IPS Applied Journal of Nutrition, Food and Metabolism Science
IPS Appl J Nutr Food Metab Sci, 1(1): 1-5 (2022)
DOI: https://doi.org/10.54117/iajnfms.v1i1.8

Nutritive and Antinutrient Values of Soybean Condiments Produced from Indigenous Fermenters

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Abstract

Several studies have shown that most condiments consumed in Nigeria today are fortified with chemicals that alter the nature and stripped the nutrients and natural immunological adjuvants designed by nature to protect the body system. Several condiments have been developed from fermented foods in order to control this ugly situation but there is still controversial thought on the nutritive and antinutrient effects of the condiment. The aim of this study was to evaluate the nutritive and antinutrient values of the soybean condiments produced using indigenous fermenters. The soybean (*Glycine max*) sample was fermented with indigenous microorganisms isolated from 7 days old fermented soybean sample. This was oven-dried, pulverized and packaged in a cleaned sterile screw-capped container. Gravimetric, spectrometric and titrimetric methods were employed for the nutritive and antinutrient parameters. *Lactobacillus plantarum* strain ZS 2058 (L), *Bacillus subtilis* strain 168 (B) and *Saccharomyces cerevisiae* strain YJM555 (Y) were the indigenous microbes used singly and in consortium for the production of light to dark brown condiments with water activity ranging from 0.27 – 0.37 for the fermented soybean in the plate and 0.22 - 0.36 for the fermented soybean wrapped with *Thaumatococcus danielli* leaves (called *Uma* in Igbo and *Ewe eran* in Yoruba). The moisture, ash, fat, protein, crude fiber, carbohydrate and B-carotene contents ranges from 2.70 – 14.75 %, 0.03 – 4.10 %, 11.11 – 14.69 %, 48.22 – 53.77 %, 10.22 – 12.04%, 8.16 – 21.61 % and 6.92 – 8.14 % respectively. The isoflavone contents (0.096 -0.132 % w/w) were significantly ($P < 0.05$) higher than that of normal soybean (0.068 %). The phytates, lectin, oxalates and tannins contents were significantly ($0.01>P<0.05$) reduced to minimum values of 0.01 mg/g, 0.02 mg/g, 0.02 g/100g and 0.08 mg/g respectively. Therefore condiments produced from the fermentation of soybean using indigenous B, L, Y, BL and BLY are recommended as this would enhance its safety and nutritional quality, and those fermented in plastic plates using BLY were the most efficient, preferable and acceptable.

Keywords: *Soybean, Glycine max, Antinutrient, Nutrition, Indigenous Fermenters*

Article History
Received: 25 April 2022
Accepted: 13 May 2022
Published: 18 May 2022

Scan QR code to view•

How to cite this paper: Iheukwumere, C. M., & Iheukwumere, I. H. (2022). Nutritive and Antinutrient Values of Soybean Condiments Produced from Indigenous Fermenters. *IPS Applied Journal of Nutrition, Food and Metabolism Science, 1*(1): 1-5. https://doi.org/10.54117/iajnfms.v1i1.8

Introduction

Soybean (Glycine max) or soybean is a species of legume, a native to East Asia and is widely grown for its edible bean which has innumerable uses (Ojewumi *et al*., 2018). Soybeans like most plants grow in distinct morphological stages as they develop from seeds into fully mature plants. Like many legumes, soybeans can fix atmospheric nitrogen (Ojewumi *et al*., 2018). Soybean seeds are extremely high in protein content. On average, dry soybean contains roughly 40% protein, 35% carbohydrate, 20% soybean oil, and 5% ash (non-aqueous, metal oxides). Therefore, soybean has the highest protein content among legume species. Soy protein is a heat-stable protein, thus allowing soy seeds to undergo high-temperature cooking and fermentation, without destroying the entire chemical composition of the soybean. The beans contain significant amounts of phytic acid, dietary minerals and B vitamins (Oboh, 2005). Soy vegetable oil, used in food and industrial applications, is another product of processing from soybean. Traditional non-fermented food uses of soybeans include soy milk from which tofu and tofu skin are made. Fermented soy foods include soy sauce, fermented bean paste, natto and tempeh (Ojewumi *et al*., 2018). Fermentation is the chemical breakdown of substances by bacteria, yeast or other microorganism into alcohol, carbon dioxide or organic acids (Oboh, 2005). Fermentation may also decrease or eliminate anti-nutritional constituents (Oboh, 2005). Overall, the nutritional quality of the fermented product is improved.

