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Production of soybean butter using different technological treatments

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ABSTRACT

Nutritional, textural, microbiological and sensory evaluation was performed in soybean butters produced from defatted flour, cooked, sprouted and fried seeds. Commercial peanut butter served as control. Soybean butters had the highest significant amounts of moisture (3.7–5.4 g/100 g) and protein (25.8–30 g/100 g). Commercial peanut butter had the highest significant amounts of fats (58.7 g/100 g) and energy (2768 KJ/100 g). The peroxide value of commercial peanut butter was lower (0.13–10.4 meq/kg) than that of soy butters (0.2–30.2 meq/kg) over the storage period of 5 months/25 °C. For microbiological evaluation, sprouted and cooked soy butters were much stable than commercial peanut butter. In texture analysis, sprouted soy butter was less significant hard (1.2 N) and the least adhesive (1.3 NS^{-1}) and chewy (0.48 N) of all treatments. Fried soy butter had the lowest overall acceptability (6.3) of sensory scores among all the soy butters; while sprouted soy butter had the highest (7.5) one. Results could be useful in improving soy butter processing, predicting storage stability and delivering soy butter to consumers who are more concerned about soy products as a functional food and low-fat content other than commercial peanut butter.

1. Introduction

Soybean with its high protein and fat contents is suitable for roasting and preparing a vegetable butter. Soy butter is a new product that is not commercially available in many parts of the world and could be used as a spread and filling for a wide variety of savory and confectionery food recipes and formulations (Agrahar-Murugkar, Kotwaliwale, Kumar, & Gupta, 2013a). Soy butter offers all positive attributes of soybeans that well-balanced protein compared to other protein sources distinguished by a relatively high amount of lysine and can provide all of the essential amino acids required for children and adults. Also, it is rich in the unsaturated fatty acids, oleic, linoleic, and linolenic which make up 85% of the oil. Besides, it is a good source of minerals, B vitamins, folic acid, and isoflavones, which are credited with slowing cancer development, heart disease, and osteoporosis (Lee, Wu, Shannon, Sleper, & Nguyen, 2007; Mazaheri-Tehrani, Yeganehzad, Razmkhah-sharabiani, & Amjadi, 2009). Not only, soynut butter has less total and saturated fat than peanut butter where a one serving tablespoon of soynut butter significantly saved 5.5 g fat and 85 calories than peanut butter (USB, 2007). But also, it is a good alternative for people with peanut allergy (Matsiko, Murindwa, Niyigena, Hitimana, & Vasanthakaalam, 2014). Moreover, as a result of soybean health benefits and its technological and functional properties; soy flour and proteins additionally incorporated into peanut spreads and peanut butters, respectively (Dubost, Shewelt, & Eitenmiller, 2003; Matsiko et al., 2014; Mazaheri-Tehrani et al., 2009).

Efforts have been directed to use some technological treatments, whether to improve the nutritive value or to enhance the sensory and technological qualities of soy products. It has hypothesized that sprouting before butter making would result in advantages associated with the sprouting process. Sprouting triggers a sequence of metabolic changes resulting in improve nutritional quality of legumes and reduction of the antinutritional factors such as trypsin inhibitor (TI) by 60% and phytic acid (Agrahar-Murugkar & Jha, 2010). Lipoxygenase I, II and III are degraded during sprouting; preventing the forming of volatile compounds thereby improving odor and flavor scores (Kumar, Rani, & Chauhan, 2006).

Processing of soybeans using cooking improves texture, palatability as well as nutritional and sensory quality characteristics and that the degree of improvement depends on the temperature, moisture content and duration of cooking (Ikya, Gernah, Ojobo, & Oni, 2013).

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Blanching and roasting of the kernels are two important processing steps involved in the nut and nut butter manufacturing industry to improve the flavor, color, texture and overall acceptability (OAA) of the product (Sena, Sinan, & Suat, 2001). Moreover, roasting extended the shelf life of grains, reduces the antinutritional factors and denaturing proteins which improving their digestibility (Kavitha & Parimalavalli, 2014). During roasting, caramelization and browning reactions occur and result in forming of brown pigments (Cammarn, Lange, & Beckett, 1990). Pyrazines are the most abundant compounds formed during roasting and are responsible for toasted and roasted flavors in foods (Lee & Shibamoto, 2002). The roasting condition of whole kernels should be properly controlled as it contributes to development of flavor and aroma and color of the final nut butters (Shakerardekani, Karim, Gazali, & Chin, 2011).

Frying of nuts is an alternative process to dry roasting, resulted in products with high added value. These products are the preferred snacks for exporting purposes. Frying against dry roasting of nuts protects the surface of the product against oxidation during storage by incorporating the frying oil with higher stability than that of the nut lipids (Marmesat, Velasco, Ruiz-Méndez, & Dobarganes, 2006).

Knowledge about the quality characteristics of soy butters involves nutritional, sensory attributes and rheological aspects are needed for the product development (Agrahar-Murugkar, Kotwaliwale, Gupta, Gulati, & Kumarm, 2014). Accordingly, the present research aimed to produce soybean butters using different technological treatments, i.e., defatted, cooking, roasting, sprouting and frying. Chemical, textural, microbiological and sensory evaluation was performed to assess the nutritional and technological qualities of the produced butters compared to commercial peanut butter.

