LWT - Food Science and Technology 59 (2014) 222–228

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Peanut skins-fortified peanut butters: Effects on consumer acceptability and quality characteristics

Cloviece T. Sanders III [a], Christa L. DeMasie [a], William L. Kerr [b], James L. Hargrove [a], Ronald B. Pegg [b], Ruthann B. Swanson [a,*]

[a] Department of Foods and Nutrition, The University of Georgia, 180 Dawson Hall, Athens, GA 30602-3622, USA
[b] Department of Food Science and Technology, The University of Georgia, 100 Cedar Street, Athens, GA 30602-2610, USA

ARTICLE INFO

Article history:
Received 19 September 2013
Received in revised form
28 March 2014
Accepted 1 April 2014
Available online 10 May 2014

Keywords:
Peanut butter
Peanut skins
Consumer acceptance
Spreadability
Particulates

ABSTRACT

Peanut skins (PS), high phenolics by-products from peanut processing, are potential functional ingredients. Effects of fortification with ground PS (3 types: dry-blanched, light- and medium-roasted) on peanut butter (PB) quality characteristics and consumer acceptability were evaluated. PS were added in concentrations of 0 (control), 2.5 and 5.0 g PS/100 g PB. Data were analyzed with Mixed Model ANOVA. Significant effects ($P < 0.05$) on product appearance and physical characteristics depended on level of incorporation and type of skins used; the greatest impact on objective appearance (L^*, a^*, b^* color and particulate presence) and instrumental physical properties (spreadability and texture profile analysis parameters) occurred with incorporation of 5.0 g medium roasted PS/100 g PB. Consumer sensory panelists ($P < 0.05$) noted an increase in stiffness with incorporation of roasted PS at both levels, and less acceptable spreadability with incorporation of 5.0 g light or medium-roasted PS/100 g PB when compared to the control. Panelists also found PS addition affected acceptability of appearance more than flavor, texture or overall acceptability. With incorporation of 2.5 g PS/100 g PB, PS addition produced PBs that equaled the control in overall acceptability, regardless of heat treatment. At the 5.0 g PS/100 g PB incorporation level, PBs containing medium-roasted PS were less acceptable ($P < 0.05$) than all other formulations.

1. Introduction

Peanut (*Arachis hypogaea* L.) production worldwide was estimated to exceed 37 million metric tons in 2012, with three million metric tons produced in the United States (USDA, 2013a, 2013b). Of the four types of peanuts grown commercially, the Runner type, used mainly for peanut butter (PB), makes up 80% of the acreage planted in the United States; nearly 60% of all US peanut production is processed into PB. About 1.2 billion pounds of PB are available annually for consumption in the United States (USDA, 2012), making this product well-suited, from a public health perspective, for reformulation (van Raaij, Hendriksen, & Verhagen, 2009). In addition, PB quality attributes important to American consumers have been identified (McNeill, Sanders, & Civille, 2000). Production of PB involves shelling to remove the hull, followed by blanching at relatively low temperatures to remove the testa, also known as peanut skins (PS). The peanuts may also be roasted at relatively high temperatures to develop the characteristic flavor, texture, and color, before grinding into a paste. According to the US FDA Standard of Identity (21 CFR § 164.150), 100 g PB must consist of no less than 90 g peanuts and contain no more than 55 g fat. During PB production, salt, sweetener, and emulsifiers or stabilizers may be incorporated into the peanut paste. Similar products that do not meet the standard of identity should be labeled as peanut spreads.

