}	4.36± 0.20^{bcd}	46.03±0.01^{e}	488.2±0.09^{b}
K-Pawa 3	7.12±0.02^{ab}	5.86±0.27^{ab}	21.60±0.00^{a}	27.94±0.02^{f}	4.63±0.03^{bc}	45.83±0.00^{e}	489.5±0.08^{b}
L-Gode	4.79±0.70^{c}	4.27±0.38^{c}	5.37±0.02^{j}	19.86±0.02^{h}	5.94±0.30^{a}	68.82±0.29^{a}	406.5±1.32^{f}
L-Jigjiga	4.78±0.08^{c}	3.82±0.12^{c}	6.34±0.02^{i}	19.65±0.04^{i}	6.29±0.08^{a}	67.72±0.02^{b}	403.1±0.43^{g}
G. Mean	**6.59**	**5.43**	**17.53**	**26.9**	**4.75**	**50.82**	**468.64**
CV (%)	**11.6**	**7.8**	**0.2**	**0.1**	**6.2**	**0.6**	**0.3**
LSD (%)	**1.66**	**0.658**	**0.071**	**0.076**	**0.644**	**0.664**	**2.63**

All values are the means expressed on a dry matter basis ± standard error.
Means with the same superscripts do not differ significantly (P<0.05) G=grand D=Dolo-Ado, K=Kelafo, L-local
CV=Coefficient of Variation, LSD=Least Significance Difference.

4.2. Mineral contents of different soybean varieties

The result of the analysis of some mineral elements, including calcium, Iron, magnesium, and zinc are presented in Table 2. The result showed that the mineral concentration of mg/100 g of the soya bean flour. Variety K-Pawa 3 had the highest calcium content followed by D-Pawa 3 and D-Gizo but there was no significant difference between D-Pawa 3 and D-Gizo. Also, variety K-Pawa 3 indicated the highest Iron content compared to others and most poor mineral content was in local varieties. The magnesium content was found the highest concentration in variety K-Pawa 2 and the next highest magnesium content was found in variety K-Pawa 3 and this indicated that K-Pawa 3 was significantly higher in all mineral content compared to other varieties. The lowest value of zinc content was on L-Jigjiga.

Table 2.Total Mineral contents of different soybean varieties

Varieties	Parameters (mg/100g)			
	Calcium %	Iron %	Magnesium %	Zinc %
D-Gezale	130.8± 0.19^{d}	9.570± 36.07^{bcd}	930.9±36.07^{e}	6.040±0.01^{abc}
D-Gizo	143.0± 2.10^{b}	9.765± 111.75^{bcd}	1144.1±111.75^{cd}	6.030±0.09^{abc}
D-Pawa 1	137.9± 1.47^{c}	8.105± 67.80^{de}	1073.5±67.80^{cde}	6.000±^{abc}
D-Pawa 2	135.4± 1.57^{c}	9.990± 2.87^{bc}	1231.8±2.86^{bc}	6.075±0.19^{abc}
D-Pawa 3	143.7± 1.32^{b}	10.815± 16.23^{ab}	1140.0±`6.23^{cd}	5.680±0.19^{cd}
K-Gezale	137.9± 1.34^{c}	9.165± 11.90^{bcde}	978.1±11.90^{de}	6.450±0.00^{a}
K-Gizo	138.1± 1.21^{c}	9.355± 0.13^{bcde}	1117.3±0.13^{cde}	6.275±0.30^{ab}
K-Pawa 1	130.2± 0.81^{d}	8.715± 61.65^{cde}	1095.1±61.64^{cde}	6.385±0.03^{ab}
K-Pawa 2	127.1± 1.74^{d}	8.110± 1.07^{de}	2429.1±1.07^{a}	6.120±0.07^{abc}
K-Pawa 3	157.2± 0.74^{a}	12.060± 9.51^{a}	1378.2±9.51^{b}	5.960±0.08^{bc}
L-Gode	55.4± 1.10^{e}	7.705± 1.20^{e}	658.5±1.12^{f}	5.275±0.03^{d}
L-Jigjiga	48.9± 1.38^{f}	5.375± 123.48^{f}	945.3±123.48^{e}	3.790±0.16^{e}
G. Mean	**123.79**	**9.06**	**1177.0**	**5.840**
CV (%)	**1.5**	**7.6**	**6.8**	**3.3**
LSD (%)	**4.11**	**1.49**	**173.3**	**0.41**

All values are the means expressed on a dry matter basis ± standard error.
Means with the same superscripts do not differ significantly (P<0.05) G=grand D=Dolo-Ado, K=Kelafo, L-local CV=Coefficient of Variation, LSD=Least Significance Difference.

