

# Flavor of Roasted Peanuts

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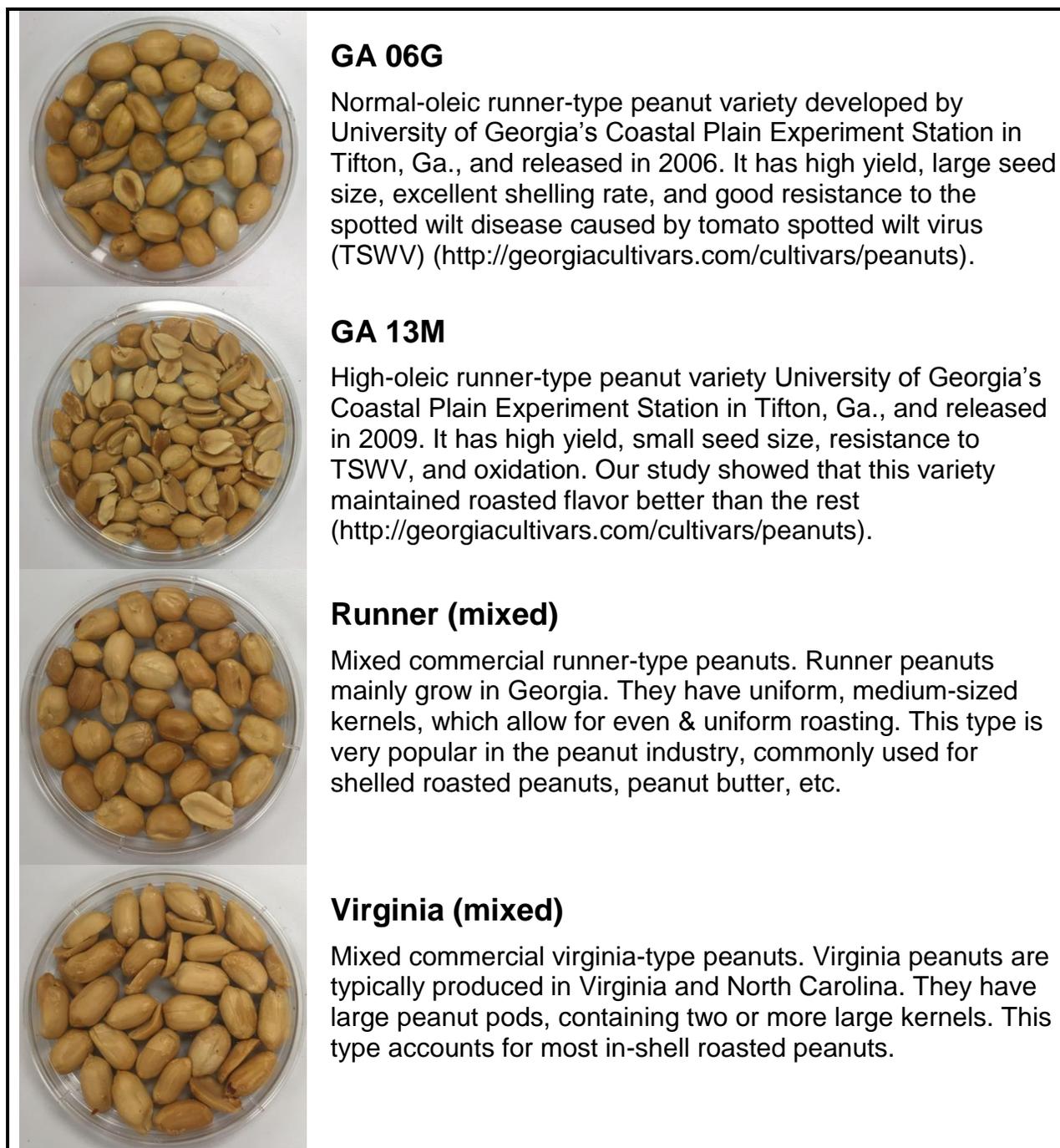
Roasted peanuts are important peanut products in the United States, which are processed in either in-shell or shelled form. Virginia is the main peanut type used for in-shell roasted peanuts, while runner (the major peanut type in Georgia) is always roasted after shelling. The flavor of roasted peanuts associates with two important reactions – Maillard reaction and lipid oxidation. Maillard reaction mainly occurs during roasting, generating pleasant flavor attributes. However, these positive attributes of roasted peanuts gradually diminish with the development of off-flavors during storage, which is known as *flavor fade* (Hui *et al.*, 2010). These off-flavors are formed during lipid oxidation. In order to retard lipid oxidation, high-oleic peanut cultivars have been developed. The following report summarizes recent work on the flavor of roasted peanuts as affected by storage, peanut types, and cultivars.