Fermented Soybean has been shown to inhibit *E. coli* infection (Ojewumi *et al*., 2018), minimize fluid losses in ETEC-infected small intestinal segments of piglets and shorten the duration of diarrhea when supplemented with the diet of malnourished children (Ojewumi *et al*., 2018). There seems to be a general agreement on the spore-forming *Bacillus* species as the main fermentation organisms (Shrestha *et al*., 2011). During the fermentation of soybean, systematic investigation showed that *Bacillus subtillis* is the most dominant bacterium responsible for the fermentation (Shrestha *et al*., 2011). The proximate composition indicates these condiments could contribute to the protein, lipid and mineral daily intake when used liberally, as done in many homes, where expensive animal products are a luxury (Oboh, 2005). In view of the controversy surrounding the use of monosodium-based seasoning salt, many homes in Nigeria are now using condiments produced from legumes as a flavorant in traditional soup preparation. However, there is limited information on the nutritional and antinutritional effects of these fermented condiments. This study is therefore sought to determine the nutrients and antinutrients (phytate, tannin, lectin and oxalate) of condiments produced from fermented soybean.

Materials and Methods

Sample Collection: This was carried out using the modified method of Suleiman and Omafe (2013). Soybean seeds were collected randomly from different shops and open markets in Eke Awka, Awka South LGA. Anambra State. Sampling was performed manually from different bags and basins, such

that soybean seeds were collected from different parts of the bags and basins. The samples were aseptically pooled and mixed properly to form a bowl and placed in a sterile nylon bag, the soybean seeds were properly labeled and taken to the laboratory for analysis.

Transportation: A sterile polythene bag containing ice blocks placed inside a cooler was used for the transportation of the sample. The temperature of the cooler was carefully checked and adjusted to 28ºC -30ºC in order to prevent or reduce microbial shock by reducing the quality of the ice inside the cooler. The samples were aseptically arranged inside the cooler without direct contact with the ice bag. The cooler was covered properly with packing tape to prevent accidental opening of the cooler. The cooler was taken to the laboratory safely for analysis.

Preparation and Local Fermentation of the Soybean: Two hundred and fifty grams of cleaned soybean seeds were weighed using an analytical weighing balance and steeped in a 500ml bucket of water overnight, after which the seedcoat were removed by rubbing between the palms and then the chaff was removed using a sieve. The soybean seed were then thoroughly washed and placed inside cleaned *Thaumatococcus danielli* leaves (called "uma" in Igbo and "ewe eran" in Yoruba) and wrapped properly and then kept inside a 500ml bucket that was well covered with the lid for fermentation to take place for 7 days at room temperature.

Processing of the Fermented Soybean: After the fermentation, the fermented soybean was prepared for culturing and the diluents used was peptone (BIOTECH) water which was prepared according to the manufacturer's instruction, then was sterilized by autoclaving at 121ºC for 15min at 15psi. Ten grams of the fermented soybean was aseptically weighed using analytical weighing balance into a 200 ml beaker (G.G) and little amount of the diluent was added and homogenized and then make up to 100 ml, part of these preparations was transferred into a 100 ml beaker (G.G) and boiled for 10-15 min using a pressure pot.