4.3. Anti-Nutritional Factors of soya bean

As seen in table 3 the result indicated that the anti-nutritional contents of soya bean varieties were presented in table 3. It was observed that the anti-nutritional content of tannin was significantly higher from the local varieties whereas adopted varieties were having less concentration on the other hand adopted varieties of SoRPARI Center the results indicated that D-Pawa 2 had a higher amount of anti-nutritional compounds D-Gizo was the lowest concentration of the polyphenols but there was no significantly different from the K-Pawa 2, also local varies have significant differences among the phytate contents.

Table 3. Anti-Nutritional Factors of soya bean

Varieties	Parameters	
	Tannins (%)	Phytates (%)
D-Gezale	0.148 ± 0.01^{d}	3.348 ± 0.13^{bc}
D-Gizo	0.228 ± 0.04^{cd}	$2.317 \pm 0.0.23^{d}$
D-Pawa 1	0.180 ± 0.04^{d}	$3.236 \pm 0.00b^{cd}$
D-Pawa 2	0.121 ± 0.03^{d}	4.861 ± 0.22^{a}
D-Pawa 3	0.169 ± 0.01^{d}	4.045 ± 0.13^{ab}
K-Gezale	0.260 ± 0.13^{cd}	2.659 ± 0.35^{cd}
K-Gizo	0.285 ± 0.04^{cd}	3.463 ± 0.01^{bc}
K-Pawa 1	0.398 ± 0.09^{c}	3.353 ± 0.10^{bc}
K-Pawa 2	0.164 ± 0.03^{d}	2.777 ± 0.24^{cd}
K-Pawa 3	0.239 ± 0.04^{cd}	4.279 ± 0.82^{ab}
L-Gode	4.179 ± 0.11^{b}	3.468 ± 0.23^{bc}
L-Jigjiga	6.660 ± 0.02^{a}	3.931 ± 0.23^{ab}
G. Mean	**1.086**	**3.478**
CV (%)	**8.1**	**12.3**
LSD (%)	**0.19**	**0.93**

All values are the means expressed on a dry matter basis ± standard error. Means with the same superscripts do not differ significantly ($P<0.05$) G=grand D=Dolo-Ado, K=Kelafo, L-local CV=Coefficient of Variation, LSD=Least Significance Difference.

4.4. Functional Properties of Soya bean

Table 4 shows the various functional properties of soya bean varieties. The water absorption capacity (WAC) and oil absorption capacity (OAC) of soya bean flour with six varieties ranged between 2.532-1.507 and 1.495-o.870 respectively. About the WAC K-Gizo showed the highest water absorption capacity and K-Pawa 2 indicated the lowest water absorption capacity. Similarly, K-Gizo and K-Pawa 2 indicated the highest oil absorption capacity, however, there was no significant difference between all the varieties.

Table 4. Functional Properties of Soya bean

Varieties	Parameters	
	WAC (%)	AOC (%)
D-Gezale	1.670 ± 0.10^{cd}	1.038 ± 0.18^{a}
D-Gizo	2.350 ± 0.19^{abc}	1.183 ± 0.00^{a}
D-Pawa 1	2.077 ± 0.16^{abcd}	1.438 ± 0.06^{a}
D-Pawa 2	1.700 ± 0.04^{cd}	1.093 ± 0.17^{a}
D-Pawa 3	1.638 ± 0.06^{cd}	1.008 ± 0.02^{a}
K-Gezale	2.077 ± 0.00^{abcd}	1.060 ± 0.08^{a}
K-Gizo	2.532 ± 0.05^{ab}	1.495 ± 0.03^{a}
K-Pawa 1	1.998 ± 0.06^{abcd}	1.245 ± 0.31^{a}
K-Pawa 2	1.507 ± 0.42^{d}	0.863 ± 0.26^{a}
K-Pawa 3	2.675 ± 0.23^{a}	1.085 ± 0.26^{a}
L-Gode	1.585 ± 0.13^{d}	0.870 ± 0.08^{a}
L-Jigjiga	1.890 ± 0.50^{bcd}	1.390 ± 0.31^{a}
G. Mean	1.975	1.147
CV (%)	15.7	22.5
LSD (%)	0.68	0.26

