Flavor of roasted peanuts

Koushik Adhikari
• Peanut in the U.S
• Reactions impacting flavor
• Flavor
  • Descriptive profile
  • Instrumental profile
• Correlations between sensory & GC profile
• Flavor fade during storage
• High-oleic trait
• Sensory Evaluation & Consumer lab, UGA Griffin Campus
• The United States is the world’s third largest producer, having a share of 8% of overall production.
• Georgia has the largest proportion with about 49% of the total national production.
• Runner peanuts are preliminarily grown in Georgia, Alabama and Florida.
• Runner group has uniform kernel size and are majorly used for processing, especially peanut butter.
• They have been the dominant type since 1979.
• Now account for 80 percent of the peanuts grown in the United States.
• Popularity of Runner due to its good flavor and roasting characteristics – peanut butter.
• Florunner – higher yields, more oleic acid... hence stable
Maillard reaction is the main reaction that forms various volatiles during processing.
  - Mostly positive impact
  - Roasted peanut flavor

Lipid oxidation or autoxidation is the main reaction that happens during storage.
  - Mostly negative impact
  - Oxidized flavor
Maillard reaction

- Positive effect on flavor during roasting
- Temperatures >150°C, chemical reactions are initiated to produce roasted flavor and color change.
- Initial phase – free amino groups in proteins (basic amino acids) react with reducing sugars (free carbonyl groups)
  - Rearrangement reactions – mainly Amadori
- Intermediate phase – Strecker degradation – pyrazines/furans/furaldehydes are formed
- Melanoidins the brown colored pigments are finally formed
• Among Maillard volatiles – pyrazines are important because they are thought to contribute to roasted flavor
• Has been studied extensively in peanuts
• Basic structure

[Chemical structure of pyrazines]

• Alkylated pyrazines are the major compounds in roasted peanuts (Bett and Boylston 1992)
• Major volatiles that are responsible for roasted peanut flavor.
• Mason and Johnson (1966) were first to identify 5 pyrazines and suggested their possible roles in roasted peanut flavor.
• Buckholz and others (1981) found that 2-ethyl-6-methyl pyrazine and 2-ethyl-3-methyl pyrazine were strongly correlated with consumer acceptability.
• Baker and others (2003) revealed that 2,5-dimethylpyrazine was the best predictor of this flavor.
Autoxidation

- Negative effect on flavor; happens during storage
- In peanut because of its high lipid content which varies from 44% - 56% in the four major market types
- Hydroperoxides is a primary non-volatile oxidation products during the oxidation process
- Decompose to various volatile aromatic secondary products
  - Including alcohols, aldehydes, ketones, furans, organic acids, and hydrocarbons
- Most of these compounds are always associated with the off-flavor
<table>
<thead>
<tr>
<th>Flavor perception</th>
<th>Responsible compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardboard</td>
<td>trans,trans- 2,6-Nonadienal</td>
</tr>
<tr>
<td>Oily</td>
<td>Aldehydes</td>
</tr>
<tr>
<td>Painty</td>
<td>Pent-2-enal, aldehydes</td>
</tr>
<tr>
<td>Fishy</td>
<td>trans,cis,trans-2,4,7-Decatrienol, oct-1-en-3-one</td>
</tr>
<tr>
<td>Grassy</td>
<td>trans-2-Hexenal, nona-2,6-dienal</td>
</tr>
<tr>
<td>Deep-fried</td>
<td>trans,trans-2,3-Decandienal</td>
</tr>
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</table>
**Lexicon for roasted peanuts**