Isolation of the Test Sample: The media used for this isolation includes Sabourand dextrose agar (SDA), de Man Rogosa and Sharpe broth (MRS) and Nutrient agar (BIOTECH). A 0.1ml of the preparation/inoculum was collected using a sterile pipette and aseptically plated onto solidified Sabourand dextrose agar plate (90 mm x 15 mm) which was prepared according to the manufacturer's instruction and the procedures described in Cheesbrough (2010) supplemented with chloramphenicol (0.05%) and spread using a spreading rod, 0.1 ml of the boiled preparation/inoculums was collected and plated unto solidified nutrient agar plate also 1 ml of the inoculums was collected using a sterile pipette and aseptically inoculated into sterile 100 ml conical flask (Glassco) containing MRS broth (Oxoid) which was prepared according to the manufacturer's instruction and the conical flask were incubated in a microaerophilic environment (containing candle used to evacuate all traces of oxygen thereby creating an environment having only carbon iv oxide). The incubation was done for 24 – 72 h at (30±2ºC). The SDA and NA were incubated in an inverted position for 24 h at 35±2ºC (for NA) and 30±2ºC (for SDA) in an incubator (STXB128). The isolates were subcultured and characterized appropriately.

Preparation of Soybean Condiments

Processing of soybean for fermentation: This was carried out using the modified method of Farinde *et al.* (2007). One kilogram of soybean was carefully picked and weighed using analytical weighing balance and steeped in a 200ml bucket of water overnight for fermentation to take place, after the soybean was dehulled by rubbing between the hands to remove seed coat, after the chaff/seed coat was properly removed using a clean sieve, the soybean was then properly washed and placed inside a beaker and then autoclaved at 121ºC for 15 min at 15psi.

Fermentation Process: This was carried out using the modified method of Hu *et al.* (2010) and Chukeatirote *et al.* (2010). After autoclaving the soybean, a 100g of soybean was weighed using analytical weighing balance and placed inside 6 different *Thaumatococcus danielli* leaves (called "uma" in Igbo and "ewe eran" in Yoruba) which were properly sterilized using the electric oven at 180ºC for 2 h, each of the leaves containing the soybean was inoculated with the fermenters prepared and diluted to a turbidity that matched 0.5 MacFarland standard that was prepared by mixing 0.05mL of 1% $BaCl_2$. $2H_2O$ and 99.5 mL of 1% Conc. H_2SO_4, 10ml of suspension *Bacillus* was added and labeled as "B", 10ml of suspension of *Lactobacillus* was added and labeled as "L", 10ml of suspension of yeast was added and labeled as "Y", consortium of suspensions 5ml of Bacillus and 5ml of Lactobacillus was added and labeled as "BL", consortium of suspensions of 3ml of Bacillus,3ml of Lactobacillus and 4ml of yeast were added and labeled as "BLY" consecutively and one of the leaves containing only soybean was set aside as the control. These leaves were carefully wrapped. This same method was repeated using sterile plates. The wrapped leaves and the plates containing the soybean were kept at room temperature for fermentation to take place for 7days.

Storage and packaging: After fermentation, the fermented samples were aseptically dried using an electric oven at 80ºC for 7days**.** After drying water activity of the fermented samples was determined, after which it was ground into powder and stored in a sterile screw-capped container for subsequent analysis.

Nutritional Constituents

Moisture Content: A crucible was dried and cooled, then initial weight of the crucible was taken as W_1, 10g of the food sample was transferred into the crucible and the weight of the crucible was taken W_2 .The crucible and its content were then heated in an oven at 105ºC for 4-6 h. After drying the final weight of the crucible and its content were taken as W_3.Then the percentage moisture content was calculated as follows:

$$\% \text{ Moisture content} = \frac{W2 - W3}{W2 - W1} x100$$

Ash Content: A crucible was dried and cooled, then initial weight of the crucible was taken as W_1, 10 g of the food sample was transferred into the crucible and the weight of the crucible was taken W_2 .The crucible and its content were then heated in a furnace at 550ºC for 3-5 h, after which the crucible was removed and allowed to cool. The final weight of the crucible and its content was taken after drying/ashing as W_3. The percentage ash content was then calculated as follows:

$$\% \text{ Ash content} = \frac{W3 - W1}{W2 - W1} x100$$

Fat Content: A soxhlet extractor was used, the soxhlet flask was dried in an oven at 105ºC and allowed to cool, after which the weight of the flask was taken as W_1. Then 10 g of the food sample was taken as W_2 and transferred into the thimble of the extractor, the sample was extracted using 250 ml of hexane for 4-5 h. After 5 h the chaff was emptied properly for the determination of the fibre content and all the solvent were recovered. The flask that contains all the extract were dried in an oven at 105ºC until all the water have been evaporated leaving the oil only, the weight of the flask and oil content was taken as W_3. The percentage fat was calculated as follows:

