# Flavor of roasted peanuts

**Koushik Adhikari**

The University of Georgia Griffin Campus

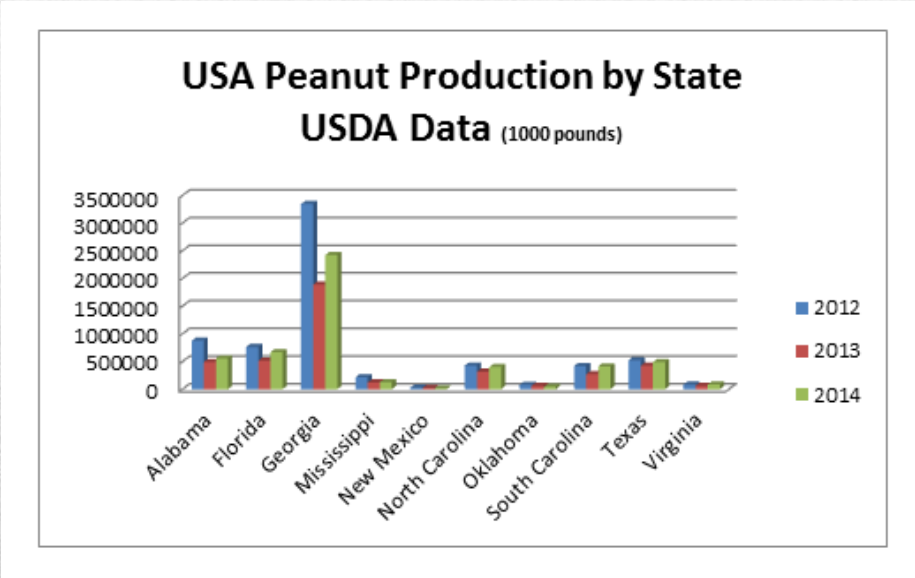
FOODPI&C

# Overview

- 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

# Peanuts in the US

- 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

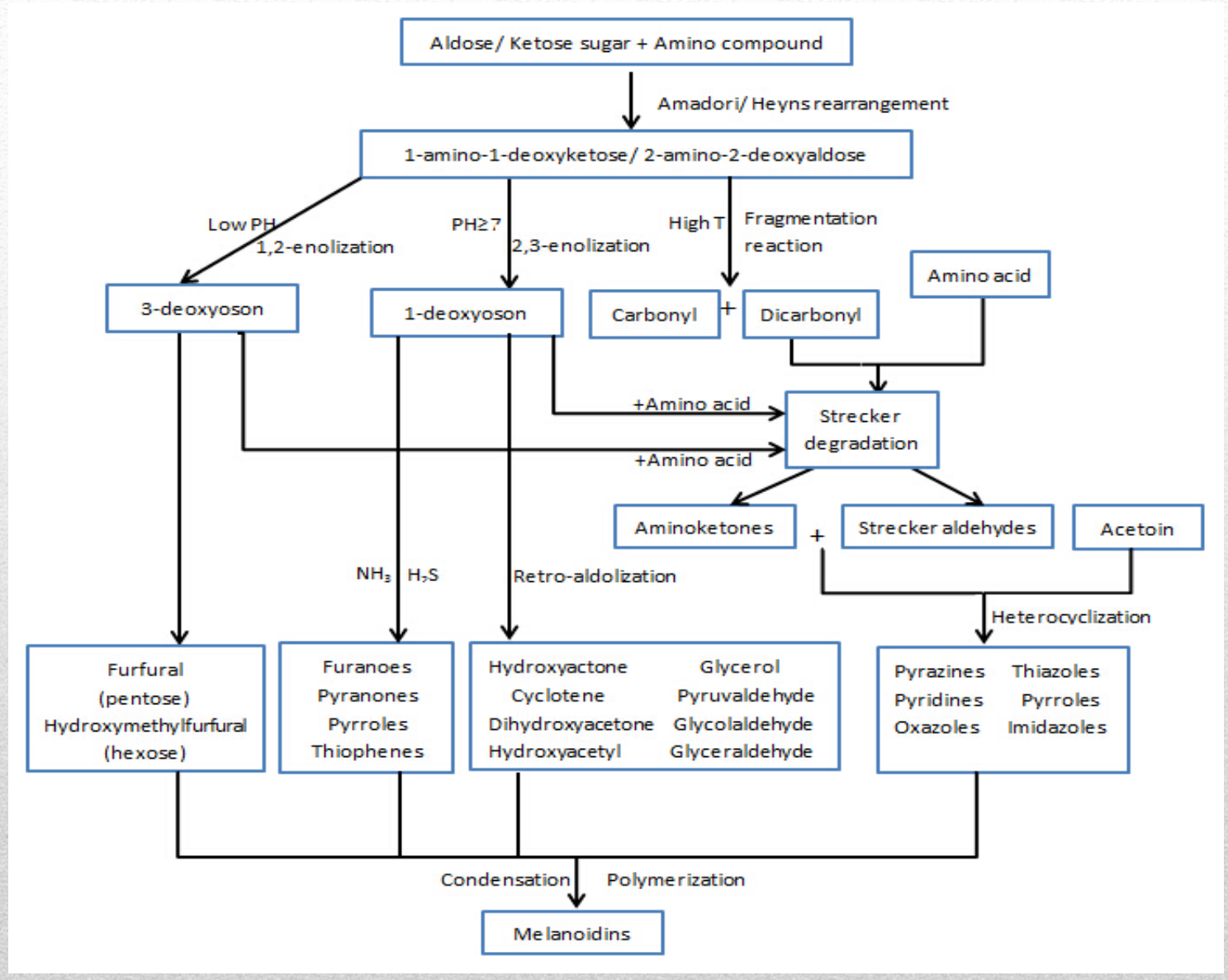
- Runner peanuts are preliminarily grown in Georgia, Alabama and Florida.
- Runner group has uniform kernel size and are majorly used for processing, especially peanut butter.
- They have been the dominant type since 1979.
- Now account for 80 percent of the peanuts grown in the United States.
- Popularity of Runner due to its good flavor and roasting characteristics – peanut butter.
- Florunner – higher yields, more oleic acid…hence stable

# Reactions

- 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

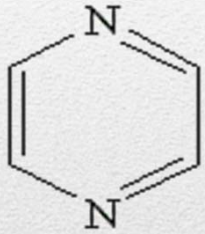
# Maillard reaction

- 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


