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Effects of short storage on consumer acceptability and volatile compound profile of roasted peanuts

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ABSTRACT

The main objective of this study was to determine the effects of 8-week storage on the consumer acceptability and volatile compound profile of roasted peanuts. Normal-oleic Georgia 06G kernels (06G), high-oleic Georgia 13M (13M), georgia runner (mixed) in-shell (InR) & kernels (R), and virginia (mixed) in-shell (InVA) & kernels (VA) were roasted to medium doneness and stored at 21 °C for consumer and chromatography-mass spectroscopy (GC–MS) tests conducted at week 0, 4 and 8. GC–MS results showed that 06G was the most oxidized samples followed by InVA after 8 weeks. Only InVA exhibited a decrease in consumer likings during storage. At week 8 InR was significantly ($p \leq 0.05$) preferred over InVA. When compared high-oleic 13M to normal-oleic 06G, 13M had significantly ($p \leq 0.05$) higher consumer likings than 06G at all three time points with a better ability to retain pyrazines and resist to lipid oxidation.

1. Introduction

Peanut (*Arachis hypogaea*) is a major crop worldwide with total production of around 29 million metric tons per year. The United States is the world's third largest producer, having a share of 8% of overall production. Runner and virginia are two important peanut types that are grown in the United States. Runner peanuts have uniform kernel size and are mainly planted in Georgia, a state in the US. They have very good roasting characteristics and are often processed after shelling (The Peanut Institute, 2017). Virginia peanuts are commonly used for in-shell roasted peanuts (Mozingo, Hendrix, Sanders, & O'Keefe, 2004). They have large kernels covered with red skin and are primarily produced in Virginia and South Carolina. Given the medium kernel size of runner peanuts, they might also be acceptable as in-shell roasted peanuts. Our previous work showed that there was no difference between consumer acceptability of freshly roasted in-shell runner and in-shell virginia peanuts (Wang, Adhikari, & Hung, 2017).

Several physiochemical changes are involved during roasting, such as heat exchange, chemical reactions and drying (Saklar, Katnas, & Ungan, 2001). Maillard reaction is the main reaction which forms a lot of volatile compounds. Among them, pyrazines are the main group of compounds that is studied the most. Amino acids and sugars are the major precursors of pyrazines and react in a 2-to-1 stoichiometric ratio during roasting (Newell, Mason, & Matlock, 1967). Aspartic acid, glutamic acid, glutamine, histidine, asparagine, and phenylalanine are the precursors of typical peanut flavor; while threonine, tyrosine and lysine are precursors of atypical peanut flavor (Newell et al., 1967). Sucrose is the predominant sugar in peanuts, which can hydrolyze to glucose and fructose in roasting process. Researchers have isolated and identified over 70 pyrazines from peanuts and proved the strong correlations between roasted flavor/aroma and pyrazine detection level (Maga, 1982; Williams et al., 2006).

However, the positive attributes of roasted peanuts gradually diminish accompanied by the development of off-flavors during storage, which is known as 'flavor fade'(Hui et al., 2010, Chapter 51). These off-flavors are generated in lipid oxidation. Lipid oxidation is a major concern in peanut industry due to the high lipid content of peanuts which varies from 44% to 56% (Sebei, Gnouma, Herchi, Sakouhi, & Boukhchina, 2013). During oxidation, unsaturated lipid molecules transform to hydroperoxides. They are primary non-volatile oxidation products which further decompose to various volatile aromatic secondary products mainly aldehydes such as hexanal. These secondary oxidation products are responsible for the oxidized flavor in peanuts.

The mechanism for flavor-fade is still unclear. Warner, Mumma, Hollender, Dimick, & Ziegler (1996) considered that aldehydes masked roasted flavor of pyrazines to cause flavor-fade in roasted peanuts because pyrazine content did not decrease with storage. But other researchers did observe a reduced level of pyrazines, which was possibly caused by free radicals and hydroperoxides from lipid oxidation (Bett & Boylston, 1992; Reed, Sims, Gorbet, & O'Keefe, 2002; Williams et al., 2006).

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To extend shelf life of roasted peanuts, high-oleic varieties have been developed. Braddock, O'Keffe, & Sims (1995) found that high-oleic roasted peanuts had two-time longer shelf life than normal-oleic roasted peanuts with less hexanal and more stable pyrazines during 6 weeks. Also, compared to normal-oleic peanuts high-oleic lines persist roasted peanutty flavor longer with less oxidized flavor during storage (Nepote, Mestrallet, Accietto, Galizzi, & Grosso, 2006). Moreover, high-oleic trait offers roasted peanuts more resistance to the effects of salted processing and humid storage condition (Mozingo et al., 2004; Reed et al., 2002). Normal-oleic Georgia 06G is the current top choice for runner production, but it is less oxidation-stable compared to high-oleic runner cultivar Georgia 13M. Moreover, our previous study (Wang, Adhikari, & Hung, 2017) found that Georgia 13M was preferred over Georgia 06G by consumers when consumed as freshly roasted peanuts.

