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Storability of soybean flour and its hazard analysis in Nigeria

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Soybean was procured from a local market in Ilorin, washed, dried, milled, packaged and stored under hermetic conditions using transparent plastic container. Proximate composition was carried out on the samples 4-monthly (once-in -4 months) for a period of one year. Moisture content was determined by air-oven method while proximate composition was carried out by Standard Methods of Association of Official Analytical Chemists (AOAC). Moisture contents ranged between 8.0 and 8.9% within one year of storage, while protein levels reduced to 34.9 from 40.4%. Whereas increasing trend was recorded in ash content during the course of storage with ranging values between 4.9 and 5.4%. No definite trend was observed in fibre composition, however, the final value at the end of 12-month storage was found to be 5.8%. Hazard analysis and critical control points (HACCP) procedures were developed and applied for production of high quality as well as safe soybean flour for both local consumption and export.

Key words: Storage, soybean, soy flour, hazard analysis and critical control points (HACCP), hazard, multipurpose dryer.

INTRODUCTION

Oilseeds are one of the most important underutilized raw materials. According to Pyke (1964), about 32% of all edible fats and oils in the world market are largely derived from vegetable sources like cotton seed, groundnut, coconut and soybean. World soybean production in the 2009/2010 harvest was roughly 260 million tons, and the major producers were the United States, Brazil and Argentina, producing 91.4, 69.0 and 57.0 million tons, respectively (USDA, 2011). Given the significant world production of soybeans, quality is essential for the sectors involved in production and/or processing of this commodity. Quality is an important parameter for commercialization and processing of the grains and can affect the value of the product and its derivatives. Soybean (*Glycine max*) is a legume crop classified as an oilseed and a good source of high quality protein because it contains significant amount of essential amino acids. Its cultivation is becoming more popular with

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farmers in the derived savannah zone of Nigeria and production levels are increasing every year especially now when people are aware of its uses. Good storage management can greatly influence the storability of soybean and subsequent germination when planted in the field as well as other products developed from it. High moisture content and temperature has been reported to increase deterioration and reduce seed viability in storage. Soybean should be stored at a moisture content of 10% or less. At harvest, soybean grains usually contain about 14% moisture. It has been found that soybean can be stored for 6 to 12 months when dried to 13% moisture content, while it can also be stored for longer period when dried to between 10 and 11% moisture content. Open-air drying is the most practical way to protect soybean in storage.

Nutritionally, soybean contains 40.00% crude protein, 19.10% ether extract, 5.71% crude fibre, 5.06% mineral content and 26.05 nitrogen free extract (Oyenuga, 1968). Bates et al. (1977) found that the chemical composition of soybeans changed with the development of the seeds and also reported different chemical composition in vitamins of mature, immature and sprouted vitamins. They found that ascorbic acid and B-carotene decreased with maturity and revealed that the level of B-complex vitamins increased four days after germination, suggesting that sprout could be another nutritious way to consume soybean. The importance of soybean flour in feed formulation and livestock production cannot be overemphasized; this was buttressed by investigations carried out by several authors. Arowora et al. (2004) investigated the utilization of weaner pigs fed soybean and other feed ingredients including biodegraded cassava peel and observed satisfactory growth performance at the end of 8 weeks. Also, Mitaru and Blair (1985) experimented on the comparative effects of dark and yellow rapeseed hulls, soybean hulls and a purified fibre source on growth, feed consumption and digestibility of dietary components in weanling pigs and found that the feed efficiency (gain: feed) values were similar for all dietary treatments with values ranging from 0.53 to 0.57. The market for soybean in Nigeria is growing very fast with opportunities for improving the income of farmers. Currently, SALMA Oil Mills in Kano, Grand Cereals in Jos, ECWA Feeds in Jos, AFCOT Oil Seed Processors, Ngurore, Adamawa State, and PS Mandrides in Kano, all these companies process soybean (Dugje et al., 2009).

In the light of aforementioned, therefore, the objective of this study was to investigate the storability of high quality soybean flour produced in Nigeria with the view of making soybean flour available for its various utilization throughout the year at reasonable prices.