Aldose/ Ketose sugar + Amino compound
Amadori/ Heyns rearrangement
1-amino-1-deoxyketose/ 2-amino-2-deoxyaldose
Low PH
1,2-enolization
PH≥7
2,3-enolization
High T
Fragmentation reaction
3-deoxyoson
1-deoxyoson
Carbonyl
+
Dicarbonyl
Amino acid
+Amino acid
Strecker degradation
+Amino acid
Aminoketones
+
Strecker aldehydes
Acetoin
$NH_3$ $H_2S$
Retro-aldolization
Heterocyclization
Furfural
(pentose)
Hydroxymethylfurfural
(hexose)
Furanoes
Pyranones
Pyrroles
Thiophenes
Hydroxyactone
Cyclotene
Dihydroxyacetone
Hydroxyacetyl
Glycerol
Pyruvaldehyde
Glycolaldehyde
Glyceraldehyde
Pyrazines
Pyridines
Oxazoles
Thiazoles
Pyrroles
Imidazoles
Condensation
Polymerization
Melanoidins

# Pyrazines

- Among Maillard volatiles – pyrazines are important because they are thought to contribute to roasted flavor
- Has been studied extensively in peanuts
- Basic structure




- Alkylated pyrazines are the major compounds in roasted peanuts (Bett and Boylston 1992)

