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Effects of processing methods on proximate compositions and organoleptic properties of soybean curd (*Awara*) refined in Zamfara, Northern Nigeria

Ahmad Abdulkadir[1], Abdulrahman Ibrahim tudu[2], Abdulaziz Umar Kurya[3*], Dinesh C Sharma[4]
[1] Department of Biochemistry, Usmanu Danfodiyo University Sokoto, Nigeria
[2] Department of Biochemistry, Federal University Gusau, Nigeria
[3, 4] School of life and Allied Health Sciences, Glocal University Saharanpur, Uttar Pradesh, India

Abstract
In Northern Nigeria, *Awara* a coagulated product of soymilk that can be produced at the domestic level is transformed using several processing methods before consumption. This study aimed to assess the effect of different processing methods on the proximate compositions and organoleptic properties of *Awara*. A Fresh molds of *Awara* were cut into desired sizes and dried under air and sun, the proximate compositions determined are Moisture, crude protein, fats, carbohydrates, crude fiber, and ash, which were found on fried *Awara* as 24.16±3.7, 6.89±0.05, 7.33±0.3, 27.35±3.2, 4.83±0.3 and 4.67±0.6 respectively, while fried air-dried *Awara* has 4.33±0.2, 4.57±0.1, 6.17±0.5, 24.93±2.6, 5.17±0.3 and 4.00±0.6 respectively, and fried sundried *Awara* has 3.03±0.2, 4.89±0.1, 7.17±0.5, 20.61±0.9, 5.83±0.3 and 3.90±0.1 respectively. The Antinutritional content analyzed are Oxalate, phytate and tannins which were found on fried *Awara* as 0.07±0.003, 23.98±0.9 and 10.42±0.8 respectively, while fried air-dried *AWARA* has 0.04±0.003, 21.38±0.5 and 12.04±0.4 respectively, and fried sundried *Awara* has 0.02±0.002, 9.58±1.2 and 7.11±0.3 respectively. The results obtained in the current study suggest that fried *Awara* contains substantial amounts of macronutrients than the air-dried and sundried *Awara* hence it is more of nutritional, therapeutic relevance and essential for survival and well-being of individuals.

Keywords: soymilk, macronutrients, antinutrients, processing, and *Awara*

1. Introduction
Nutrition is the field of science that interprets the interaction of nutrients and other substances in foods with relation to health and disease of an organism; it includes food intake, absorption, assimilation, catabolism, and excretion [1, 2]. As society became industrialized, a wide range of resources became available, but food remained the prime need for every individual [3]. Most of the global foods are obtained from plants product, while some foods are directly obtained from animals interestingly, even the animals that are used as a food source were grown by feeding on plant-sourced foods since they contained the nutrients essential for growth and development [4]. Food processing is the transformation of agricultural products into food or one of its forms ready for consumption. The extremely varied modern diets are only truly possible on a wide scale because of food processing and the act of processing can often improve the taste of food significantly [5]. Drying has been anciently used as a method of preservation of foods. Drying inhibits the growth of microorganisms by removing the water through evaporation (air drying, sun drying, smoking, of wind drying) [6]. Soybean plant has been cultivated and used as a food supplement because of its high content of macronutrient that are essential for the well-being of an individual, soybean curd is one kind of traditional snacks which contains a high-quality protein that can be easily digested and absorbed [7, 8]. Incorporating soybean curd into a western diet could be an important means of preventing and treating many chronic diseases, such as cancer and cardiovascular diseases as supported by epidemiological studies [9]. The ratio of polyunsaturated to saturated fatty acids of soybean curd is higher than cheese which renders it nutritionally acceptable [10]. In the northern part of Nigeria, Soybean curd (*Awara*) is regarded among the best local snack food that is processed using different methods to suit the choices of consumers, this makes the products widely accepted as casual cheese snacks by a large percentage of the population. The main contributing factor to the wellbeing of an individual is the maintenance of a balanced diet; the term malnutrition is multifaceted which can be directed to insufficient, excessive, or imbalanced consumption of nutrients by an organism. In developed countries, malnutrition is often associated with nutritional imbalances or excessive consumption, while in developing countries, malnutrition is more likely to be caused by poor access to a range of nutritious foods or inadequate knowledge, and hence the body will be deficient of calories, protein, carbohydrates, vitamins or minerals. A prolonged state of malnutrition result in "severe malnutrition" or "severe undernutrition" specifically known as Protein-Energy Malnutrition (PEM) is often associated with micronutrient deficiency [11]. Two forms of PEM are kwashiorkor and marasmus, which commonly result due to inadequate intake of protein [12]. Because soybean curd contributes diversely in curving the menace of malnutrition and other diseases related to inadequate intake of proteins this research paper aims to elucidate the nutritional compositions, levels of Antinutritional factors and effects of different processing methods on these factors [13].

2. Materials and Methods

Chemicals and Reagents: All the Chemicals and Reagents for the study were of analytical grade and purchased from authorized scientific supplier.

Sample collection: The dried soybean samples were purchased from Zamfara central market and transported to Sokoto and kept in the departmental laboratory, Usmanu Danfodiyo University, Sokoto before preparations.

