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Full Length Research Paper

Effect of drying methods on the physico-chemical properties of soyflour

Famurewa, J. A. V.[1] and Raji, A. O.[2]

[1]Department of Food Science and Technology, P. M. B. 704, Federal University of Technology, Akure, Nigeria.
[2]Department of Agriculture and Environmental Engineering, University of Ibadan, Ibadan, Nigeria.

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This study investigated the relationship between the drying methods and the physicochemical properties of soybean during drying prior to converting it into flour. Three samples were prepared for each of Tax 1485 and mixed varieties. A sample for each variety was subjected to a drying method. The three drying methods used are roasting, oven and sun drying. The dried samples were converted to flour in attrition mill. Supplemented breads (5% soy + 95% wheat) were prepared from the flour for organoleptic evaluation; proximate analysis was also carried on the flour samples. The analyses were replicated thrice. The result of this study showed that oven drying method has highest acceptability levels when compared to the other two methods in both Tax 1485 and mixed variety; showing 58 and 64%, respectively. It was also established that oven drying method retained highest protein content of 40.54 and 33.7% for Tax 1485 and mixed variety, respectively, though there was no significant difference in the protein values. The results show that drying for a long period (as observed in sun drying) and with high temperature (as observed in roasting), to achieve safe moisture content, will defeat the purpose of using soy flour as supplement due to a significant reduction in the protein content and acceptability. Moderately high temperature of 60°C in oven as being investigated is therefore recommended.

Key words: Roasting, boiling, oven drying, sun drying, quality.

INTRODUCTION

Osho and Dashiell (1995) reported that across the continent of Africa, protein energy malnutrition affects 40% of children under three years with 5% of the children classified as severely malnourished. The low protein intake has been attributed to the increasingly high cost of traditional sources of animal protein (Osho, 2003). The search for alternative sources of inexpensive protein has led to increased soybean utilization for household consumption and industrial processing in Nigeria.

According to Osho and Dashiell (1995), soybean is now internationally acclaimed as the miracle crop, the cow of China, the Cinderella crop of West and the pearls of the orient, all because of its versatility; its production and utilization is on the increase in Nigeria. This has been made possible by the successful development of improved soybean varieties that can grow well in Nigeria by International Institutes of Tropical Agriculture (IITA) and other Nigerian Institutions. It is mainly cultivated for its seeds, used commercially as human food and live-stock feed, and for the extraction of oil. The oil is produced almost entirely for human consumption, while the meal is mainly used as animal feed. Only a small portion of defatted meal is made into soy protein products by modern processing technology; and these processed products are not consumed directly but incorporated as ingredient into various types of western food (Liu, 2000; Katz, 1998; Salunkhe et al., 1992).

Protein and oil make up about 60% of the soybean, and about one third consists of carbohydrates, including polysaccharides, stachyose (3.8%), raffinose (1.1%) and sucrose (5.0%) There is an inverse relationship between protein and oil contents; thus cultivars possessing higher protein have lower oil contents (Hammond et al., 1993).

*corresponding authors E-mail: famurewajav@yahoo.com

Abbreviations: BOS, Boiled and open sundried sample; **BOD,** boiled and oven dried sample; **ROA,** roasted sample.

Table 1. Inhibitors and their biological responses in man and animals.

Substance	Biological response
Trypsin inhibitors	Increased synthesis and secretion of pancreatic enzymes, particularly hypertrophy and inhibition of growth.
Haemaglutinins	Agglutination of red blood cells.
Estrogens	Inhibition of growth and increased uterine weight
Allergen	Allergen and asthma
Raffinose and stachyose	Flatulence

Source: Salunkhe et al. (1992).

Seeds of soybean do not contain starch (Fukushima, 1991; Katz, 1998). Therefore, most of the studies on soybean carbohydrates are mainly restricted to sugars. Prominent sugars of soybean include sucrose, raffinose, stachyose and verbascose. Phosphatides, sterols and other constituents are also present as minor constituents. Present in soybean are factors that can interfere with the utilization of its protein (Liener, 1994). There are many of these factors that are inactivated by heat (heat labile) which include the protease inhibitors, lectins and goitrogens. A summary of the role of these inhibitors in the physiological reactions in man and animal is shown in Table 1.

Soybean is generally acceptable when converted to flour from which other forms of products are prepared (Famurewa and Folorunso, 2005). Conversion to flour accompanied by heat treatments are necessary because some factors that make soybean unpopular are eliminated; such as the beany flavour, long processing time and difficulty in cooking the raw bean (Famurewa and Raji, 2005). The most commonly used traditional drying methods include sun drying, oven drying and roasting. Each drying method has effect on the vitamin content and other nutritional composition of soybean depending on the intensity of the heat, duration of drying and exposure to environmental contamination (Perilla et al., 1997). Hence, there is the need to evaluate the interdependence of nutrient composition, physical properties and drying methods. This is expected to help in product formulation and would go a long way in ensuring that the desired nutrient is not lost through indiscriminate drying process.

MATERIALS AND METHODS

Sources of soybean samples

Soybeans (Glycine max) (Tax 1485) were obtained from the International Institute for Tropical Agriculture (IITA) in Ibadan and the mixed variety from Akure main market.

