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Full Length Research paper

Impact of Processing Techniques on Soybean (Glycine max) Nutritional and Anti-Nutritional Properties

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Effect A major source of vegetable protein in Nigeria's animal feed sector, soybeans are a leguminous vegetable that grows in tropical, subtropical, and temperate climates. The study looked into how conventional processing techniques affected the nutritional and anti-nutritional qualities of soybeans. The following processing methods were applied to the soybeans: soaking for 24 hours, sun drying and milling (sample B); soaking for 12 hours, de-hulling, sun drying and milling (sample C); sprouting for 120 hours, sun drying and milling (sample D); and sun drying and milling, which served as the control (sample A). The proximate composition of soybeans revealed that samples' protein contents ranged from 23.98 to 28.44%, with samples B, C, and D having the highest protein contents. Crude fiber ranged from 4.68 to 6.58%, and the fat content ranged from 20.51 to 26.20%. The control's moisture content, which varied from 7.23 to 10.92%, significantly decreased. The samples' anti-nutritional characteristics revealed that the phytic acid content ranged from 5.45 to 8.05%, with samples B, C, and D showing a considerable decrease. While the protease inhibitor ranged from 4.91 to 7.09%, with a notable decline in samples B, C, and D, the tannin concentration varied from 19.23 to 25.23 mg/100g. According to the study, traditional processing techniques can both greatly enhance the nutritional qualities of soybeans and dramatically decrease their anti-nutritional qualities, which increases the nutrients' bioavailability.

Key words: De-hulling, *glycine max*, milling, proximate, sprouting, sun drying.

INTRODUCTION

Education Legumes are a good source of protein, carbohydrates, dietary fiber, and minerals. Only a small percentage of the known species of legumes are widely used and promoted. The soybean (US) or soya bean (UK) is an East Asian legume plant that is commonly grown for its edible bean, which has a variety of uses. The plant is classified as an oilseed rather than a pulse by the UN Food and Agricultural Organization (FAO, 2008). Soybeans are the only protein that can be fed to pigs and poultry. Although soybeans are low in sulfur-containing amino acids like cysteic and methionine (Potter and Hotchkiss, 1995), their protein quality is comparable to that of animal protein sources like meat and milk, which have enough lysine to make up for cereal's lysine deficiency (Fabiyi and Hamidu, 2011). To increase the nutritional content of soybeans and other legumes, a range of processing methods can be employed, including as toasting, frying, extrusion, salt treatment, fermentation, germination pressure heating, cooking, soaking, and urea treatment (Akande & Fabiyi, 2010).

About 40–45% protein and 18–22% oil are found in soybeans, which are also rich in vitamins and minerals (Goyal et al., 2012). Phytic acid, saponins, and trypsin inhibitors are some of the anti-nutritional components found in raw soybeans that lower the nutritional value of grain legumes and can have negative effects on both people and animals when ingested in excess (Mikic et al., 2009; Sharma et al., 2011). Trypsin inhibitors decrease digestibility by preventing the breakdown of dietary protein and the absorption of amino acids. They can inhibit either trypsin or chymotrypsin (Roy et al., 2010). These anti-nutrients should be removed from legumes in order to enhance their nutritional value and organoleptic attractiveness for potential human consumption. Furthermore, by boosting the bioavailability of vitamins, amino acids, and protein digestibility, processing methods can raise the nutritional value of soybeans (Prodanov et al., 2004). Most farmers have found it very challenging to treat the seeds in a way that eliminates anti-nutritional components (Okagbare and Akpodiete, 2006). Given this, the purpose of this study is to evaluate the effects of soybean seed processing methods on the nutritional and anti-nutritional properties of soybeans.

MATERIALS AND METHODS

Source of Materials

Soybeans (*Glycine max*) were obtained from a local market in Ado-Ekiti, Nigeria. The beans were sorted and cleaned from extraneous materials.

Chemicals and Reagents

Mercuric oxide of reagent grade, Eagle Scientific Limited, England, produced paraffin wax, a 40% sodium hydroxide solution, a 4% sodium sulphate solution, a boric acid indicator solution, methyl red, and 0.2% bromocresyl; B.D.H. Limited, England, produced petroleum ether, antifoam (like silicone or octyl alcohol), and 95% (v/v) ethyl alcohol. Reagent grade potassium sulfate or anhydrous sodium sulfate 98% sulfuric acid, nitrogen-free. All of the other reagents were analytical grade.