All values are the means expressed on a dry matter basis ± standard error. Means with the same superscripts do not differ significantly ($P<0.05$) G=grand D=Dolo-Ado, K=Kelafo, L-local CV=Coefficient of Variation, LSD=Least Significance Difference.

4.5. Physical Properties of Soya bean

As seen in table 5, the result indicated that one hundred seed weight and bulk density of soya bean varieties ranged from 16.50-7.00 and 0.766-0.683 percent and 0.766-0.682 ml respectively. D-Pawa 2 had a significantly higher seed weight compared to other seed varieties and L-Gode indicated the lowest seed weight. From the bulk density, L-Gode indicated the highest volume of the soya bean varieties whereas the D-Pawa 1 shows the lowest volume compared to other varieties.

Table 5. Physical Properties of Soya bean

Varieties	Parameters	
	Seed Weight %	Bulk density %
D-Gezale	15.75 ± 0.24^{a}	0.7635 ± 0.00^{a}
D-Gizo	10.75 ± 0.25^{bc}	0.7115 ± 0.00^{cd}
D-Pawa 1	14.50 ± 0.22^{a}	0.6825 ± 0.03^{f}
D-Pawa 2	16.50 ± 0.23^{a}	0.7195 ± 0.01^{bcd}
D-Pawa 3	11.50 ± 0.25^{b}	0.7170 ± 0.20^{bcd}
K-Gezale	10.50 ± 0.05^{bc}	0.7255 ± 0.01^{bc}
K-Gizo	11.50 ± 0.21^{b}	0.7020 ± 0.10^{de}
K-Pawa 1	11.00 ± 0.20^{b}	0.7345 ± 0.00^{b}
K-Pawa 2	11.75 ± 0.02^{b}	0.7145 ± 0.01^{cd}
K-Pawa 3	8.28 ± 0.01^{cd}	0.7170 ± 0.01^{bcd}
L-Gode	$7.00 \pm 0.03d$	0.763 ± 0.01^{a}
L-Jigjiga	$7.50 \pm 0.03d$	0.7660 ± 0.00^{a}
G. Mean	11.38	0.719
CV (%)	5.1	0.6
LSD (%)	1.25	0.01

All values are the means expressed on a dry matter basis ± standard error. Means with the same superscripts do not differ significantly ($P<0.05$) G=grand D=Dolo-Ado, K=Kelafo, L-local CV=Coefficient of Variation, LSD=Least Significance Difference.

5. Discussion

5.1. Proximate Composition of Soya Bean

The result of the study indicated that soya bean has low moisture content ranging from 4.78-7.34% and this result implies that it can be stored for a very long time since moisture is an important medium for the multiplication of microorganisms also this study is in line with a study that was conducted in Nigeria the results shows that soya bean has a lower amount of moisture content can be stored for a long time and micro-organisms can't grow easily (6.12%) (NWOSU et al., 2019).

On the other hand, the ash content of the soya bean is significantly higher and ranged between 3.82-6.30% which implies that higher ash content the higher important in mineral sources also, the study is an inline study that was conducted in Nigeria the result indicated that the ash content of 4.29% is indicative that the flour sample could be important sources of minerals (Etiosa et al., 2017). The soya bean protein content is ranged from 19.65-30.35% which indicates a higher concentration of protein compounds and these results can be used for solving many malnutrition problems, especially protein-energy malnutrition cases such as marasmus and kwashiorkor. Compared to other literature the crude fat content ranged from 5.37-21.61% which is lower content but still some of the varieties like D-Gezale and K-Pawa 1 indicated promising results of 21.61% and 21.60% respectively also the results of this

study were in agreement with (Etiosa et al., 2017). the fiber content of this study was found between 3.75% and 6.29% of D-Gezale and L-Jigjiga respectively. Fiber has many benefits for humans and can prevent constipation as well as can cut the risk of colon cancer also this finding agreed with the reported results by (Bayero et al., 2019) and the authors revealed 6.84% of fiber content.