PS, which comprise about 3 g per 100 g of the peanut seed, are primarily an industry by-product with only small quantities utilized in animal feed and specialty food products (Davis, Dean, Price, & Sanders, 2010; Nepote, Grosso, & Guzman, 2002; Sobolev & Cole, 2004). Despite their limited use, PS which are high in phenolics and dietary fiber and low in cost have great potential as a functional ingredient (Davis et al., 2010; Francisco & Resurreccion, 2008; Ha, Pokorný, & Sakurai, 2007; Yu, Ahmedna, & Goktepe, 2006). Phenolic compounds have been reported to be anti-inflammatory, and protective against oxidative stress, carcinogenesis, heart disease and diabetes (Ballard, Mallikarjunan, Zhou, & O'Keefe, 2009; El-Alfy, Ahmed, & Fatani, 2005; Jensen, 2006; Scalbert, Manach,

* Corresponding author. Tel.: +1 706 542 4834; fax: +1 706 542 5059.
E-mail address: rswanson@uga.edu (R.B. Swanson).

http://dx.doi.org/10.1016/j.lwt.2014.04.001

Morand, Rémésy, & Jiménez, 2005). Consumers are increasingly aware of the protective role that dietary antioxidants, like phenolics, have against the development of chronic diseases (IFIC, 2011).

PS contain an array of phenolic compounds including flavonoids (catechins and procyanidins) and stilbenes (*trans*-resveratrol) with free phenolic acids (caffeic, ferulic and *p*-coumaric) and their esterified- and glycosylated-derivatives dominating (Lou et al., 2004; Nepote et al., 2002; Yu, Ahmedna, & Gokepe, 2005). Reported total phenolics content (TPC) of defatted PS ranges from 36 to 280 mg gallic acid equivalents (GAE)/g (Francisco & Resurreccion, 2009) with levels varying due to type, maturity, environmental conditions, extraction procedures, and storage conditions (Bravo, 1998; Francisco & Resurreccion, 2009). Processing effects on phenolic levels in PS also have been found, with higher levels of phenolics associated with dry- rather than wet-blanching (Yu, Ahmedna, Goktepe, & Dai, 2006). Though roasting tends to increase the total phenolics when compared to the raw product (Yu et al., 2005), the extent of roasting influences the final levels present (Ma et al., 2013).

Recently, both Hathorn and Sanders (2012) and Ma et al. (2013) reported a concentration-dependent increase in TPC when PS were incorporated into PB. Using descriptive sensory analysis, Hathorn and Sanders (2012), who incorporated 0, 0.5, 1.0, 5.0, 10.0, 15.0 and 20 g PS per 100 g PB found that the incorporation of 1 g roasted PS (processed through a Wiley mill) did not alter the sensory flavor profile of the resultant PBs. With PS levels greater than 5 g per 100 g PB however, increased intensity of the attributes 'woody', 'hulls', 'skins', 'bitter', and 'astringent' were found. Furthermore, instrumental color analysis revealed decreasing Hunter L^* values and increasing a^* values as roasted PS incorporation increased. The effects on texture, which has been identified previously as a PB quality characteristic important to consumers (McNeill et al., 2000), were not investigated. Conditions of PS roasting are unknown.

In our previous studies, Ma et al. (2013) successfully produced PS-enhanced PBs that met the standard of identity (21 CFR § 164.150) by incorporating PS micro-ground to a particle size of less than 300 μm. Potential use for fortification of dry-blanched and three PS roasted to different extents was investigated at 5 levels (0, 1.25, 2.5, 3.75, and 5.0 g PS/100 g PB). Overall, incorporation of dry-blanched PS produced the fewest alterations in PB physical (modified texture profile analysis and spreadability) and color (L^*, C^*, h) properties when assessed instrumentally. Furthermore, at 2.5 and 5.0 g PS incorporation per 100 g PB, the TPCs increased by a factor of 4.5 and 8.1 respectively, when PBs containing dry-blanched skins were compared to PBs without PS (Ma et al., 2013). Subsequent studies showed that antioxidant capacity, proanthocyanidin levels and total dietary fiber were also increased (Ma, Kerr, Swanson, Hargrove, & Pegg, 2014). Incorporation of the roasted PSs at levels equal to the dry-blanched PS revealed lower concentration dependent increases in TPC, antioxidant capacity, proanthocyanidin levels and total dietary fiber (Ma et al., 2013, 2014). However, neither flavor effects of fortification nor consumer acceptability of the PS-fortified PBs were reported.