Peroxide value (PV) is commonly used to predict shelf-life of roasted peanuts (Mozingo et al., 2004). Based on the sensory panel studies conducted by Braddock et al. (1995), oxidation of roasted peanuts became noticeable at a PV of 10 meq/kg, and reached unacceptable level by 20 meq/kg. Used 20 meq/kg as end point, researchers predicted the shelf-life of roasted peanuts was 4 to 6 weeks for normal-oleic varieties and about 32 weeks for high-oleic varieties depending on processing procedures and relative humidity of storage environment (Mozingo et al., 2004; Reed et al., 2002). These results suggested that unacceptable oxidation could occur in regular roasted peanuts within short storage period. In addition, after roasting there is 6 to 8 weeks of shipping and handling for peanuts before consumers make a purchase (Mozingo et al., 2004). Therefore it is important to select the peanut types that could persist quality better during distribution.

The purposes of this study were to 1) measure the effects of 8-week storage on consumer acceptability and volatile compounds of six roasted peanuts (normal-oleic Georgia 06G, high-oleic Georgia 13M, in-shell runner, in-shell virginia, shelled runner and shelled virginia); 2) compare the differences between high-oleic and normal-oleic runner cultivars, and also between runner and virginia type (in-shell and shelled); and 3) explain consumer acceptability by other consumer ratings and volatile compounds.

2. Materials and methods

2.1. Sample preparation

The sample description of the six samples used in this study are shown in Table 1. High- (Georgia 13M) and normal-oleic (Georgia 06G) peanut pods were obtained from the University of Georgia Department of Crop and Soil Science (Tifton Campus). Runner (mixed) and virginia (mixed) peanut pods were provided by Golden Peanut Company (Alpharetta, GA, USA). All the peanuts were from a single harvest season. Before processing, peanut pods were sorted, cleaned and dried at 40 °C for about 15 h in a mechanical convection oven (Model 645 Freas, Precision Scientific, Winchester, VA). All the pods were heated at 163 °C for 5 min in Lincoln impingement oven (Lincoln Impinger, Fort Wayne, IN) to reduce the potentiality of mold problem. After cooling down to room temperature (21 ± 1 °C) by a cooling fan, sample were flushed with nitrogen, vacuum sealed and kept at 4 °C.

Before roasting, the samples were firstly equilibrated at 21 °C for 12 h. The samples 06G and 13M were used for shelled roasted peanut samples only, while runner and virginia were used for both in-shell (InR, InVA, respectively) and shelled (R, VA, respectively) roasted samples. All samples were roasted in a Lincoln impingement oven to a medium doneness based on the surface color Lightness (L) value of ~50. A benchtop ColorFlex Spectrophotometer (HunterLab, Reston, VA) was standardized by black glass and white tile (L = 93.24, a* = −1.30, b* = 0.84). The color of roasted peanuts was measured in duplicate by placing samples evenly at the bottom of the sample cup. Four readings per sample were obtained for each sample (Yeh, Phillips, Resurreccion, & Hung, 2002). The roasting conditions and *L* value for peanuts are summarized in Table 1. After roasting, peanuts were cooled to room temperature (21 ± 1 °C) by a cooling fan and the roasted kernels were then blanched in an Ashton peanut blancher (Model EX, Ashton Food Machinery Co., Newark, NJ). The blanched kernels were further manually split into halves and misshapen kernels were sorted out before packaging. All the samples were flushed with nitrogen, vacuum packaged, properly labeled, and stored at 4 °C till used for the storage study.

2.2. Sampling procedure

The storage time in this study (week 0, 4 and 8) was defined as the period or duration of time where the peanut samples were stored at 21 °C. In week 0, peanut samples were removed from refrigerated storage 2 d before the first sensory test day, equilibrated at 21 °C for 12 h and stored in Ziploc® bags (S. C. Johnson & Son, Inc., Racine, WI). Consumer acceptability testing and gas chromatography–mass spectroscopy (GC–MS) analyses were performed at week 0, 4 and 8.

2.3. Consumer analysis

Approval from UGA's IRB (Project ID: STUDY 00001433) was taken before collecting the sensory data. For each time point, the same group of 71 consumers were recruited through Facebook, flyers or an existing consumer database established and maintained at Sensory Evaluation and Consumer Lab, Department of Food Science and Technology, University of Georgia (Griffin Campus). All the consumers were between the ages of 18–65 y, having no allergy to peanuts or any kind of nuts, and eat peanut products at least once a month.

The consumer tests were carried out in partitioned booths under incandescent light at 21 °C. About 5 g of each peanut sample coded with a 3-digit random number was served with the corresponding ballot in a sequential monadic order based on a completely randomized serving order. Demographic questionnaire was presented with the last sample. A 9-point hedonic scale was used for liking questions and a 9-point category scale was used for intensity questions. Yes/no question was used to calculate the percentage of consumers who tasted old/stale flavor. Unsalted crackers (Kroger Co., Cincinnati, OH) and water were served as palate cleansers in-between samples.

2.4. Gas chromatography-mass spectrometric (GC–MS) analysis

Headspace-solid phase microextraction (HS-SPME) technique was applied for extraction of the volatiles in the peanut samples. Samples

Table 1
Peanut samples and their roasting conditions.

Variety	Abbreviation	Temperature (°C)	Time (min)	Lightness (*L*)	Oleic Acid Level
Georgia 06G kernel	06G	168.3	22.50	50.70	normal
Georgia 13M kernel	13M	168.3	20.00	50.38	high
Runner (mixed) kernel	R	171.1	18.00	50.61	normal
Virginia kernel	VA	165.6	30.00	49.85	normal
Runner (mixed) in-shell	InR	171.1	21.00	50.31	normal
Virginia in-shell	InVA	168.3	25.00	50.31	normal