Production of Soybeans Flour

After the soybeans were washed and sorted, four different processing methods were applied to produce soybean flour. Soybeans that have been sun-dried and crushed into flour make up Sample A, the control, while soybeans that have been soaked in water at 12 °C for 24 hours make up Sample B. In sample D, the soybeans sprouted for 120 hours before being dried and crushed into flour; in sample C, the soybeans were soaked for 12 hours, then dehulled, sun-dried, and milled into flour.

For the purpose of sprouting, the soybean seeds were immersed in water for a full day. The seeds were able to germinate after being spread out on the jute bags and covered with the same material. Water was sprayed on the jute bags twice a day until the seeds began to grow. The sprouting seeds were crushed into flour after being exposed to the sun for four days.

Determination of Proximate Composition

Crude protein, crude fat, ash, fiber, and moisture content were all examined using the AOAC (2005) method. The total carbohydrate content was determined by subtracting the percentages of crude protein, fat, ash, and crude fiber from 100%.

Determination of Anti-nutritional Properties

Tannin was determined gravimetrically using the Makkar and Goodchild (1996) method, while phytate was calculated using the Young and Greaves (1990) method. The Ladd and Butler (1972) approach was used to determine the protease inhibitor.

Statistical Analysis

The results from the experiment were statistically analyzed using SPSS version 20. The Duncan Multiple Range Test (DMRT) was employed to separate the means when the findings showed substantial differences.

RESULTS AND DISCUSSION

Impact of Conventional Processing Techniques on the Soybean Proximate Composition

The results of the study on how traditional processing methods affect the proximate composition of soybeans are shown in Table 1. Crude protein contents (%) for samples B, C, D, and the control (sample A) were 23.98, 24.67, 25.07, and 28.44, respectively. The statistics showed that sample A had the lowest protein level and sample D had the highest protein content when compared to the other samples. Sprouting may have increased the crude protein's bioavailability in the soybeans, resulting in Sample D's higher protein level. The significant rise in crude protein in sprouted soybeans could be due to intricate metabolic processes that occur during hydration and sprouting. Enzymes break down the protein component during these processes, producing simple molecules that are used to make new compounds. The total crude protein constituent improved as a result of the sprouting enzymes' higher hydrolytic activity and the elimination of starch (Ramadan, 2012). The higher crude protein concentration in relation to sprouting is especially noteworthy from a nutritional standpoint since it would enhance absorption and digestion. However, the results showed that there is no appreciable change in the levels of protein in samples B and C, even if soaking and dehulling significantly increases the protein content when compared to sample A. Crude fat percentages for samples A, B, C, and D were 26.20, 23.35, 22.43, and 20.51, respectively. The findings showed that crude fat greatly increased in sample A and significantly decreased in sample D (Ragab et al., 2010). The dissociation of lipid complexes and a metabolic process may be the reason of this, but it also indicates that sample A will be more vulnerable to rancidity than the other samples.

Table 1. Proximate Composition of Processed Soybeans Samples (%)

Parameters/ Samples	A	B	C	D
Moisture content	7.23^{c} $\pm$ 0.27	8.43^{bc}$\pm$ 0.07	9.14^{b} $\pm$ 0.63	10.92^{a} $\pm$ 0.29
Ash content	4.76^{c} $\pm$ 0.90	5.27^{b} $\pm$ 0.68	3.83^{d} $\pm$ 0.39	6.75^{a} $\pm$ 0.60
Crude fiber	6.58^{a} $\pm$ 0.38	5.10^{b} $\pm$ 0.30	5.15^{b}$\pm$ 0.17a	4.68^{c} $\pm$ 0.78
Fat content	26.20^{a} $\pm$ 0.75	23.35^{b} $\pm$ 0.83	22.43^{b} $\pm$ 0.90	20.51^{a} $\pm$ 0.69
Crude protein	23.98^{c} $\pm$ 0.97	24.67^{b} $\pm$ 0.10	25.07^{b} $\pm$ 0.63	28.44^{a} $\pm$ 2.50
Carbohydrate	38.48^{c} $\pm$ 0.68	41.61^{b} $\pm$ 0.35	43.52^{a} $\pm$ 0.50b	39.62^{c} $\pm$ 0.71

Values are means of triplicates

Values along the same row followed by different superscripts are significantly different ($p \leq 0.05$).

Where: Sample A: Control, soybeans dried and milled

Sample B: Soybeans soaked for 24h, dried and milled into flour

Sample C: Soybeans soaked for 12h, de-hulled, dried and milled into flour

Sample D: Soybeans sprouted for 120h, dried and milled into flour.