Results of the study indicated significantly higher carbohydrate content of range between 44.75-68.82 percent. These can be promising results that can be used for managing protein energy malnutrition because of higher carbohydrate content the body can manage protein, fat, and mineral substance to use for bodybuilding, repairing damaged tissues rather than using them as a source of energy. This study is in line with the reported results by (Eshun, 2012) and he showed that high carbohydrate content ranges between 34.97-39.86 percent. The energy content (kcal/100g) ranged from 403.1-493.0 percent and this study is in line with research that was conducted in Ghana and the result revealed that energy content ranged (from 458.58-473.62% (Eshun, 2012).

5.2. Mineral Concentrations of Soya Bean

The finding of the study indicated that the calcium contents ranged from 48.9-157.21% and these results can be developed for many products like complementary foods for infants because calcium helps to build the bones and teeth of infants since calcium is one of the main components of teeth and bones. This study is in line with

the research result of (Eshun, 2012) which indicated that calcium is responsible for teeth and bone formation.

The Iron content of soya beans in this study was significantly higher and Iron contents ranged between 5.37-12.06 % K-Pawa 3 indicating a superior result this can be used for better management of Iron deficiency in vulnerable groups like lactating mothers, young children, and adolescent girls also this agreed with (Mehas, 2001) which indicates that iron plays a vital role for red blood cells that carry on and release oxygen.

Magnesium indicated significantly higher content and magnesium helps our body for enabling protein formation and plays a role in holding calcium content to the teeth as well as helping to release energy. The results of the study indicated that zinc content ranges from 3.79-6.45 percent according to the different literature zinc has many health benefits and this research is in line with research that indicated magnesium helps protein-making and energy releasing and zinc helps the immune system fight off invading bacteria and viruses (Eshun, 2012).

6. Conclusion and Recommendation

6.1. Conclusion

The results of this study indicated that soya bean varieties that were grown in Kelafo and Dolo-Ado center are promising results, contains high protein, crude fat contents, and carbohydrates and it's also an inexpressive source of macronutrients which is good sources for developing many food products and intervention programs that can alleviate the protein energy malnutrition. The fiber content was low but still can be useful for helping our body for preventing or release constipation, and correcting some of the problems that many people are facing like diabetes and obesity. Also, the ash content was high in some of the soya bean varieties, and this indicated that they are important sources of minerals like magnesium, calcium, zinc, and iron.

6.2. Recommendation

According to the results of the study, the authors is suggesting some recommendations about the benefits of the soya bean

- Food products prepared from soya beans can be divided into fermented and unfermented
- K-Pawa 1, K-Pawa 3, D-Pawa 3, and D-Gezale are highly promotable for developing many food products like
    - Weaning foods for infants
- It's very important for preparing one extra meal for lactating mothers
- Product development with enriching cereals with low protein, fat, and minerals contents
- Can be Prepared soya milk products

- It is recommended for people who suffer from lactose intolerance and it's commonly the most alternative to substitute for them

7. References

AACC. (2000). *Approved methods of the American association of cereal chemists* (Vol. 1). Amer Assn of Cereal Chemists.

AOAC, H. W. (2000). International A: Official Methods of Analysis of the AOAC International. *The Association: Arlington County, VA, USA*.

Argaw, B., et al. Technical, Allocative and Economic Efficiency of Soya bean Production: The Case of Smallholder Farmers in Pawe District, Ethiopia1.

Bayero, A., et al. (2019). Proximate composition and the mineral contents of soya beans (Glycine max) available in Kano State, Nigeria. *ChemSearch Journal*, *10*(2), 62-65.

Bourre, J.-M. (2006). Effects of nutrients (in food) on the structure and function of the nervous system: update on dietary requirements for brain. Part 1: micronutrients. *Journal of nutrition health and aging*, *10*(5), 377.

Byth, D. (1968). Comparative photoperiodic responses for several soya bean varieties of tropical and temperate origin. *Australian Journal of Agricultural Research*, *19*(6), 879-890.

Conforti, F. D., et al. (2006). The effect of soya flour and flaxseed as a partial replacement for bread flour in yeast bread. *International journal of food science & technology*, *41*, 95-101.

