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Characterization of peanuts after dry roasting, oil roasting, and blister frying

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ABSTRACT

Peanuts were systematically deep fried, blister fried, or dry roasted at 177 °C to Hunter L-values of 53.0 ± 1.0, 48.5 ± 1.0, and 43.0 ± 1.0, corresponding to light, medium, and dark roasting, respectively. Thermal modifications of the epidermal and parenchyma cells were observed in the scanning electron microscopic images for processed peanuts, compared to raw peanuts. Peanut microstructure was most extensively damaged by blister frying, followed by deep frying, and then dry roasting. The moisture content decreased with increased surface color, due to more moisture loss with longer heat processing time. For light roasting, blister fried peanuts had significantly higher moisture contents than the deep fried and dry roasted peanuts, while for medium and dark roasting, blister fried had lower moistures than the other two. Descriptive sensory analysis was able to distinguish the flavor and texture profiles of peanuts prepared by different roasting methods. In storage testing throughout 16 weeks, peroxide value measurements indicated the blister fried peanuts had the longest shelf life, followed by the dry roasted, and then the deep fried. Descriptive sensory analysis proved that the rate of the loss of roast peanut flavor during storage was faster in dry roasted peanuts followed by blister fried and deep fried.

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1. Introduction

In the U.S.A., the majority of peanuts grown are converted into value-added products utilizing the entire seed, such as peanut butter, confections, and snack products. For such purposes, peanut kernels are usually thermally processed as the first step in the manufacture of the final products to achieve a specific flavor, color, and texture (Perren & Escher, 2013). Peanuts are processed typically by dry roasting or oil roasting, and to a lower extent by boiling, microwave heating, or a combination of multiple processing methods (Woodroof, 1983; Young, Schadel, & Heertje, 1993). Dry roasting is performed by heating the food material using hot air without the use of oil or water as a carrier. The most commonly used oil roasting methods for peanuts are deep frying and blister frying. Blister frying has not been scientifically defined but according to cooking instructions, this process involves the steps of boiling blanched peanuts in water for a certain time, draining the excess water, and then deep frying the soaked kernels in vegetable oil, resulting in a highly crispy, highly crunchy snack with blisters on the kernel surface (Miyagi, 2013). Although there are several commercial products prepared by dry roasting, deep frying, and blister frying, the scientific comparison of different roasting methods has not been reported.

Roasting is defined as the heat treatment at temperatures above 125 °C, at which non-enzymatic reactions occur to form pigments with specific yellow-brown color (Kleinert, 1966). During roasting, color has been extensively used as a quick and non-destructive indicator of food quality for certain foods, especially for roasted coffee beans, hazelnuts, almonds, and peanuts (Baggenstoss, Poisson, Kaegi, Perren, & Escher, 2008; Kaftan, 2012; Ozdemir et al., 2001; Pattee, Giesbrecht, & Young, 1991). Different temperature and roasting time combinations were able to achieve the equivalent peanut surface colors (McDaniel, White, Dean, Sanders, & Davis, 2012; Smith, Perry, Marshall, Yousef, & Barringer, 2014). McDaniel et al. (2012) found that, at a given color, moisture contents decreased with decreasing roast temperatures due to the

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longer roast times required for the same color formation. It was also found that peanuts roasted at lower temperatures had higher tocopherol contents. Another study investigating oven, microwave, and combination roasting suggested that significant differences were observed with flavor attributes for peanuts roasted to equivalent colors by different roasting methods; however, no significant differences were found in free fatty acid or peroxide values (Smith et al., 2014). Also, different roasting methods may cause different types of and/or alter the extent of thermal modifications (e.g. cell wall rupture, protein body distension, and cytoplasmic network disruption) to the microstructure of peanut kernels (Young et al., 1993).

The method of roasting is known to affect the physical, chemical, sensory, as well as the storing properties of roasted peanuts. As oil roasting is a faster roasting process than dry roasting, the best way to compare different roasting methods should be based on the concept of equivalent color roasting instead of equivalent roasting time. The process of blister frying involves an initial soak of the raw peanuts in water which could result in loss of soluble protein and sugars which are involved in peanut texture and roasted flavor. The objective of this study was to systematically compare the effects of different roasting methods on the peanut quality related properties, including moisture content, nutritional content, microstructure, and sensory properties, as well as storability, at equivalent surface colors in order to identify what qualities can be controlled in order to produce high quality peanut products.