The moisture contents (%) of samples A, B, C, and D were 7.91, 8.43, 9.14, and 10.92, in that order. Despite the fact that samples A and B and B and C do not differ much, the results showed that sample D's moisture content has significantly increased while sample A's has drastically dropped. The results were in line with those of Ramadan (2012), who discovered that raw soybeans (Giza 21 and Giza 35) had respective moisture contents of 6.15 and 7.32. Therefore, compared to the other samples, sample D would be more susceptible to microbial deterioration. The matching ash (%) contents of samples A, B, C, and D were 3.83, 4.76, 5.27, and 6.75, respectively. The results showed that all of the samples varied significantly. Sample D's ash concentration has considerably increased, whilst sample C's is noticeably lower. The substantial effect of sprouting on the bioavailability of soybean minerals is responsible for this, whereas sample B's notable decline might have resulted from de-hulling, since most of the pericarp that constitutes the ash was discovered to have been de-hulled. This, however, is in line with Ramadan (2012), who discovered that soybeans (Giza 21 and Giza 35) had ash contents of 5.80 and 6.80, respectively. The carbohydrate (%) contents of samples A, B, C, and D were 38.48, 41.61, 43.52, and 39.62, respectively. The results showed that sample C had a significantly larger carbohydrate content than sample A, despite the fact that there is no discernible difference between samples A and D.

The impact of conventional processing methods on soybean flour's antinutritional properties

The results of the investigation into how traditional processing methods affect the anti-nutritional properties of soybeans are shown in Table 2. The percentages of phytic acid in samples A, B, C, and D are 8.05, 6.27, 5.58, and 5.45, respectively. The results showed that there were substantial differences among all the samples. Despite being high in sample A, phytic acid dramatically decreased in sample D, while it also decreased significantly in samples B and C. The impact of phytic acid reduction in soybeans may be due to leaching, dehulling, and sprouting. Odumodu (2010) reported higher quantities of phytotic acid in fermented soybeans than this study did. The phytic acid content of soybean seeds and products ranged from 1% to 1.5% of dry mass (Mikic et al., 2009). Additionally, Osman (2007) observed that soaking, boiling, and germination all reduced the phytic acid content.

Values are means of triplicates

Values along the same row followed by different superscripts are significantly different ($p \leq 0.05$)

The tannin concentrations of samples A, B, C, and D were 25.23, 21.55, 19.23, and 20.13 mg/100g, respectively. The results showed that there was a considerable variation in the tannin concentration of the samples. The tannin content of samples B, C, and D significantly decreased. This could be explained by the fact that the tannin concentration was significantly affected by soaking, dehulling, and sprouting. Additionally, the results demonstrated that there was no significant difference in the tannin content between samples C and D, suggesting that the dehulling and sprouting of soybeans had a significant reducing effect. Protease inhibitors in samples A, B, C, and D are 7.09, 6.03, 5.72, and 4.91%, respectively. The results showed a significant difference between all samples. The significant reduction of the protease inhibitor in samples B, C, and D may be attributed in large part to soaking, dehulling, and sprouting.

Table 2. Anti-nutritional Properties of Processed Soybeans Samples

Parameter	A	B	C	D
Phytic Acid (%)	$8.05^{a} \pm 0.87$	$6.27^{b} \pm 0.48$	$5.58^{c} \pm 0.32$	$5.45^{d} \pm 0.72$
Tannin (mg/100g)	$25.23^{a} \pm 0.28$	$21.55^{b} \pm 0.97$	$19.23^{c} \pm 0.20$	$20.13^{c} \pm 0.18$
Protease inhibitor (%)	$7.09^{a} \pm 0.81$	$6.03^{b} \pm 0.26$	$5.72^{c} \pm 0.30$	$4.91^{d} \pm 0.39$

CONCLUSION

Studies have shown how traditional processing methods affect the nutritional and anti-nutritional properties of soybeans. The findings showed that conventional processing significantly increased soybeans' nutritious content while reducing their anti-nutritional traits. Soybeans' protein content rose sharply as a result of being soaked, dehulled, and sprouted, but their fat content sharply dropped. Additionally, there was a significant drop in phytic acid due to sprouting, which inhibits the absorption of nutrients. Soybeans' lipid content was significantly reduced by the soaking, dehulling, and sprouting processes, which may have had a negative effect on rancidity.

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