# Pyrazines

- 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

# Autoxidation

| **Flavor perception** | **Responsible compounds** |
|---|---|
| Cardboard | *trans*,*trans*- 2,6-Nonadienal |
| Oily | Aldehydes |
| Painty | Pent-2-enal, aldehydes |
| Fishy | *Trans*,*cis*,*trans*-2,4,7-Decatrienol, oct-1-en-3-one |
| Grassy | *Trans*-2-Hexenal, nona-2,6-dienal |
| Deep-fried | *Trans*,*trans*-2,3-Decandienal |

| ***Lexicon for roasted peanuts*** <br> ***AROMATICS* (Johnson and others, 1988)** | |
|---|---|
| Roasted Peanutty | The aromatic associated with medium-roast and having fragrant character such as methyl pyrazine. |
| Raw bean/peanutty | The aromatic associated with light-roast peanuts and having legume-like character (specify beans or pea if possible). |
| Dark roasted peanut | The aromatic associated with dark-roasted peanuts having very browned or toasted character. |
| Sweet aromatic | The aromatics associated with sweet material such as caramel, vanilla, molasses, fruits (specify fruit). |
| Woody/Hulls/Skins | The aromatics associated with base peanut character (absence of fragrant top notes) and related to dry wood, peanut hulls, and skins. |
| Cardboard | The aromatic associated with some-what oxidized fats and oils and reminiscent of cardboard. |
| Painty | The aromatic associated with linseed oil, oil based paint. |
| Burnt | The aromatic associated with very dark roast, burnt starches, and carbohydrates, (burnt roast or espresso coffee). |
| Green | The aromatic associated with uncooked vegetables/grasstwigs, *cis-3-hexanal* |
| Earthy | The aromatic associated with wet dirt and mulch |
| Grainy | The aromatic associated with raw grain (bran, starch, corn, sorghum). |
| Fishy | The aromatic associated with plastic and burnt plastics. |
| Chemical/plastic | The aromatic associated with plastic and burnt plastics. |
| Skunky/mercaptan | The aromatic associated with sulfur compounds, such as mercaptan, which exhibit skunk-like character. |

# Descriptive profile

# Descriptive aroma profile

Aroma/Flavor terms used by Wang and others, 2015, to study short term shelf-life of peanuts

| | |
|---|---|
| Roasted peanutty | The aromatic associated with medium-roast peanuts |
| Oxidized | The flavor associated with rancid fats and oils |
| Cardboard | The aromatic associated with somewhat oxidized fats and oils and reminiscent of wet cardboard |
| Fishy | The aromatic associated with trimethylamine, cod liver oil or old fish |
| Painty | The aromatic associated with linseed oil, oil based paint |

# Instrumental aroma profile

- 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-nonen-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.

# Correlations

- 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)