The goal of the present study was to assess quality and potential consumer acceptability of seven PS-fortified PBs, produced as described by Ma et al. (2013). PS subjected to three different heat treatments (dry-blanched, light-roasted and medium-roasted) were incorporated into PBs at three levels (0, 2.5 and 5 g/100 g); the PB devoid of skins served as the control. Specific objectives were: (1) to assess the effect of the level of PS incorporation and heat treatment on physical attributes of the final product; and (2) to determine the effect of fortification with PS subjected to different heat treatments and incorporated at different levels on consumer acceptability of the high phenolics PBs.

2. Materials and methods

Dry-blanched PS supplied by Sylvester Blanching, a division of Universal Blanchers, LLC (Sylvester, GA), were produced under hot air at 96 °C for 45 min. Light- and medium-roasted PS were obtained from the Golden Peanut Company, LLC (Alpharetta, GA). Light-roasted skins were heated at 124 °C for 10 min, followed by 168 °C for 10 min. Medium-roasted skins were produced by heating at 124 °C for 10 min, followed by 182 °C for 10 min. Peanut paste and other ingredients were provided by Seabrook Ingredients, Inc. (Edenton, NC). Ground PS-sugar blends were produced by micro-grinding in a Super Masscolloider CA6-3 (Masuko Sangyo Co., Saitama, Japan) as described by Ma et al. (2013). After sieving, >99% of the particles had sizes less than 300 μm. PBs were fortified with ground PS (either dry-blanched, light- or medium-roasted) at 0, 2.5, and 5.0 g/100 g. One hundred grams of the control formulation contained 90 g peanut paste, 6.5 g sugar, 1.5 g salt, and 2.0 g stabilizer; neither ingredient source nor lot differed with formulation. In the high phenolics formulations, PS replaced the peanut paste. As the skins contained 18–29 g oil per 100 g, refined, bleached, and deodorized peanut oil (Planter's Nut and Chocolate Company, Glenview, IL) was incorporated to maintain the lipid content at ~45 g per 100 g of the final product.

2.1. Sensory evaluation

An incomplete block design augmented by a control (Gacula, 1978) was used to assess consumer acceptability of the PB formulations due to the potential for sensory fatigue. Each panelist evaluated the control sample ($n = 140$) and three high phenolics formulations. The number of evaluations for each high phenolics formulation ranged from 66 to 73. Samples (~9 g) were portioned into soufflé cups, subsequently covered and held at 21–23 °C for 24 h prior to evaluation. These samples, coded with 3-digit random numbers, were presented monadically under white light to panelists seated in individual booths. Presentation order was randomized for each panelist. Water, held at room temperature for 24 h, unsalted top saltine crackers (Nabisco Premium, Kraft Foods Global, Inc., East Hanover, NJ) and baby carrots (WM Bolthouse Farms, Inc., Bakerfield, CA) were used as palate cleansers. Samples were evaluated in five phases. Methodology for phases 1 thru 4 was adapted from McNeill et al. (2000). In phase 1, panelists evaluated appearance acceptability prior to removal from the uncapped soufflé cup. In phase 2, panelists spread the PB sample onto an unsalted top saltine cracker with a plastic knife (Bakers and Chefs, Sam's West, Inc., Bentonville, AR) and evaluated acceptability of the ease of spreadability, followed by an assessment of consistency on a 9-point scale where 1 = runny and 9 = stiff. In phase 3, texture, flavor, and overall acceptability of each sample previously spread on the cracker carrier was determined. All acceptability assessments were based on a 9-point hedonic scale, where 1 = dislike extremely and 9 = like extremely. In phase 4, panelists were asked to provide like/dislike descriptors for each sample (Meilgaard, Civille, & Carr, 2007). In phase 5, demographic and product use information was collected.

2.2. Objective appearance

To evaluate particulate presence, methodology was adapted from USDA procedures for grading PB (USDA, 1983). A 6-point reference scale, where 1 was low and 6 was high, was created using six commercially-available PBs (Table 1) as scale reference points. Products, ~15 g at 21–23 °C, were evenly spread onto USDA particle analysis sheets; each reference sample covered an area of 11.4 × 7.1 cm. Three samples from each prototype formulation,