$$\% \text{ Fat content} = \frac{W2 - W1}{W2} x100$$

Fibre Content: The weight of the total chaff that generated during extraction of fat was taken as (W_1) and transferred to a beaker and 200 ml of water and 3 g of NaOH was added and boiled for 30 minutes. The solution was filtered and the residue generated was transferred into another flask, 200ml of water and 3g of sulphuric acid was added and boiled for 30 minutes, the solution was filtered and the residue generated was dried in an oven at 105ºC until a constant weight is generated after 3-5 h (W_2). The dried residue was transferred into a dried crucible and ashed in a furnace at 550ºC for 3-4 h, the sample was removed from the furnace and cooled. Then the weight of the crucible and its content was taken as (W_3). The percentage fat was calculated as follows:

$$\% \text{ Fibre content} = \frac{W3 - W2}{W1} x100$$

Protein: A 0.5g of the sample was weight and transferred into a digestible flask, 20ml of sulphuric acid and 0.5g of selenium powder (catalyst) was added, this mixture was heated in a fume cardboard for about 7h (i.e until a clear or colourless solution is seen). The sample generated was diluted (1:4 dilution was carried out), 5ml of the diluted sample was collected into a distillation flask and 5ml of 40% NaOH was added, then 10ml of 10% boric acid was put inside a conical flask, 5 drops of bromocresol green and 1drop of methyl red was also added and was properly mixed. The conical flask was placed under the tip of the condenser and the distillation started, 50 drops of the distillate were allowed to enter into the conical and then the color of the solution was turned blue. A burette was filled with 0.01 HCl and titrated against the content of the flask until the colour was changed to wine red, the titrate value was taken

% Nitrogen = titre x molarity of acid used (0.01M) x atomic mass of nitrogen x DF = Tv x M x A x DF

Carbohydrate
% CHO = 100 – (% moisture ± % fat ± % ash% ± fibre ± % protein) according to the methods of (AOAC, 2000)

Isoflavones and Anti-nutrient Analysis
Analysis of total isoflavones content
Preparation of standard: A total of 15 mg of genistein reference compound was accurately weighed in a 100 ml conical flask (Pyrex). Methanol (80 ml) was added, the solution was sonicated for 5 min and the volume was adjusted to 100 ml with methanol. A 5 ml aliquots was transferred into 25 ml conical flask (Pyrex) and 1.0 ml of 2% $AlCL_3$ (W/V) in methanol was added. The flask volume was made up with methanol in order to obtain a solution at 30ug/ml as described in the study published by Cesar *et al*. (2008).

Determination of Isoflavones content: A total of 50 mg of the powdered soybean and condiment extract samples, previously dried at 105ºC for 4h were accurately weighed in a 50 ml volumetric flask. Methanol (40 ml) was added to each content and the solutions were sonicated for 5min. The volume was adjusted to 50 ml with methanol and these were filtered using Whatman No. I filter paper. An aliquot of 5 ml from each solution was transferred into 25 ml volumetric flask (pyrex) and 1 ml of 2% $AlCL_3$ (W/v) in methanol was added in each content and then made up with methanol. The blank solutions of genistein standard and soybean/condiments extract sample solution were similarly prepared, without the addition of $AlCL_3$. The absorbance of the solutions was measured using UV/Visible spectrophotometer (UV1200, LABSCIENCE England) at 382 nm as described in the study published by Cesar *et al*. (2008).

Analysis of anti-nutrients contents
Tannin: This was determined using method described in the study published by Adeyemo and Onilude (2013). One gram of each sample was weighed into 250 ml beaker (pyrex). Each was soaked with solvent mixture (80 ml of acetone and 20 ml of glacial acetic acid) for 5 h to extract tannin. The samples were filtered through a double layer filter paper (Whatman No 1) to obtain the filtrates which stored for further use. A standard solution of tannic acid was prepared ranging from 10ppm to 30 ppm. The absorbances of the standard solution as well as that of the filtrates were read at 500 nm using UV-visible spectrophotometer (UV- 1200, LAB SCIENCE, England).