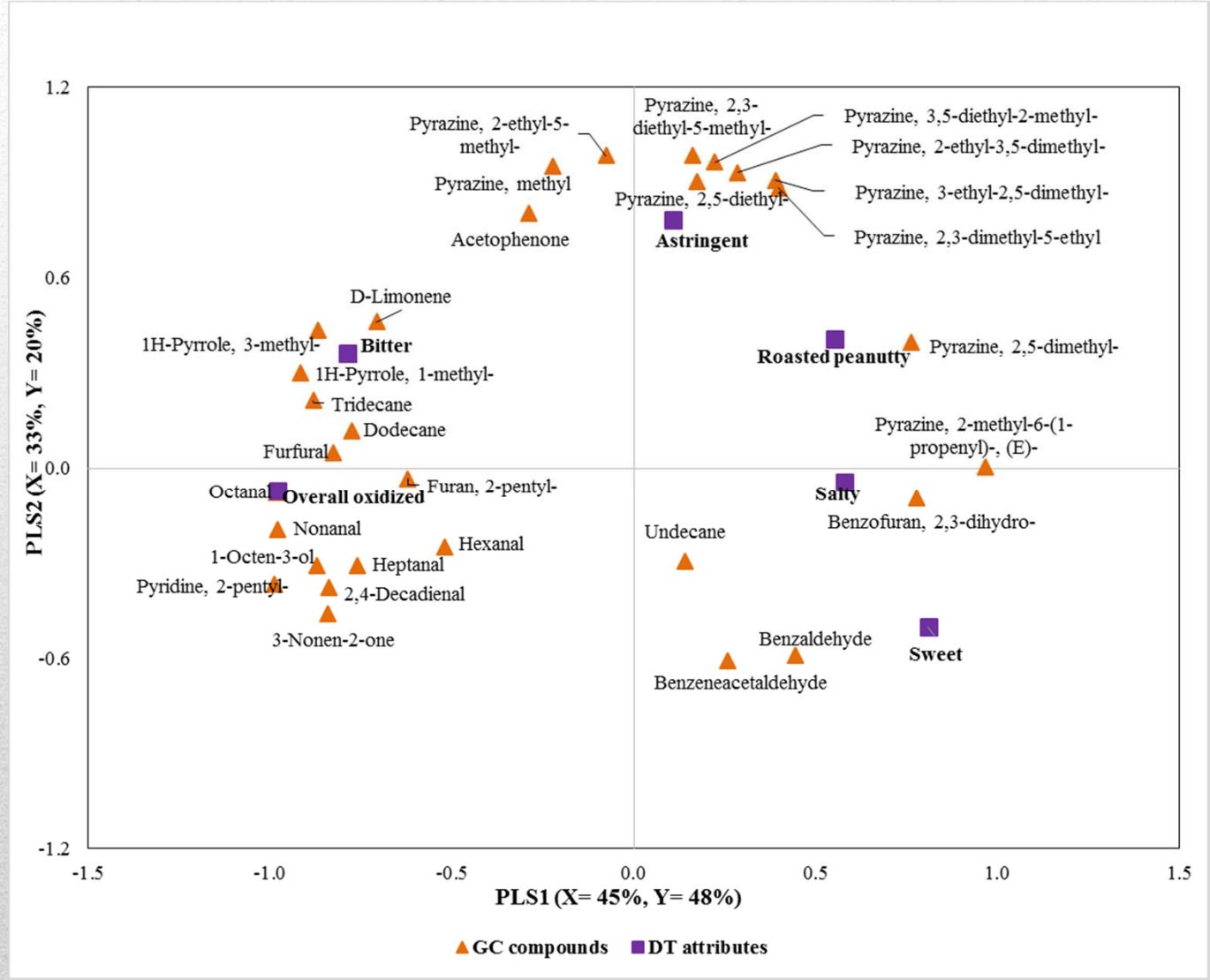
| Flavor perception | Responsible compounds |
|---|---|
| Cardboard | *trans,trans*- 2,6-Nonadienal |
| Fishy | *Trans,cis,trans*-2,4,7-Decatrienol; Oct-1-en-3-one |
| Painty | Pent-2-enal; Aldehydes |

- Early stage of oxidation ⟶ Cardboard
- As storage time further increases ⟶ Fishy, Painty

- 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).

# Correlations

# 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.

# Flavor fade

- 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

- 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)