MATERIALS AND METHODS

Soybean was procured from a local market in Ilorin, Kwara State, Nigeria. One batch, divided into three samples was used in this research investigation. The samples were washed and dried using multipurpose dryer (MPD) developed by researchers at Nigerian Stored Products Research Institute (NSPRI). The dried samples were milled and analyzed for proximate composition before packaging in transparent polythene bags with gauge of 0.04 mm and stored under hermetic conditions for one year. Samples were taken for analysis at the end of 4^{th}, 8^{th} and 12^{th} month storage respectively. The three samples were taken as three replicates for analysis. The mean values of 3 replicates with their corresponding standard errors were recorded for analysis. The treatment means of the samples analyzed were subjected to t-test at 5% level of significance using two-tail. Proximate determination of samples was carried out using the standard methods of AOAC (2000). Protein content of *soybean flour* samples was estimated using Microkjeldahl distillation apparatus as per the standard method of AOAC (2000). Crude fat content (triglycerides of fatty acid) of *soyflour* samples was estimated as per the standard method of AOAC (2010) using fat extraction tube of soxhlet apparatus. Ash content was carried out by igniting the sample until only the inorganic residue was left:

$$\text{Ash content} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Crude fibre was determined as that fraction remaining after digestion with standard solutions of sulphuric acid and sodium hydroxide under carefully controlled conditions.

$$\% \text{ crude fibre in sample} = \frac{Mr - Ma}{Ms}$$

Mr = Mass (g) of crucible + dried residue; Ma = Mass (g) of crucible + ash; Ms = Mass (g) of sample taken

Hazard analysis was developed and applied in the production of safe soybean flour.

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of soybean flour. The results indicated that moisture reduction of samples were still within safe moisture level. Moisture content (MC) represents the amount of extrinsic water in the samples analyzed. There was a decreasing trend in MC values obtained during the course of storage. This decrease was significantly lower ($P<0.05$) when the final value of treatment mean was compared with the initial of 8.9±1.0%. The decreasing trend observed is similar to the work of Mejule and Lameke (1982) who reported moisture reduction of 0.31% during the course of storage of cocoa beans. Similar result in moisture reduction of 0.30% was obtained by Opadokun and sowunmi (1985) who worked on storability and quality of maize and sorghum stored in metal silos for four years. Gradual reduction was observed in protein levels during the course of storage. The crude protein of freshly dried soybean flour was found to be 40.4±0.4%, while reduction at the end of 12-month storage was found to be 34.9±0.1%. This decreasing trend was found to be significant ($P<0.05$). This observation is similar to the results obtained by Opadokun and Sowunmi (1985) who

Table 1. Proximate composition of soybean flour in storage.

Parameters	Mean values (before storage)	Mean values (4-month storage)	Mean values (8-month storage)	Mean values (12-month storage)
Crude protein (%)	40.4±0.4	38.3±0.3	37.3±0.1	34.9±0.1
Crude fibre (%)	5.3±0.1	6.1±0.2	5.6±0.1	5.8±0.1
Ash (%)	4.9±0.1	5.1±0.1	5.3±0.1	5.4±0.1
Ether extract (%)	21.6±1.3	14.6±0.4	13.4±0.8	13.8±0.1
N.F.E. (%)	27.3±0.2	35.8±1.4	38.8±1.6	40.5±1.7
M.C. (%)	8.9±1.0	8.3±0.9	8.2±0.9	8.0±1.0