Phytate: This was determined using the method described in the study published by Adeyemo and Onilude (2013). Two grams of each sample were weighed into 250 ml conical flask (Pyrex). These were soaked in 100 ml of 2% hydrochloric acid (HCl) and allowed for 3 h. These were filtered through double-layered filter paper (Whatman No. 1). The filtrates were each placed in 250 ml beaker (Pyrex) and added 100 ml of distilled water. Then 10 ml of 0.30 % ammonium thiocyanate solution was added into each solution as an indicator. This was titrated with standard iron (III) chloride solution, which contained 0.0019 g iron per ml. The endpoint was slightly brownish yellow, which persisted for 5 min. The percentage phytates for each sample was calculated using the formula

$$\% \text{ Phytate} = \frac{X\ x\ 1.19\ x\ 100}{0.00195}$$

Where X = Titre Value

Oxalate: This was determined using the method described in the study published by Popoola *et al*. (2014). One gram sample was weighed into 250ml conical flask (Pyrex) and boiled in 150ml water containing 27.5ml 6M HCl plus two drops of caprylic alcohol (octanol) for 25min. The mixture was cooled, transferred to a 200ml volumetric flask and made up to mark. The mixture was then filtered through Whatman 541 filter paper. The first 80ml filtrate was discarded and the rest was retained for analysis. A volume of 10ml of this filtrate was evaporated to near dryness at 40- 45ºC in a vacuum oven, and re- dissolved in 10ml of 0.01M H_2SO_4.

Then 0.5 mm $K_2Cr_20_7$ and 025 mm $MnCl_2$ were prepared in 250 ml volumetric flask; this solution was the background (blank) solution during oxalate standard solution. One millilitre (1mL) from each extracted sample and 9 ml from the blank solution, a total of 10 mL was taken for each sample and incubated for 60 min. The total oxalate in the sample was analyzed using a UV-visible spectrophotometer (UV-1200, LAB SCIENCE, England) at 190 nm. Standard solution of oxalic acid was used for this analysis.

Lectin: The samples were dissolved in distilled water and kept at a low temperature (4ºC) for 24 h in order to allow the foam to separate from the liquid. After 24 h, the samples were filtered using cheesecloth. Then the filtrates were kept in an oven at 30ºC for 24 h and then their pH was adjusted at 7.0. After this, they were they were centrifuged at 4000 rpm for 20 min and the supernatants were collected and analyzed spectrophotometrically at 280 nm.

Data Analysis: The data obtained in this study were presented in tables and figures. Their percentages were also calculated. The sample means and standard deviations of some of the analytical data were also calculated. The significance of the prevalence of the isolates in the studied samples was determined at 95% using one-way analysis of variance (ANOVA). Pairwise comparison was carried out using student "t" test.

Results

The nutrient constituents of the prepared condiments are shown in Table 1. The condiments showed varying moisture contents. The condiments prepared in the plates had lower moisture contents than those prepared in the leaves. The moisture content of the condiments was significantly ($P< 0.05$) lower than that of the "okpeyi", and higher than that of maggi except the condiments prepared with Bp and BLYP, that had equivalent moisture content with that of maggi, The ash contents of the prepared condiments were significantly ($P < 0.05$) lower than that of the maggi, and equivalent to that it okpeyi except those prepared with Bp, BL, LL, YP, YL, BLP and BLYP.

The fat contents were significantly ($P<0.05$) higher than that of the magi and okpeyi. The protein and crude fiber contents were significantly ($P <0.05$) higher than that of maggi but equivalent to that of Okpeyi. The carbohydrate contents of the prepared condiments were equivalent to that of maggi and okpeyi except the condiments prepared with BP. There was a significant ($P<0.05$) increased in the carbohydrate content when compared to the control (ordinary soy bean). The study also revealed that the prepared condiments contained significant ($P <0.05$) amount of B-carotene, which was not contained in the maggi, but an equivalent value was contained in okpeyi. Generally, the condiments had reduced amounts of ash, fats and crude fiber whereas the amounts of proteins, carbohydrates and B-carotenes increased, but the decreased in crude fiber content was not statistically significant ($P >0.05$).