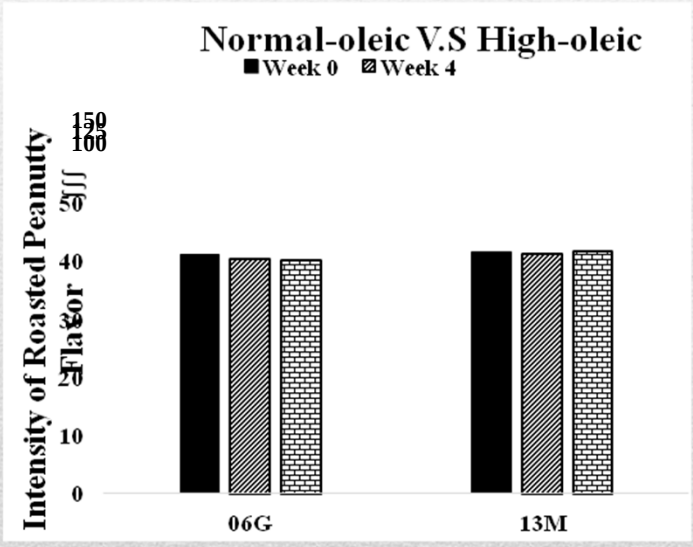
# High-oleic trait

- 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

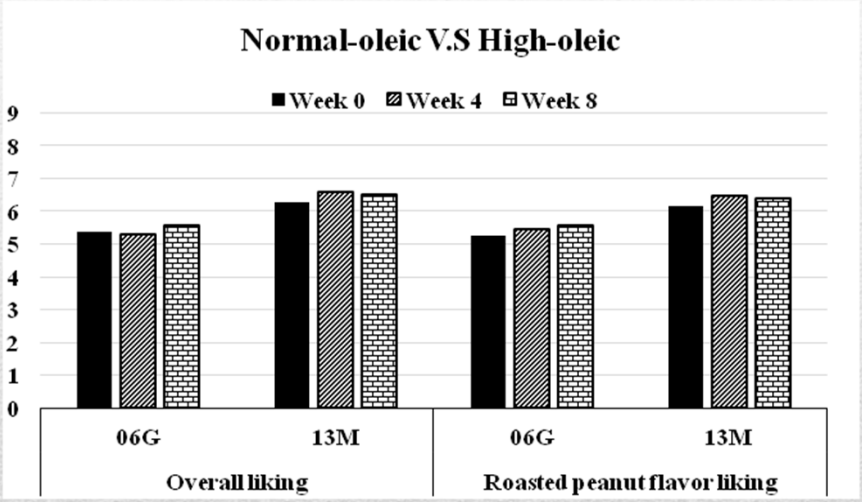
Normal-oleic 06G vs High-oleic 13M – Roasted Peanutty




No change or difference was observed over 8 weeks

# Some results from our study funded by GPC

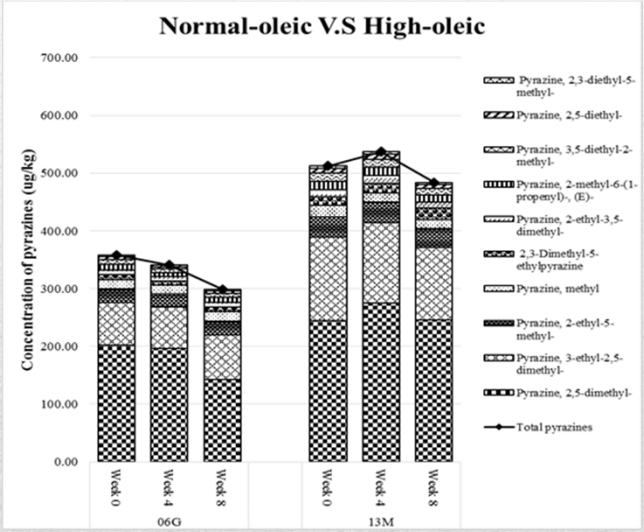
Normal-oleic 06G V.S High-oleic 13M - Consumer tests