Drying methods of samples

6 kg of soybean sample having 12% initial moisture content was divided into 3 portions. Each sample was subjected to a drying method. The procedures for each of the samples are as follows:

Boiled and open sundried sample (BOS)

Boiling was done for 30 min (Muller, 1988), drained and sun dried in the open air for four days, to a constant weight.

Boiled and oven dried sample (BOD)

Boiling was done for 30 min, drained and oven dried at a temperature of 60°C for 13 h (Edem et al., 2001) to a constant weight.

Roasted sample (ROA)

Roasting was done on temperature controlled hot plate set at 105°C for 50 min (Famurewa and Raji, 2005), to a constant weight.

Milling of soy samples

Each of the treated samples was milled to flour with an attrition mill driven by a 5 horse power electric motor. The plate mill has burrs of 300 mm diameter, splined at 25° to the horizontal and a variable screw conveyor of 12 mm pitch length. The milling was done at gap set of 0.6 mm (Famurewa, 1998) through only one milling run.

Analyses of the samples

Two analyses, chemical and organoleptic evaluation, were carried out on each of the samples to determine the protein content and general acceptability of each.

Organoleptic evaluation

Soy/wheat flour of 5% soy flour inclusion and 95% wheat flour from each sample was used to prepare bread. Seven points hedonic scale was then used with 10 trained panelists testing the bread for taste, aroma, appearance crust, crumb and overall acceptability. Acceptability ranges from 1 (dislike very much) to 7 (like very much). 100% wheat flour bread was also presented as the control.

Chemical analysis

This involved the determination of the proximate composition on each sample based on the standard of AOAC (1990). Average of 3 replications was used.

Table 2. Result of organoleptic evaluation of soy\wheat bread from undehulled Tax 1485 soybean samples subjected to different thermal treatments.

Sample	Overall acceptability (%)	Appearance (%)	Taste (%)	Aroma (%)	Crust texture (%)	Crumb texture (%)
Roasting	36.0^{a}	41.0^{a}	36.0^{a}	36.0^{a}	37.0^{a}	32.0^{a}
Boil and oven dry	58.0^{c}	55.0^{b}	53.0^{c}	58.0^{c}	47.0^{b}	43.0^{b}
Boil and sun dry	48.0^{b}	44.0^{a}	47.0^{b}	40.0^{b}	37.0^{a}	40.0^{b}

Values are means of three replicates; values in a column denoted by different letters differ significantly at $p < 0.05$.

Table 3. Organoleptic evaluation of soy\wheat bread from undehulled market soybean with different thermal treatments.

Treatment	Acceptability (%)	Taste (%)	Aroma (%)	Appearance (%)	Crust (%)	Crumb (%)
Roasting	48.00^{b}	55.63^{b}	40.67^{a}	48.14^{a}	58.35^{a}	53.24^{a}
Boil and oven dry	64.00^{a}	58.24^{b}	54.17^{b}	50.73^{ab}	63.41^{b}	58.41^{ab}
Boil and sun dry	60.00^{a}	47.32^{a}	43.21^{a}	49.25^{a}	65.43^{b}	64.13^{b}

Values are means of three replicates; values in a column denoted by different letters differ significantly at $p < 0.05$.

Table 4. Result of proximate analysis of undehulled Tax 1485 soybean samples subjected to different thermal treatment tests.

Sample	Protein (%)	Ash (%)	Fat (%)	Fibre (%)	Carbohydrate (%)
Roasting	40.096^{a}	9.575^{b}	21.012^{b}	9.380^{c}	19.937^{a}
Boil and oven dry	40.544^{a}	8.496^{a}	18.787^{a}	7.631^{b}	24.842^{b}
Boil and sun dry	40.256^{a}	8.800^{a}	19.817^{ab}	6.623^{a}	25.504^{b}

Values are means of three replicates; values in a column denoted by different letters differ significantly at $p < 0.05$.

Statistical analysis

The data was subjected to analysis of variance (ANOVA) and the means were separated using Duncan's multiple range test using Statistical Packages for Social Sciences (SPSS) version 10.0 computer software (Duncan, 1955)

RESULTS AND DISCUSSION

Effects on sensory qualities

The result of sensory characteristics of wheat breads supplemented with undehulled and undefatted Tax 1485 soybean flour (5% soy/95% wheat flour), subjected to different drying methods is presented in Table 2. Roasted sample has the least value of all the sensory characteristics, while BOD sample is the best in terms of acceptance with an overall acceptability of 58%, which is significantly different from other two methods; BOS (48%) and ROA (36%). As presented in Table 3, also in mixed variety, ROA has least acceptability (48.0%), while BOD has highest (64%), though not significantly different from BOS (60.0%). In both Tax 1485 and mixed variety, BOD samples are most accepted, while ROA samples are least accepted

The possible reason for low acceptability of ROA sample, compared to BSD and BOD, is that roasting will reduce the fibrous nature of the seed coats, therefore making more quantity of the coat to be reduced to flour size. The presence of appreciable quantity of bran in the bulk will change the colour, making it less attractive in appearance, thereby causing reduced acceptability (Famurewa and Raji, 2005).