Preparation of soybean curd (*AWARA*): Soybean seed (8.0kg) was cleaned, sorted, and washed with clean water and left for soaking in water for six hours. The soaked soybeans were drained, washed with water, and hulled using mortar and pestle. Grinding took place immediately after the beans were cleaned. 3 liters of water were added to obtain slurry which was mixed with a small amount of water and then filtered using a muslin cloth to extract the soymilk and leaves the residue. To further extract the soymilk, the residue was mixed with water again and filtered. The soy extract was subjected to boiling at about 98ºC with constant stirring for about 20mins. Effluent from previously prepared *Awara* was left to ferment and then used as a coagulant. A 3ltrs of coagulant was added to the boiling soymilk and allowed to curdle until the whey separated visibly from the curd. The mixture (curd & whey) was then poured into a clean porous cloth and pressed by application of pressure to separate the whey from the curd thereby forming a soybean curd (*AWARA*). The soybean curd (*Awara*) was then cut into desired sizes and shapes whereby some portions were fried in hot vegetable oil, while some portions were dried under sun and air to form dried pellets and then fried in hot vegetable oil [14].

Determination of Proximate Chemical Composition

Proximate compositions of the samples were determined using the standard analytical techniques. Moisture content was determined by transferring exactly 5g of the fresh sample (in triplicate) into a dried, weighed flat crucible to a constant weight, in a hot air oven at 100ºC. Crude protein, crude lipids, crude fiber, and ash were all determined using the recommended methods of the Association of Official Analytical. Chemists (AOAC, 1999). The carbohydrates content of the samples was determined by the difference obtained after subtracting the crude protein, crude lipid, fiber and ash contents from 100% total dry weight [15].

Quantitative Analysis of Antinutritional factors

Antinutritional factors such as oxalate, phytic acid, and tannin were determined by the procedures described by Young and Greaves (1940) and Day and Underwood (1986) respectively [16].

4. Results and Discussion

Table 1: Proximate compositions of *Awara* produced using different processing methods

Parameter (%)	FUA (control)	FA	FAD	FSD
Moisture	29.75±0.07^{a}	24.16±3.7^{b}	4.33±0.2^{c}	3.03±0.2^{ab}
Crude protein	7.18±0.3^{a}	6.89±0.05^{b}	4.57±0.1^{c}	4.89±0.1^{c}
Fats	5.03±0.05^{a}	7.33±0.3^{ab}	6.17±0.5^{b}	7.17±0.5^{ab}
Carbohydrate	28.97±0.6^{a}	27.35±3.2^{b}	24.93±2.6^{c}	20.61±0.9^{d}
Crude fiber	6.23±0.3^{a}	4.83±0.3^{b}	5.17±0.3^{ab}	5.83±0.3^{ab}
Ash	4.83±0.3^{ab}	4.67±0.6^{ab}	4.00±0.6^{ab}	3.90±0.1^{a}

Values are expressed as mean ± STD (n=3). All values with different superscript on the same row are significantly different at $P < 0.05$ when compared with the control group (one-way ANOVA followed by Dunnett comparison test). The yield of cheese was found to be 62.5% and 37.5% goes as residue.

Key: FUA= Fresh undried*Awara*, FA= Fried *Awara*, FAD= Fried air-dried *Awara* and FSD= Fried sun-dried *Awara*.

Soybean products are a good source of proteins, carbohydrates, low in fats, and rich in mineral contents. The incorporation of soybean food such as Awara into the diet could be an important means of preventing and treating chronic nutrients deficiency diseases (Obo and Omotosho, 2005). In this study, the yield of *Awara* was found to be 62.5% which was in agreement to (60.75-66.25%) reported by Shokumbi *et al*., (2011), this may be due to production methods used. The processing methods used were observed to have a significant impact on the proximate compositions as shown in table 1 above. The moisture contents reduced drastically from 29.75±0.07 to 4.17±0.2 which is evident that all the processed samples have lower moisture contents than the control (29.75±0.07). Besides, subjecting the sample to sun-drying method leads to further decrease of the moisture content (3.03±0.2) which is almost equal to (4.30± 1.04) reported by Yakubu and Amuzat (2012), this could be a result of exposure of the samples to heat while drying as well as frying. It was observed that the total moisture content of the fried sun-dried sample was found below, (3%) on the other hand, within the range of water activity (0.6) that does not support microbial growth, this is beneficial in increasing the shelf life of *Awara*. The limiting value of water activity for the growth of any microorganism is about 0.6, and below this, the spoilage of foods is non-microbial, rather it may be due to other factors like a chemical reaction. The crude protein was found to be high in the fresh sample (control), having (7.18±0.3) which is however low compared to that reported by Yakubu and Amuzat (2012), while fried air-dried and sun-dried sample has (4.57±0.1) and (4.89±0.1) respectively, which might be a reflection of high-temperature effect in disrupting the 3D structure of the protein. Besides, the fried sample has the highest fat contents (7.33±0.3) while the fresh (control) has the least (5.3±0.3), which is contrary to (31.81%) obtained by Maijalo *et al*., (2016), and maybe due to low solubility of fats in water, however, fried air-dried and fried sun-dried sample has (6.17±0.5) and (7.17±0.5) respectively, higher than (2.75%) reported by Oladapo and Jadesimi (2013), which might be due to fact that heat aids extraction of oil.