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

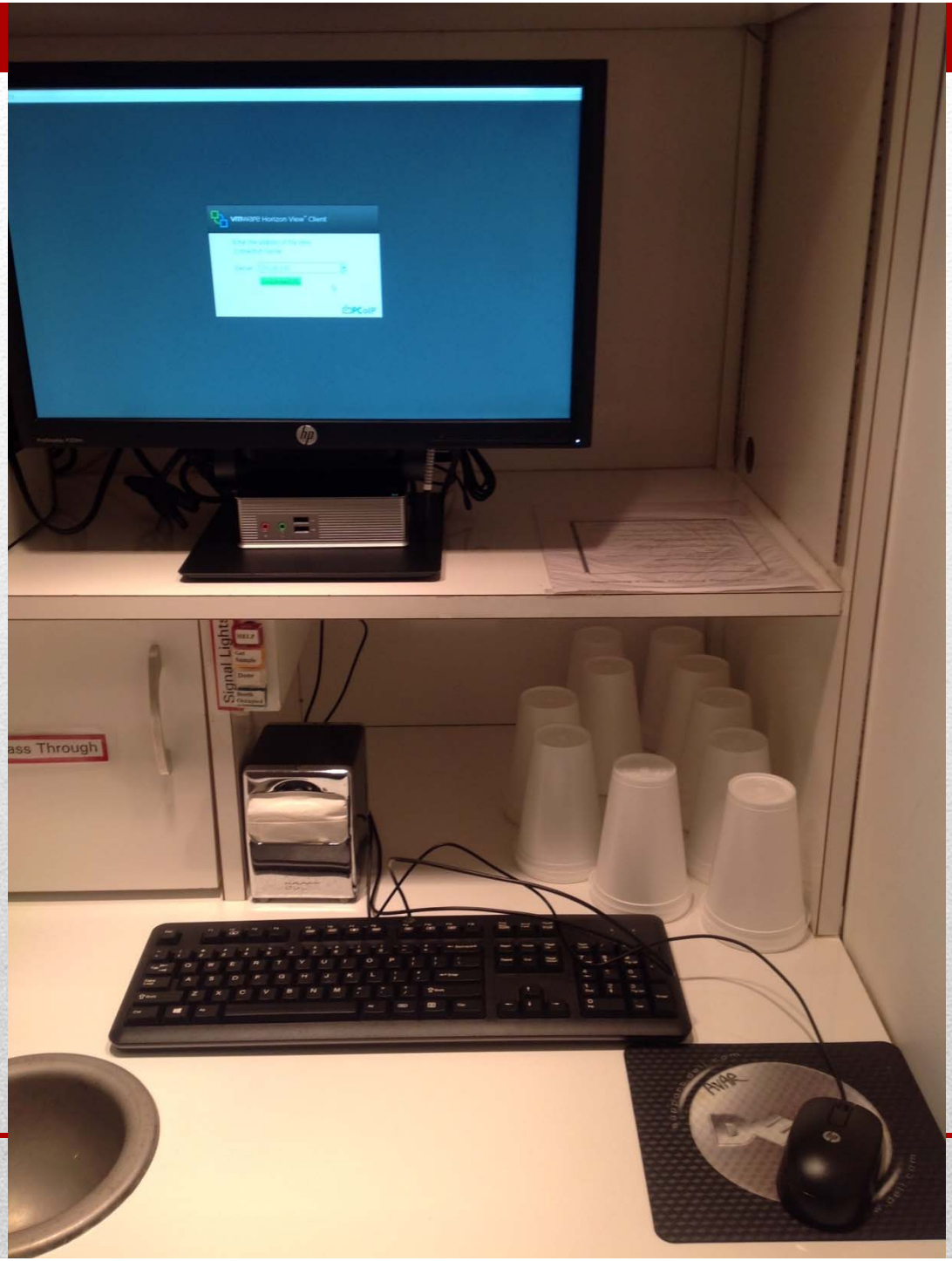
## Evaluation booths

- 18 booths;10 booths are computerized
- Compusense *five* for data collection
- Could be used for both analytical and affective tests

# Preparation area



# Evaluation booths


Signal Light
ass Through


Salty
Control

# Test capabilities

- 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

## In-shell

## Kernels

# 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!**

**koushik7@uga.edu**