Effect of processing on proximate composition

The result of proximate analyses (moisture free basis) on Tax 1485 and mixed variety are presented in Tables 4 and 5. In Tax 1485, ROA sample has highest fibre (9.4%) and ash content (9.6%). On the other hand, it has the least protein (40.10%), but this is not significantly different from others. BSD sample has least carbohydrate content (25.5%). BOD method retained highest protein (40.54%), though not significantly different from others. In mixed variety, BOD though retained highest protein content (33.70%), was not significantly different from others. BOD retaining highest protein in both Tax 1485 and mixed variety could be attributed to the combination of the moderately high temperature and duration of drying. According to Chitale and Itapu (2003), a moderately high temperature short time process results in consider-

Table 5. Proximate analysis of flour from undehulled soybean (market source) with different thermal treatments.

Treatment	Protein (%)	Ash (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
Roasting	32.70[b]	11.83[a]	22.69$_a$	9.73[a]	23.40[c]
Boil and oven dry	33.70[ab]	10.49[b]	20.41[b]	8.23[b]	26.67[b]
Boil and sun dry	32.77[b]	10.24[b]	19.38[b]	8.62[b]	28.99[a]

Values are means of three replicates; values in a column denoted by different letters differ significantly at $p < 0.05$.

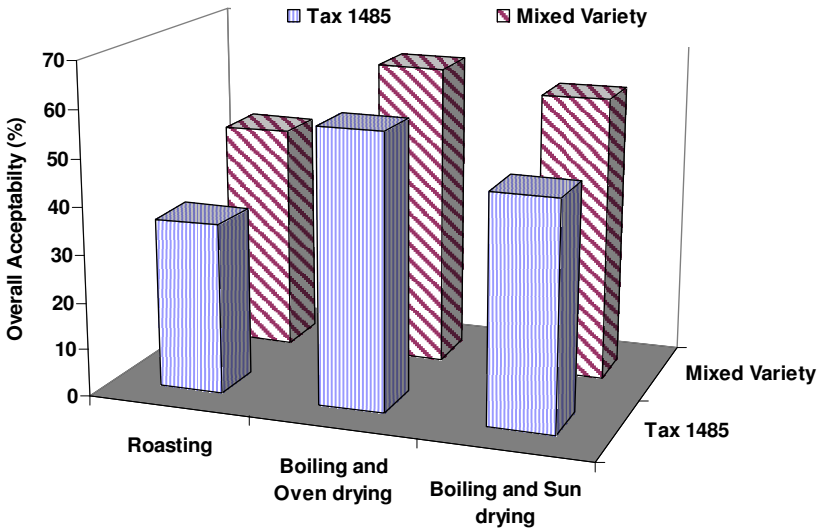

Figure 1. Overall acceptability of the samples.

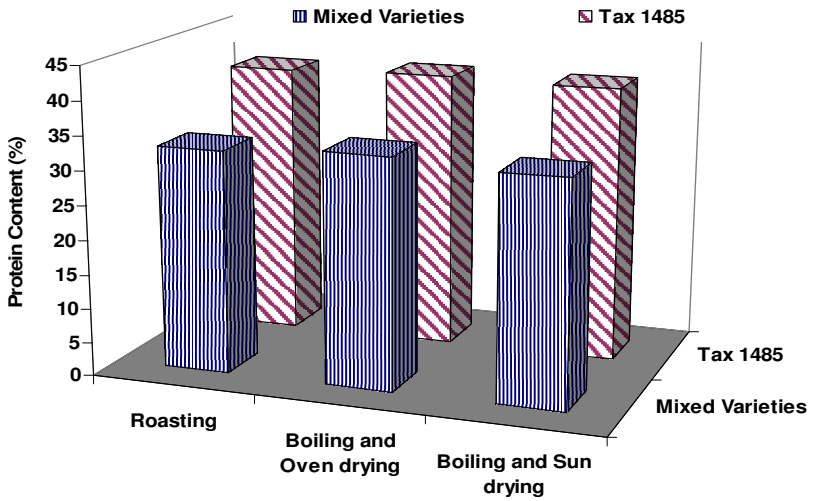

Figure 2. Protein content of samples.

able retention of nutrients like B complex, vitamins and certain minerals like calcium, iron and zinc. Contrarily, a very high temperature is the possible reason for low protein retention of roasting method. Roasting (at 105°C) is a high temperature process compared to oven drying (at 60°C). This leads to denaturation of protein and maillard reaction. Figures 1 and 2 show that the studied parameters are functions of variety. Both Tax 1485 and

mixed variety have different proximate composition and acceptability values when subjected to the same drying method, while Tables 2-5 show that they also depend on drying method because the same sample was sub-jected to different drying methods have different values. BOD on the average yielded better results on the qualities.

Conclusion

It can thus be concluded from the results of this study that moderate high temperature oven drying will produce soy-flour of high acceptability and retained protein among the commonly used drying methods, that is, boiling for 30 min and oven drying at 60°C until equilibrium moisture content is reached.

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