*AROMATICS (Johnson and others, 1988)*

<table>
<thead>
<tr>
<th>Aromatic Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Roasted Peanutty</td>
<td>The aromatic associated with medium-roast and having fragrant character such as methyl pyrazine.</td>
</tr>
<tr>
<td>Raw bean/peanutty</td>
<td>The aromatic associated with light-roast peanuts and having legume-like character (specify beans or pea if possible).</td>
</tr>
<tr>
<td>Dark roasted peanut</td>
<td>The aromatic associated with dark-roasted peanuts having very browned or toasted character.</td>
</tr>
<tr>
<td>Sweet aromatic</td>
<td>The aromatics associated with sweet material such as caramel, vanilla, molasses, fruits (specify fruit).</td>
</tr>
<tr>
<td>Woody/Hulls/Skins</td>
<td>The aromatics associated with base peanut character (absence of fragrant top notes) and related to dry wood, peanut hulls, and skins.</td>
</tr>
<tr>
<td>Cardboard</td>
<td>The aromatic associated with some-what oxidized fats and oils and reminiscent of cardboard.</td>
</tr>
<tr>
<td>Painty</td>
<td>The aromatic associated with linseed oil, oil based paint.</td>
</tr>
<tr>
<td>Burnt</td>
<td>The aromatic associated with very dark roast, burnt starches, and carbohydrates, (burnt roast or espresso coffee).</td>
</tr>
<tr>
<td>Green</td>
<td>The aromatic associated with uncooked vegetables/grasstwigs, <em>cis-3-hexanal</em></td>
</tr>
<tr>
<td>Earthy</td>
<td>The aromatic associated with wet dirt and mulch</td>
</tr>
<tr>
<td>Grainy</td>
<td>The aromatic associated with raw grain (bran, starch, corn, sorghum).</td>
</tr>
<tr>
<td>Fishy</td>
<td>The aromatic associated with plastic and burnt plastics.</td>
</tr>
<tr>
<td>Chemical/plastic</td>
<td>The aromatic associated with plastic and burnt plastics.</td>
</tr>
<tr>
<td>Skunky/mercaptan</td>
<td>The aromatic associated with sulfur compounds, such as mercaptan, which exhibit skunk-like character.</td>
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Aroma/Flavor terms used by Wang and others, 2015, to study short term shelf-life of peanuts

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<td>Oxidized</td>
<td>The flavor associated with rancid fats and oils</td>
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<tr>
<td>Cardboard</td>
<td>The aromatic associated with somewhat oxidized fats and oils and reminiscent of wet cardboard</td>
</tr>
<tr>
<td>Fishy</td>
<td>The aromatic associated with trimethylamine, cod liver oil or old fish</td>
</tr>
<tr>
<td>Painty</td>
<td>The aromatic associated with linseed oil, oil based paint</td>
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</table>
• Our lab detected 30 volatile compounds from roasted peanuts – found by other researchers as well
  • **Aldehydes/ketones:** hexanal; heptanal; octanal; nonanal; 2,4-decadienal; 3-nonene-2-one
  • **Furan derivatives:** furfural; 2-pentyl furan; 2,3-dihydro benzofuran
  • **Pyrroles:** 1-methyl-1H pyrrole; 3-methyl-1H pyrrole
  • **Pyrazines:** methyl pyrazine; 2,5-dimethyl pyrazine; 2-ethyl-5-methyl pyrazine; 3-ethyl-2,5-dimethyl pyrazine; 2-ethyl-3,5-dimethyl pyrazine; 2,3-dimethyl-5-ethyl pyrazine; 2,5-diethyl pyrazine; 2-methyl-6-(trans-1-propenyl) pyrazine; 2,3-diethyl-5-methyl pyrazine; 3,5-diethyl-2-methyl pyrazine.
• Off-flavors
  • Associated with secondary oxidation products: alcohols, aldehydes, ketones, furans, organic acids, and hydrocarbons
  • Flavor perceptions for some lipid oxidation products (Min and Bradley 1992)

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<td>Painty</td>
<td>Pent-2-enal; Aldehydes</td>
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- Early stage of oxidation ➝ Cardboard
- As storage time further increases ➝ Fishy, Painty
Correlations