2. Materials and methods

2.1. Materials

Jumbo grade size peanuts (>21/64 on a slotted screen) of the Georgia 06G cultivar, a high-yielding, large-seed, runner-type variety, were obtained during the 2013 harvest from the USDA ARS National Peanut Laboratory (Dawson, GA, USA). The peanuts had been cured, shelled, sized using standard screens, blanched and stored utilizing standard industry practices prior to delivery to the USDA ARS Market Quality & Handling Research Unit at North Carolina State University (Raleigh, NC, USA). A pilot plant scale roaster previously described (Poirier, Sanders, & Davis, 2014) built by the Bühler Aeroglide Corporation (Cary, NC, USA) with an adjustable air flow rate (up to 1.27 m/s), air flow direction, bed depth, and temperature control (up to 204 °C) was used for the dry roasting. The air flow direction was changed from up-flow to down-flow at the half point of the roasting time. Following roasting, the roasting tray containing the peanuts was placed onto a forced air blower for cooling to ambient temperature. A pilot plant scale fryer (Vulcan-Hart, Baltimore, MD, USA) holding 16 L of pure peanut oil (Ventura, Brea, CA, USA) was used for deep frying and blister frying. Following frying, the peanuts were spread onto a fine mesh steel screen with a cooling fan installed above for cooling to ambient temperature. The batch size for deep frying and blister frying was 2 kg of peanuts per batch.

The peanuts were dry roasted, deep fried, or blister fried at 177 °C to three equivalent surface colors (Light, L = 53.0 ± 1.0, Medium, L = 48.5 ± 1.0, and Dark, L = 43.0 ± 1.0) as determined by a Hunter Lab Model D25 colorimeter (Hunter Lab Associates, Reston, VA, USA). Processing times were determined using the linear regression on the preliminary curves of the Hunter L-values versus roasting time. The time used for each treatment was summarized in Table 1. Blister frying was conducted by immersing the peanuts in boiling water for 10 min, followed by deep frying. After cooling, the roasted peanuts were placed into glass jars, and stored frozen (−26 °C) until further analysis.

Table 1
Roasting time used for each treatment to achieve equivalent color roasting of light, medium, and dark at average surface Hunter L values of 53.0 ± 1.0, 48.5 ± 1.0, and 43.0 ± 1.0, respectively.

	Deep fry	Blister fry	Dry roast
Light	1.3	3.0	11.9
Medium	1.6	3.5	14.0
Dark	2.0	4.3	17.0

2.2. Color distribution

Single seed color of 100 blanched kernels for each treatment was measured using the Hunter Lab scale with a Model DP-301 Chroma Meter (Minolta Camera Co., Ltd. Japan). The percentage of the single seed color within an interval of L = 2.5 was calculated by JMP Pro 10.0 (SAS, Cary, NC, USA) and plotted in lightness (L) distribution charts (Fig. 1).

2.3. Protein content of rinse water

A CE Instruments NA 2100 Protein Analyzer (Thermo Finnigan, Milan, Italy) was used for analysis of total nitrogen using combustion analysis and thermal conductivity detection (TCD). The apparatus was equipped with a Model AS128 auto-sampler, a combustion oven containing the oxidation catalyst and a reduction oven containing copper, traps for carbon dioxide and water containing soda lime and anhydrous magnesium perchlorate, respectively, and a GC column packed with active carbon and a thermal conductivity detector. The TCD temperature was set at 60 °C and the pressure was 1200 Pa. An analytical portion (100 mg) of phenylalanine was used for calibration. A portion of the rinse water (500 μL) used to soak the peanuts prior to blister frying was added to metal capsules and loaded into the autosampler for nitrogen measurement.

2.4. Sugar content of rinse water

The rinse water used to soak the peanuts prior to blister frying was analyzed for sugar content using a Dionex BioLC HPLC system (Dionex Corporation, Sunnyvale, CA, USA) at a controlled temperature of 25 °C (Pattee, Isleib, Giesbrecht, & McFeeters, 2000). The system consisted of a gradient pump, an autosampler, and a Pulsed Amperometric Detector (PAD). The column used was a Dionex PA-1, 250 mm length and 4 mm i.d., fitted with a Dionex PA-1 Guard column. Aliquots of the rinse water were spiked with an internal standard solution containing lactose and cellobiose (Sigma-Aldrich, St. Louis, MO, USA). The solutions were passed through a syringe fitted with a Dionex OnGuard® II H Filter into autosampler vials. An external standard solution was prepared containing myo-inositol, glucose, fructose, sucrose, raffinose, stachyose and the internal standards. Sugars were identified through comparisons of retention time of unknown samples to known standards. Sugar contents were calculated from the chromatogram peak heights relative to the internal standards. All sugar standards were purchased from Sigma-Aldrich (St. Louis, MO, USA).

2.5. Moisture content

Whole peanut seeds from each treatment were analyzed in triplicate using a forced air oven at 130 °C for 6 h to determine the moisture content (MC) (Young et al., 1982). The weight differences before and after oven incubation were compared to dried mass for MC.