The study showed that the prepared condiments had an appreciable value of isoflavone as shown in Table 2. The isoflavone contents of the prepared condiments were significantly ($P < 0.05$) higher than that of the control (ordinary soybean). The isoflavone content was seen most in the condiments prepared with BLYL, BLYP, BLL and BLP. Also condiments prepared from LL and LP contained higher isoflavone than those prepared with BP, BL, YP and YL. There was no significant difference ($P >0. 05$) between the isoflavone content of the condiments prepared with CP and CL, and that of condiments prepared from ordinary soybean. Similar trend was seen among the condiments prepared with BP, BL, YP, YL, and that prepared from CP and CL.

The study revealed significant ($P< 0-05$) reduction in the values of the anti-nutrients. The values of phytates significantly ($P<0.05$) reduced from 1.19mg/g to a maximum level of 0.10 in condiment prepared from YL, a minimum level in condiments prepared from LP, BLL and BLYL, and zero level in condiments prepared from BLYP and BLP respectively (Table 3). The values of lectin significantly ($P <0.05$) reduced from 3.30mg/g to a maximum level of 0.11 in Condiment prepared from YL, a minimum level in condiment prepared from BLYP. The values of Oxalates significantly ($P<0.05$) reduced from 0. 72g/100g to maximum level of 0:38 in condiment prepared from YP, minimum level in condiments prepared from BLYL. While the value of Tanning significantly ($P <0.05$) reduced from 1.96 mg/g to a maximum level of 0.93 in condiments prepared from Y_L, minimum level in condiments prepared from BLYP (Table 3).

Discussion

The microbial fermentation results in degradation of various antinutrients, and increases the amount of small peptides and these will improve the essential amino acids and protein contents (Mukherjee *et al*., 2016). Similar observation was made in the present study. Also the different nutritive and antinutrients values reported in the present study due to the fermentative activities of bacteria (*Bacillus* and *Lactobacillus*) and fungus (*Saccharomyces*) could be attributed to variation and efficiencies of the metabolic enzymes produced by the organism. Teng *et al*. (2012) and Mukherjee *et al*. (2016) reported that the dissimilarity in the fermentative activities of bacteria and fungi could be attributed to the different metabolic activities and enzymes involved in the two species, although in both, the antinutrients decrease and nutritional quality improves.

Table 1: Nutritional constituents of the prepared condiments

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Crude fiber (%)	Carbohydrate (%)	B-Carotene (mg/100g)
Bp	2.70±0.07	0.04±0.00	13.32±0.17	51.11±0.47	11.22±0.08	21.61±0.12	7.22±0.11
Bl	9.85±0.03	2.82±0.00	13.86±0.22	51.19±0.31	11.01±0.03	12.37±0.10	7.37±0.10
Lp	9.83±0.01	1.64±0.01	11.11±0.14	52.01±0.51	11.64±0.11	13.67±0.04	6.92±0.11
Ll	9.25±0.07	0.07±0.00	14.21±0.31	52.12±0.29	11.33±0.08	13.02±0.11	8.10±0.10
Yp	10.95±0.01	4.10±0.01	12.63±0.19	48.22±0.41	11.96±0.12	12.24±0.42	8.16±0.21
Yl	14.75±0.02	3.27±0.01	12.77±0.22	49.01±0.33	12.04±0.08	8.16±0.07	8.21±0.12
BLP	10.81±0.05	0.03±0.00	14.11±0.24	52.19±0.33	10.76±0.11	12.10±0.10	8.11±0.08
BLL	12.50±0.03	1.78±0.01	14.31±0.17	52.25±0.42	10.88±0.12	8.28±0.04	8.14±0.17
BLYP	5.26±0.01	0.08±0.00	14.61±0.12	53.15±0.29	10.22±0.08	16.68±0.11	7.42±0.11
BLYL	9.09±0.03	1.82±0.01	14.69±0.21	53.77±0.33	10.46±0.03	10.17±0.07	7.62±0.14
Maggi	3.17±0.01	69.01±0.22	5.04±0.01	13.92±0.11	0.04±0.00	8.82±0.01	0.00±0.00
Okpeyi	25.00±0.00	1.67±0.01	7.21±0.01	41.71±0.37	14.12±0.11	10.29±0.11	8.72±0.14
Cp	5.26±0.01	5.26±0.01	18.11±0.22	45.63±0.21	17.42±0.14	8.32±0.08	4.22±0.02
CL	8.33±0.04	6.33±0.01	18.26±0.17	45.72±0.41	18.11±0.17	3.25±0.01	4.31±0.07