• Hexanal: Beany flavor in raw peanuts (Pattee and others 1969b).
• Methylbutanal & Methylpropanal: Dark roast flavor (Crippen and others 1992).
• N-methylpyrrole: Woody/hulls/skins flavor (Crippen and others 1992).
PLS Biplot from our study
Correlations

• Major results from our tests
  • Among all the pyrazines, **2,5-dimethyl pyrazine**, seemed most responsible roasted peanutty flavor.
  • Lipid oxidization products (mainly **octanal and nonanal**), (+)ve with overall oxidized flavor; (-)ve with roasted peanutty flavor.
  • Two pyrroles: (+)ve with bitter taste; (-)ve with roasted peanutty flavor.
• **Definition:**
  Loss of positive attributes associated with fresh-roasted peanuts accompanied by the development of off-flavors during storage (Hui and others 2010)
• Development of off-flavors: Lipid oxidation products, masking the roasted flavors
• Loss of the roasted peanut flavor: Loss of pyrazines and associated flavors during storage.
• Sweet attribute significantly decreased from day 0 to day 7, no further decrease was found from day 7 to day 21 (Williams and others 2006).

**Flavor fade**
Flavor fade

- Reduced roasted flavor during storage
  - Warner and others (1996) found that levels of pyrazines relatively stable while aldehydes increased.
  - Masking of pyrazines by large quantities of low-molecular weight aldehydes
  - Bett and Boylson (1992) reported the content of alkypyrazines decreased significantly especially in the early storage time.
  - Degradation of pyrazines was supported by others work (Reed and others 2002; Williams and others 2006)
  - Flavor entrapment or degradation by lipid radicals and hydroperoxides (Williams and others 2006)
• Mechanism:
  Oleic acid increases; less double bonds in lipid profile; oxidize slower
• Compared to normal oleic roasted peanuts, high-oleic peanuts:
  • Have **longer shelf life** (Braddock and others 1995; Mozingo and others 2004; Nepote and others 2006; Reed and others 2002; Talcott and others 2005)
  • **Persistence of roasted flavor better** during storage (Braddock and others 1995; Nepote and others 2006)
  • **Less susceptible to** salt during processing (Mozingo and others 2004) and change in water activity (Reed and others 2002)
Some results from our study funded by GPC

Normal-oleic 06G vs High-oleic 13M – Roasted Peanutty

No change or difference was observed over 8 weeks
Some results from our study funded by GPC

Normal-oleic 06G V.S High-oleic 13M - Consumer tests

High-oleic 13M was significantly preferred over normal-oleic 06G for both overall liking and roasted peanut flavor liking at all three time points over 8 weeks
Some results from our study funded by GPC

Normal-oleic 06G vs High-oleic 13M – GC results

13M had more pyrazines throughout as compared to 06G
SENSORY EVALUATION & CONSUMER LAB

The University of Georgia Griffin Campus

FOODPI&C
## Facilities

### Preparation area
- Fully equipped kitchens for sample preparation
- Ovens, microwave ovens, refrigerators, freezers and other equipment necessary for sample preparation
- Pilot-plant to help with needs of the client

### Evaluation booths
- 18 booths; 10 booths are computerized
- Compusense *five* for data collection
- Could be used for both analytical and affective tests
Preparation area
Evaluation booths
• Both analytical and affective
• Analytical/Trained
  • Discrimination testing
  • Descriptive testing
• Affective/Consumer
  • Qualitative
    • One-on-one interviews and focus groups
  • Quantitative
    • Preference tests and acceptability tests
Consumer acceptability of peanuts – GPC funded
- Acceptability of Vidalia onions
- Descriptive lexicon for peaches
- Acceptability of steaks by millennials and non-millennials
- Storage study on raw blanched peanuts
- Acceptability of dogfoods by pet owners – appearance
- Descriptive analysis of elderberry juice
- Descriptive analysis of bread

Other tests
Thank you!

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