### Peanuts in the United States

The United States is the world's third largest producer of peanuts, having a share of 8% of overall global production. Among all the states, Georgia has the largest proportion with about 49% of the total national production. Runner and virginia are the two major peanut types. Runner peanuts have uniform kernel size and are mainly planted in Georgia. They have very good roasting characteristics and are often processed further after shelling, mainly into peanut butter. Virginia peanuts are commonly used for in-shell roasted peanuts (Mozingo *et al.*, 2004) but also for the classic, oil-roasted 'cocktail' peanuts. They have larger kernel size as compared to the other varieties and are primarily grown in Virginia, Texas and South Carolina.

## Maillard Reaction and Roasted Peanut Flavor

During roasting, a series of physiochemical reactions, mainly *Maillard reaction*, occur to produce roasted flavor and color change. Maillard reaction is a complicated series of chemical reactions among amino acids and reducing sugars, which generates volatiles compounds and also brown coloration due to the production of pigments called melanoidins. Figure 1 shows medium roasted shelled peanuts with brief descriptions of a study done in our lab (Wang *et al.* 2017). Among them, pyrazines are the most extensively studied volatiles due to their contributions in roasted flavor/aroma. The formation of pyrazines starts at 100 °C and a rapid increase in production appears as temperature rises to 150 °C (Koehler and Odell, 1970). Mason *et al.* (1966) were the first to identify five different pyrazines and suggested their possible roles in roasted peanut flavor. Baker *et al.* (2003) revealed that 2,5-dimethylpyrazine was the best predictor of roasted peanut flavor. Currently, more than 70 pyrazines are isolated and identified from peanuts. Our lab detected 10 of them from six roasted peanut samples using the technique of headspace solid-phase microextraction/gas chromatography-mass spectrometry (HS-SPME/ GC-MS). Highest concentration of 2,5-Dimethylpyrazine was found had the highest concentration during 8-week of storage and its strong correlation with roasted peanuty flavor was further proved by our work (Wang, *et al.*, 2017). We also found a close correlation between (E)-2-methyl-6-(1-propenyl) pyrazine and consumer's rating of roasted peanuts flavor intensity. A detailed description of roasted peanut flavor has recently been reviewed by Davis and Dean (2016).



### **GA 06G**

Normal-oleic runner-type peanut variety developed by University of Georgia's Coastal Plain Experiment Station in Tifton, Ga., and released in 2006. It has high yield, large seed size, excellent shelling rate, and good resistance to the spotted wilt disease caused by tomato spotted wilt virus (TSWV) (<http://georgiacultivars.com/cultivars/peanuts>).

### **GA 13M**

High-oleic runner-type peanut variety University of Georgia's Coastal Plain Experiment Station in Tifton, Ga., and released in 2009. It has high yield, small seed size, resistance to TSWV, and oxidation. Our study showed that this variety maintained roasted flavor better than the rest (<http://georgiacultivars.com/cultivars/peanuts>).

### **Runner (mixed)**

Mixed commercial runner-type peanuts. Runner peanuts mainly grow in Georgia. They have uniform, medium-sized kernels, which allow for even & uniform roasting. This type is very popular in the peanut industry, commonly used for shelled roasted peanuts, peanut butter, etc.

### **Virginia (mixed)**

Mixed commercial virginia-type peanuts. Virginia peanuts are typically produced in Virginia and North Carolina. They have large peanut pods, containing two or more large kernels. This type accounts for most in-shell roasted peanuts.

Figure 1. Medium roasted peanuts used in the study by Wang *et al.* 2017

## Lipid Oxidation and Off-flavors

Lipid oxidation is a major concern in peanut industry because of the high lipid content of peanuts which varies from 44% to 56% in major market peanut types. Roasting and storage of the finished products also has a major impact on the extent of lipid oxidation. Both dry and oil roasting at high temperatures lead to breakdown of the microstructure of the kernels and hence promote lipid oxidation (Davis and Dean, 2016). Lipid oxidation is also considered as a mechanism that increases peanut volatiles throughout storage (Pattee *et al.*, 1971). During oxidation, unsaturated lipid molecules firstly transform to hydroperoxides, which are the primary non-volatile oxidation products. Then hydroperoxides decompose to various volatile aromatic secondary products including alcohols, aldehydes, ketones, furans, organic acids, and hydrocarbons. Most of these secondary oxidation products are responsible for the oxidized flavor in peanuts. However, the flavor threshold of hydrocarbons is very high (90-2150 ppm), which makes this group have least possibility to be responsible for off-flavors. Our lab detected five aldehydes, one ketone, and one alcohol from roasted peanuts during 8 weeks of storage and the origins of these compounds are shown in Table 1.