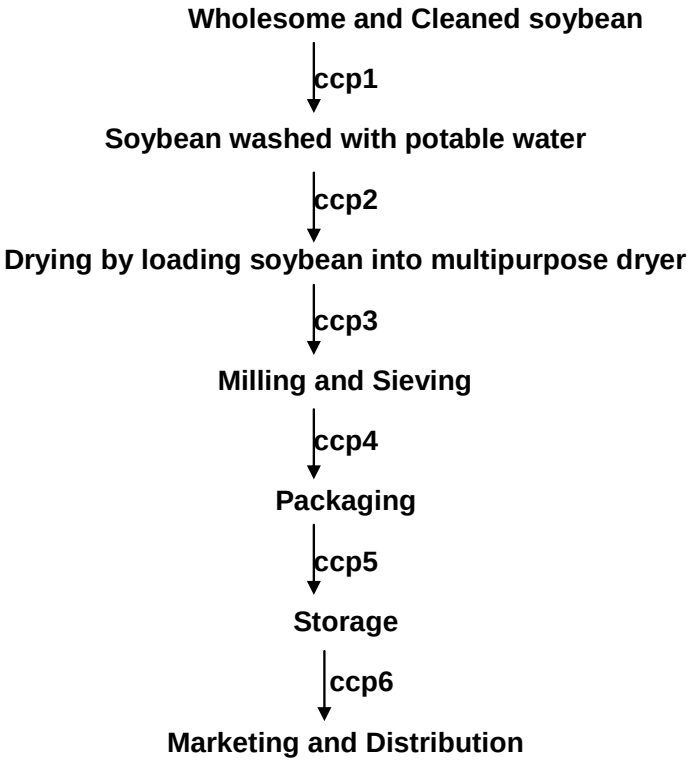

Figure 1. Flow chart for production of soybean flour**.**

found reduction of 0.3% in the crude protein of maize stored in silos at the end of 12 months. These authors also found reduction of 0.9% in crude protein of sorghum stored in silos at the end of three years.

There was no definite trend in fibre composition in storage. Fibre was observed to range between 5.3 ± 0.1 and 6.1±0.2% during the course of one year storage. This trend was not significant (P>0.0.05) when the treatment means of the initial and final fibre content were compared. It was observed that the crude fibre composition of soybean flour sample in this study was higher than that of yellow maize and guinea corn which were found to be between 1.32 and 2.94% respectively (Oyenuga, 1968). The total minerals composition (ash) in this study was found to increase from 4.9 to 5.4% in storage. However, this increase was not significant (P>0.05) between the initial and final values of minerals content. This was in agreement with the results obtained by Opadokun and Sowunmi (1985) that had range between 2.1 and 3.1% during the course of storage of sorghum in metal silos for one year. Ether extract was found to be decreasing generally during the course of storage. Although the lowest value was obtained from samples stored for 8 months with the value of 13.4 ± 0.1% , it was found that this decrease was significantly lower (P<0.05) when compared the initial and final values of ether extract obtained.

Nitrogen free extract (NFE), this simply refers to the carbohydrate composition of the samples analyzed. There was increase in the trend of NFE values obtained during the course of storage. This increase was significant (P<0.05) when compared the treatment means of initial and final NFE values obtained in storage.

Hazard analysis and critical control points (HACCP) was applied to control and reduce the hazards to acceptable levels thereby producing safe soybean flour for human consumption as follows: Wholesome and clean soybean was procured from a local market in Ilorin and transported to the laboratory using transparent, cleaned and covered plastic, (CCP_1) was uncontaminated soybean (Figure 1). Cleaned soybean samples were washed with potable water in order to eliminate microbial hazard and extraneous materials (CCP_2). Washed soybean samples were loaded into the multipurpose dryer (MPD). At this stage, good handling practices were employed in order to eliminate body contamination and pathogens (CCP_3). The milling of dehydrated soybean was carried out using stainless steel hammer mill and stainless sieves which were sterilized (CCP_4). The soybean flour samples were packaged in food grade polythene which conformed with standard specification with gauge of 0.04 mm. This would eliminate leakage and microbial contamination (CCP_5). The packaged soybean flour were stored under hermetic conditions until sold. This would eliminate moisture migration, caking, mouldiness and mycotoxin contamination during the course of storage (CCP_6). The soybean flour sold to the market were monitored until sold completely. The vehicle used for its transportation was thoroughly cleaned to

avoid contamination.

Conclusion

The results of this study showed that soybean flour produced was highly nutritious and can be stored without adverse effects on its qualities for one year in transparent polythene bags under hermetic conditions. The final protein level of 34.9% is high enough to justify its consumption at the end of one year. Hence it is still safe for local consumption and export within one year of production.

Conflict of Interest

The authors have not declared any conflict of interest.

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