Doyle, J. J., et al. (2003). The rest of the iceberg. Legume diversity and evolution in a phylogenetic context. *Plant Physiology*, *131*(3), 900-910.

Eshun, G. (2012). Nutrient composition and functional properties of bean flours of three soya bean varieties from Ghana. *African Journal of Food Science and Technology*, *3*(8), 176-181.

Etiosa, O. R., et al. (2017). Mineral and proximate composition of soya bean. *Asian Journal of Physical and Chemical Sciences*, *4*(3), 1-6.

Fentahun, G.-E. (2019). Production and Marketing Trends of Soy Bean in Ethiopia.

Friedman, M., et al. (2001). Nutritional and health benefits of soy proteins. *Journal of Agricultural and Food Chemistry*, *49*(3), 1069-1086.

Guzmán, C., et al. (2015). A new standard water absorption criteria based on solvent retention capacity (SRC) to determine dough mixing properties, viscoelasticity, and bread-making quality. *Journal of Cereal Science*, *66*, 59-65.

Gwada, R. O., et al. (2020). Determinants of Food Security among Small-Scale Soybean Households in Butere Sub-County, Kenya. *Contemporary Agriculture*, *69*(3-4), 90-101.

Houssard, C., et al. (1980). Development of species diversity in some Mediterranean plant communities. *Vegetatio*, *43*(1), 59-72.

Howell, R., et al. (1978). Genetic and other biological characteristics [Soybeans]. *Soybeans: chemistry and technology*.

Jideani, V. (2011). Functional properties of soybean food ingredients in food systems. *Soybean-Biochemistry, chemistry and physiology*, 345-366.

Joel, N., et al. (2011). Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends. *African Journal of Food Science*, *5*(8), 466-472.

Kanu, P. J., et al. (2009). Production and evaluation of breakfast cereal-based porridge mixed with sesame and pigeon peas for adults. *Pakistan Journal of Nutrition*, *8*(9), 1335-1343.

Kennedy, A. R. (1995). The evidence for soybean products as cancer preventive agents. *The Journal of nutrition*, *125*(suppl_3), 733S-743S.

Liu, K. (1997). Chemistry and nutritional value of soybean components. In *Soybeans* (pp. 25-113). Springer.

Maitra, C. (2018). *review of studies examining the link between food insecurity and malnutrition*. FAO.

Medic, J., et al. (2014). Current knowledge in soybean composition. *Journal of the American oil chemists' society*, *91*(3), 363-384.

Mehas, K. Y. (2001). *Food science: The biochemistry of food and nutrition*. McGraw-Hill Education.

Messina, M. J., et al. (1994). Soy intake and cancer risk: a review of the in vitro and in vivo data. *Nutrition and cancer*, *21*(2), 113-131.

Muchabi, J., et al. (2014). Conservation agriculture in Zambia: effects on selected soil properties and biological nitrogen fixation in soya beans (Glycine max (L.) Merr). *Sustainable Agriculture Research*, *3*(526-2016-37858).

NWOSU, D. J., et al. (2019). Proximate and mineral composition of selected soybean genotypes in Nigeria. *Journal of Plant Development*, *26*, 67.

Papastoitsis, G., et al. (1991). Initiation of the degradation of the soybean Kunitz and Bowman-Birk trypsin inhibitors by a cysteine protease. *Plant Physiology*, *96*(4), 1086-1092.

Sridhar, K., et al. (2007). Agrobotanical, nutritional and bioactive potential of unconventional legume–Mucuna. *Livestock Research for Rural Development*, *19*(9), 126-130.

Wang, T. L., et al. (2003). Can we improve the nutritional quality of legume seeds? *Plant Physiology*, *131*(3), 886-891.

Yohannes, T. G., et al. (2020). Developing and nutritional quality evaluation of complementary diets produced from selected cereals and legumes cultivated in Gondar province, Ethiopia. *Current Research in Nutrition and Food Science Journal*, *8*(1), 291-302.

Yoshida, H., et al. (2003). Variation in the content of tocopherols and distribution of fatty acids within soya bean seeds (Glycine max L.). *Journal of Food Composition and Analysis*, *16*(4), 429-440.