The carbohydrates contents are found to be 28.97±0.6, 27.35±3.2, 24.93±2.6, and 20.61±0.9 for fresh (control), fried, fried air-dried, and fried sun-dried respectively. The values for the fresh and fried samples are consistent with (28.26±2.66 and 27.40± 2.62) reported by Yakubu and Amuzat (2012). Most carbohydrates found in soybean are oligosaccharides including raffinose and stachyose which are causative factors for flatulence and an uncomfortable feeling rarely experienced upon the ingestion of soybean products. Unfortunately, these carbohydrates are not effectively destroyed by the heat process.

The ash contents of the fresh (control) was found to be highest (4.83±0.3) followed by (4.67±0.6), (4.00± 0.6), and (3.90± 0.1) of the fried, fried air-dried, and fried sun-dried respectively. It is apparent that there is a significant

difference between the samples, although the values are higher than those reported by Maijalo *et al.,* (2016), the fried sun-dried sample has ash contents (3.90± 0.1) which is consistent with (3.60±60) reported by Yakubu and Amuzat (2012).

Dietary fibers are complex carbohydrates that cannot be digested by human digestive enzymes but are essential for the maintenance of normal functioning of the gut. There was a significant difference in the results obtained for crude fiber where the percentage was found to be decreasing as the processing method was adopted. However, the processed samples have values higher than (0.2±0.2 and 0.6±0.2) obtained by Yusuf and Ali (2013).

Table 2: Effect of processing methods on Antinutritional factor content in *Awara*

Samples	Oxalate (mg/g)	Phytate (mg/g)	Tannins (mg/g)
UFA (control)	0.09±0.003[a]	26.62±1.1[a]	10.42±0.5 [a]
FA	0.07±0.003[b]	23.98±0.9[b]	10.42±0.8 [a]
FAD	0.04±0.003[c]	21.38±0.5[c]	12.04±0.4[b]
FSD	0.02±0.002[d]	9.58±1.2[d]	7.11±0.3[c]

Values are expressed as mean ± STD. Values with different superscript on the same column are significantly different at P<0.05.

Key: UFA= Unfried*Awara*, FA= Fried *Awara*, FAD= Fried air-dried *Awara*, and FSD= Fried sun-dried*Awara*.

Antinutritional factors have been recognized for a long time to interfere with the absorption of nutrients, these are partly removed during domestic processing methods to improve the nutritional quality of foods. In this study, it was observed that the level of antinutritional factors decreases as the heat exposure of sample increases where the oxalates, phytates, and tannins in the un-fried (fresh) sample were (0.09±0.003), (26.62±1.1), and (10.42±0.5) respectively. The fried sample has (0.07±0.003), (23.98±0.9) and (10.42±0.8). Furthermore, the fried air-dried sample has (0.04±0.003), (21.38±0.5)and (12.04±0.4). Finally, the fried sun-dried sample was found to have (0.02±0.002), (9.58±1.2), and (7.11±0.3). This indicates that Antinutrients are heat sensitive compounds and can be destroyed when high temperatures are applied during processing.

Table 3: Sensory analysis of *Awara* processed using different methods

Samples	Color	Smell	Taste	Mouthfeel	General acceptability
UFA (control)	5.0±0.1 [a]	3.0±2.3[a]	4.25±0.5 [a]	4.25±0.9 [a]	4.5±0.6 [a]
FA	5.0±0.1 [a]	4.5±0.6 [b]	5.0±0.1 [b]	4.75±0.5 [a]	5.0±0.1 [b]
FAD	4.5±0.6[b]	4.5±0.6 [b]	4.25±0.9 [a]	4.0±0.0 [b]	4.5±0.6 [a]
FSD	4±0.8[b]	3.0±0.1.4[a]	3.25±0.9 [c]	2.75±1.3 [c]	2.5±1.9 [c]

Values are expressed as mean ± STD (n=3), values with different superscript on the same column are significantly different at P<0.05.

Key: UFA= Unfried*Awara*, FA= Fried *Awara*, FAD= Fried air-dried *Awara* and FSD= Fried sun-dried *Awara*

The results from the sensory analysis show that sample subjected to frying (only) was found to have high acceptability, this was attributable to the characteristic color, taste, and smell of the sample while fried air-dried and fried sun-dried samples have less acceptability as the characteristic organoleptic properties are observed. The dried sample has a low degree of cohesion which could be due to high heat exposure while drying.

4: Conclusion

The results obtained in this study revealed that processing methods have significant effects on the proximate compositions as well as the organoleptic properties of the sample, However, considering the less Antinutritional contents of FA that are within the tolerable limit and high proximate content, it's logical to conclude and recommend that intake of FA is more beneficial to health with potential therapeutic relevance, unlike FAD and FSD which are proved to have reduced proximate content.

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