2. Materials and methods

2.1. Materials

Soybean seeds and defatted soybean flour (5 g fat/100 g flour) were obtained from Soybean Factory, Food Technology Research Institute, Agricultural Research Center, Al-Giza, Egypt. The Plate count Agar medium was obtained from Conda Pronadisa, Madrid, Spain. MacConkey Agar medium was obtained from Biolife, Milano, Italy. Yeast and mold agar medium was obtained from the Difco™ Co, Becton Dickinson, Sparks, MD, USA. High viscosity carboxymethyl cellulose (CMC) produced by TIC gums, MD, USA. All other chemicals used were of analytical reagent grade. Commercial peanut butter was obtained from AHEF® Food Industry Company, Mattarya- Egypt. Ingredients as listed in order on the label: peanuts, vegetable oil, hydrogenated vegetable oils, honey, and salt. The processing parameters were not mentioned on the label. Other materials such as vanilla, vinegar, sunflower oil, granulated cane sugar, honey, salt and crackers were obtained from the local market, Al-Giza, Egypt.

2.2. Methods

2.2.1. Technological treatments of soybean seeds

Soybean seeds were sorted, cleaned of impurities, washed, and then subjected to some technological treatments before manufacturing of soybean butters as illustrated in Fig. 1. The seeds were soaked in acidified water (20 ml vinegar/100 ml water) for 12 h at 25 °C. Then, the excess water was drained and seeds were further rinsed with distilled water. For sprouting, rinsed seeds were placed into single layer filter paper in sterile tray then placed in the incubator (Incucell 55, Munich, Germany) at 25 °C, 90% relative humidity for 72 h. The sprouted seeds were blanched for a period of 10 min at 70 °C. For cooking, rinsed seeds were cooked for 30 min at 100 °C. Samples were roasted in a convection oven (Memmert, Cambridge, UK) at 100 °C for 2 h. For frying, rinsed and roasted seeds were deeply fried at 180 °C in sunflower oil till golden brown color and crunchy texture appeared. Samples from sprouting, cooking and frying treatments were allowed to cool at 25 °C, grounded into powder using Braun® mill, Combimax K 650, Germany at speed 4 and sieved through a 300 micron sieve. Three replicates of 100 g seeds were carried out for each run.

2.2.2. Manufacturing of soybean butters

Soybean butters were manufactured from defatted soybean flour, cooked, sprouted and fried dry milled samples according to Woodroof (1983).

The samples were blended in a food processor Braun®, Combimax K 650, Germany in speed 12 for 2 min. Sugar, honey, salt, vanilla, CMC and 8 g of sunflower oil were added to the soybean samples and were mixed for 7 min. Then, another 8 g of oil was added and mixed for 5 min; the rest 8 g of oil was added to the mixture and mixed for 5 min. The proper composition of the formulation for 100 g formula was 65 g soy sample, 24 g oil, 6 g granulated cane sugar, 1.5 g honey, 0.5 g CMC, 1.5 g salt and 1.5 g vanilla. Soybean butters were poured into sterilized glass jars (three replicates for each run), then autoclaved at 121 °C/20 min, left to cool and stored at 25 °C until analysis.

2.2.3. Proximate analysis

Moisture, protein, fat, crude fiber and ash contents of the commercial peanut butter and the above mentioned soybean butters were determined according to the methods of AOAC (2007). The nitrogen content was estimated by the semi micro Kjeldahl method, and the nitrogen conversion factor used for the crude protein calculation was 6.25. The carbohydrate content was calculated by subtracting the contents of crude protein, fat, ash, crude fiber, and moisture from 100 g of commercial peanut butter and soy butters. The proximate compositions of different butters were averaged from four replicates. The results were expressed on a dry basis.

2.2.4. The energy of commercial peanut butter and soybean butters

The energy of commercial peanut butter and soybean butters were calculated by the formula of James (1995) as follows:

$$Energy\ (KJ) = [Fat\ x\ 9 + Protein\ x\ 4 + Total\ carbohydrate\ x\ 4]x4.18$$

2.2.5. Peroxide value of commercial peanut butter and soybean butters

The peroxide value of commercial peanut butter and soybean butters was determined at intervals from zero time until 5 months using the official methods of the American Oil Chemists' Society AOCS (1991). One gram fat extracted from commercial peanut butter or soy butters was dissolved in 10 ml of glacial acetic acid/chloroform and 0.2 ml of potassium iodide solution. Samples stand in the dark for a minute, and 20 ml diluted starch solution were added, prior to titration with 0.1 Mol/L sodium thiosulfate solution. The peroxide value of different butters was averaged from three replicates and expressed as meq/kg butters.

2.2.6. Microbiological evaluation

The growth of the total bacteria, fecal Coliforms (indicates hygienic conditions), yeast and mold was performed in commercial peanut butter and soybean butters at intervals— zero time and 1–5