Table 1. Origins of selected secondary oxidation products

<b>Compounds</b>	<b>Origins</b>
Hexanal	Linoleic acid
Heptanal	Oleic and linoleic acid
Nonanal	Oleic acid
Octanal	Oleic and linoleic acid
2,4-Decadienal	Linoleic acid
3-Nonen-2-one	Linoleic acid
1-Octen-3-ol	Linoleic acid

Our results showed that all these oxidation products had strong positive correlation with overall oxidized flavor and negatively correlated with roasted peanutty flavor. Among them, octanal and nonanal were best predictors of the overall oxidized flavor. As storage time increases, more off-flavors gradually appear. First is cardboard flavor which relates to oxidized products in their early stages of oxidation, followed by fishy and painty flavor. In our study, due to the short storage period (8 weeks) all intensities of these three off-flavors were close to 0.

## Flavor Fade

Flavor fade is a common phenomenon which happens during storage of roasted peanuts, which defines as the decrease of pleasant attributes of roasted peanuts (roasted peanut flavor and sweet taste) accompanied by the development of off-flavors. The mechanism for flavor-fade is still unclear. Warner *et al.* (1996) indicated that the concentration of pyrazines did not reduce during storage. Thus, they concluded that the loss of roasted flavor result from masking of pyrazines by aldehydes (oxidation products). But other researchers did observe a decrease in pyrazines (Williams *et al.*, 2006), which might be responsible for loss of roasted flavor. We also detected a reducing trend in total pyrazine concentration in most roasted peanut samples, although the change was not very significant. It would be possible that a greater change might appear if the storage period is extended. Williams *et al.* (2006) considered that the degradation of pyrazines was caused by lipid radicals and hydroperoxides from lipid oxidation.

Flavor fade also affect consumer's acceptability of roasted peanuts. Our results showed that when buying peanuts, *flavor* was the most important consideration followed by *price* and *texture*. In addition, consumer flavor liking had the largest contribution to their overall liking of roasted peanuts. From the aspect of aroma profile, all aldehydes had a strong negative correlation with consumer overall liking; while only 3 out of 10 pyrazines ((E)-2-Methyl-6-(1-propenyl) pyrazine, 2,3-dimethyl-5-ethylpyrazine, and 2,5-dimethylpyrazine) had a moderate positive correlation with consumer overall liking. This suggested that aldehydes might be better predictors of consumer liking of roasted peanuts than pyrazines.

## High-oleic Trait

Unsaturated fatty acids, mainly oleic (18:1 n-9) and linoleic acids (18:2 n-6), consist of approximately 80% of oil in peanuts. Linoleic acids are essential fatty acids for humans, but they are vulnerable to lipid oxidation compared to oleic acids due to multiple double bonds in their structure. Thus, the ratio of oleic to linoleic acids is regarded as an indicator for rate of lipid oxidation. In order to extend shelf life, high-oleic cultivars are developed. GA 13M is one of them. Compared to normal-oleic runner cultivar GA 06G (the current top choice for runner production), high-oleic GA 13M had higher consumer likings (such as overall liking, liking of flavor, sweetness and roasted peanut flavor, etc.) during 8-week of storage. GA 13M also had lower oxidation products and a better capability to maintain pyrazines during storage.

Some researchers did not observe different consumer likings between normal- and high-oleic roasted peanuts (Nepote *et al.*, 2006). Baker *et al.* (2003) found roasted high-

oleic (SunOleic97R) peanut had least roasted peanut flavor and aroma under all roasting conditions. However, Nepote *et al.* (2009) pointed out that consumer acceptability of high-oleic peanuts depended on specific cultivars. Moreover, previous research stated that high-oleic roasted peanuts generated less oxidized flavors with better persistence of roasted flavor during storage (Nepote *et al.*, 2006). Therefore, a higher consumer acceptability of high-oleic GA 13M might take advantages from the characteristics of this cultivar including better resistance to oxidation. The main limitation of our study on roasted peanuts was that it was based on a single-season harvest.

## Future

Flavor is the most important attribute of roasted peanuts to consumers, which makes flavor fade a concern to peanut industry. The rate of flavor fade is influenced by several factors involving peanut types and cultivars. Based on our research work, we can infer that utilization of high-oleic lines (like GA 13M) is a promising solution for the flavor fade problem in roasted peanuts. Further work on flavor of roasted peanuts and other products such as peanut butter and flavored peanut pastes is necessary to prove the points discussed in this paper by applying a longer storage period and multiple-season-harvested crops.

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