Table 2: Isoflavone constituents of the prepared condiments

Sample	Isoflavone content (% W/W)
Bp	0.108±0.001
BL	0.114±0.002
LP	0.119±0.001
LL	0.121±0.001
YP	0.096±0.001
YL	0.098±0.001
BLP	0.127±0.002
BLL	0.129±0.001
BLYP	0.131±0.002
BLYL	0.132±0.001
Maggi	0.014±0.000
Okpeyi	0.101±0.001
Cp	0.092±0.001
CL	0.094±0.001
Control	0.068±0.000

Control = ordinary soybean

Table 3: Anti nutrients properties of the prepared condiments

Sample	Phytate (mg/g)	Lectin (mg/g)	Oxalates (g/100g)	Tannins (mg/g)
Bp	0.03±0.00	0.06±0.00	0.12±0.00	0.11±0.00
BL	0.05±0.00	0.07±0.00	0.10±0.00	0.14±0.00
LP	0.01±0.00	0.05±0.00	0.08±0.00	0.10±0.00
LL	0.02±0.00	0.06±0.00	0.07±0.00	0.12±0.00
YP	0.08±0.00	0.10±0.00	0.38±0.00	0.89±0.01
YL	0.10±0.00	0.11±0.00	0.34±0.00	0.93±0.01
BLP	0.00±0.00	0.04±0.00	0.06±0.00	0.10±0.00
BLL	0.02±0.00	0.06±0.00	0.05±0.00	0.11±0.00
BLYP	0.00±0.00	0.02±0.00	0.03±0.00	0.08±0.00
BLYL	0.01±0.00	0.04±0.00	0.02±0.00	0.10±0.00
Cp	1.17±0.00	3.16±0.01	0.68±0.00	178±0.01
CL	1.21±0.00	3.32±0.01	0.62±0.00	1.98±0.01
Control	1.19±0.01	3.30±0.01	0.72±0.00	1.96±0.01

Control = ordinary soybean

The significant increase in the isoflavone content of the prepared condiments supported the findings of many researchers (Teng *et al*., 2012; Mukherjee *et al*., 2016; Attia *et al*., 2020). Many researchers have reported the medicinal benefits of isoflavones against some life-threatening diseases such as cancer, diabetes, and cardiovascular diseases (Das *et al*., 2020; Egbuna and Tupas, 2020). Chen *et al*. (2012) reported that isoflavones possessed antioxidant property, and genistein component provide *in vivo* protection from acute myeltoxicity and reduced the production and activity of low-density lipoprotein (LDL). Dixit *et al*. (2012) reported that isoflavones possessed antioxidant and radioprotective properties. Lokuruka (2010) reported that isoflavones increases the body weight, ensures the healthy existence of male and female hormones and protect the body against cancer. Similar deduction was made by Okafor *et al*. (2015), Roger *et al*. (2015) and Ndukwe and Solomon (2017).

Conclusion

This study has shown that condiment produced from fermentation of soybean using indigenous *Bacillus subtilis* strain 168 (B), *Lactobacillus plantarum* strain ZS2058 (L) and *Saccharomyces cerevisiae* strain YJM555 (Y) were safe with high nutritive values and low antinutrient values.

Competing interests

The authors report no conflicts of interest.

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