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# Effects of Drying Methods on the Physico-Chemical Properties of Soyflour

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**Abstract:** This study investigated the relationship between the drying methods and the physicochemical properties of soybean during drying in the process of 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 flours for organoleptic evaluation and proximate analysis. The analyses were replicated three times. The results of this study showed that Oven drying method had highest acceptability compared to the other two methods (Boil and ovendrying, 58%, Boil and Sundrying,48% and Roasting 36% for Tax 1485 and 64, 60 and 48%, respectively for the mixed variety. It was also established that Oven drying method retained highest protein content of 40.54% compared with 40.25 and 40.09%, respectively for sundrying and roasting, respectively. This however did not show any significant ($p<0.05$) difference. The results showed 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 their acceptability. Moderately high temperature of 60°C using oven as being investigated is therefore recommended.

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

## INTRODUCTION

Osho and Dashiell[1] 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[2]. 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[1] 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 which 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 livestock feed and for the extraction of its 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 converted 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[3-5].

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[6].

Seeds of soybean do not contain starch[4,7]. 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[8]. There are many of those factors that are inactivated by heat (heat labile) which include the protease inhibitors, lectins and goitrogens.

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

| Substance | Biological responses |
|---|---|
| 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, increased uterine weight |
| Allergen | Allergen and asthma |
| Raffinose and stachyose | Flatulence |

Source: Salunkhe[5]

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[9]. 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[10]. 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[11]. 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 (TAX 1485 and mixed variety):** Soybeans (*Glycine max*) (Tax 1485) were obtained from International Institute for Tropical Agriculture (IITA) in Ibadan and the mixed variety from Akure main market.

**Drying methods samples:** Six kilogram each of soybean samples having 12% initial moisture content were divided into 3 portions. Each sample was subjected to a drying method. The procedures for each of the samples are as follows:

**Sundried sample (BSD):** Boiling was done for 30 min[12], drained and sun dried for four days, to a constant weight.

**Ovendried sample (BOD):** Boiling was done for 30 min, drained and oven dried at a temperature of 60°C for 13 h[13], to a constant weight.

**Roasted sample (ROA):** Roasting was done on temperature controlled hot plate set as 105°C for 50 min[10], 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, 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). Hundred percent 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[14]. Average of three (3) determinations were used.

## 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

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

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

Values in the same column for each treatment 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 | Overall acceptability (%) | Appearance (%) | Taste (%) | Aroma (%) | Crust texture (%) | Crumb texture (%) |
|---|---|---|---|---|---|---|
| Roasting | 48.00b | 55.63 | 40.67 | 48.14 | 58.35 | 53.24 |
| Boil and oven dry | 64.00a | 58.24 | 54.17 | 50.73 | 63.41 | 58.41 |
| Boil and sun dry | 60.00a | 47.32 | 43.21 | 49.25 | 65.43 | 64.13 |

Values in the same column for each treatment 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

| Samples | Protein (%) | Ash (%) | Fat (%) | Fibre (%) | Carbohydrate (%) |
|---|---|---|---|---|---|
| Roasting | 40.096a | 9.575 | 21.012 | 9.380 | 19.937 |
| Boil and oven dry | 40.544a | 8.496 | 18.787 | 7.631 | 24.842 |
| Boil and sun dry | 40.256a | 8.800 | 19.817 | 6.623 | 25.504 |

Values in the same column for each treatment are means of three replicates
Values in a column denoted by different letters differ significantly at $p<0.05$

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

| Treatment | Protein (%) | Ash (%) | Fat (%) | Fiber (%) | CHO (%) |
|---|---|---|---|---|---|
| Roasting | 32.70$^{b}$ | 11.83 | 22.69 | 9.73 | 23.40 |
| Boil and oven dry | 33.70$^{ab}$ | 10.49 | 20.41 | 8.23 | 26.67 |
| Boil and sun dry | 32.77$^{b}$ | 10.24 | 19.38 | 8.62 | 28.99 |

CHO: Carbohydrate
Values in the same column for each treatment are means of three replicates
Values in a column denoted by different letters differ significantly at $p<0.05$

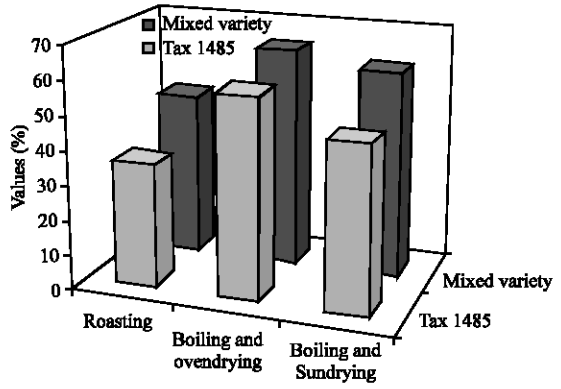


Fig. 1: Overall acceptabilities of the samples

methods is presented in Table 2. Roasted sample had 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 to the other two methods; BSD 48% and ROA 36%. As presented in Table 3, also in mixed variety, ROA also had the least acceptability 48.0% while BOD had the highest 64%, though not significantly different from BSD(60.0%. In both Tax 1485 and mixed variety, BOD samples were the most accepted samples while ROA samples were the least accepted.

The possible reason for low acceptability of ROA sample, compared to BSD and BOD, is that roasting reduces 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[10].

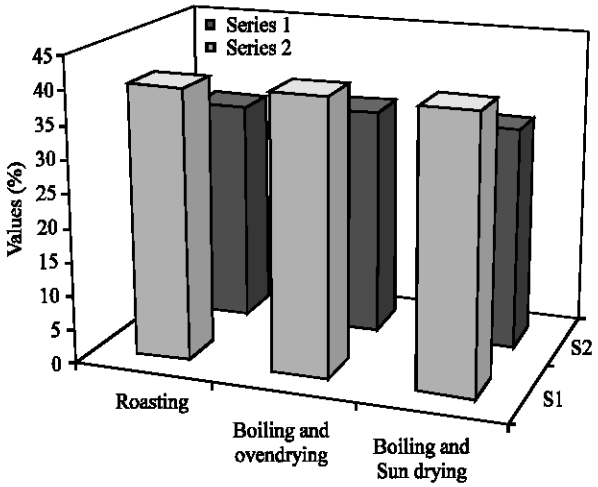


Fig. 2: Protein contents of samples

**Effect of processing on proximate composition:** The result of proximate analyses (moisture free basis) on Tax 1485 and the mixed variety are presented in Table 4 and 5. In Tax 1485, ROA sample had the 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 the others. BSD sample had the 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%, it is also not significantly different from the others. BOD retaining the 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[15] , a moderately high temperature short time process results in considerable retention of nutrients like B complex, vitamins and certain minerals like calcium, iron and zinc. Contrarily, a very high temperature is the possible reason responsible for low protein retention of the roasting method. Roasting at 105°C is a high temperature process compared to oven drying at 60°C. This possibly leads to denaturation of the protein and maillard reaction.

Figure 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 (Table 2-5) also showed that they also depend on drying method because the same sample subjected to different drying methods gave 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 of soybean will produce soy-flour of high acceptability and retained its protein among the commonly used drying methods. Boiling and Oven Drying method; boil for 30 min[12] and oven dry at 60°C until equilibrum moisture content is reached. This duration and level of heat treatment, exterminate the anti-nutritional factors, without the problem of under or over cooking.

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