

# **Overview of Distilled Spirits Flavor Production and Evaluation of Their Characteristics – with Selected Aroma Bottle Samples**

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## **Outline**

**Summary of Flavor Production**

**Set of 10 Key Flavors presented as  
aroma bottles**

**On the origin of flavor species and the  
survival of the key notes**

## **Heart and Soul**

**How well do you know  
the heart and soul of your  
beverage?**

## **Heart and Soul**

**Subjective – Flavor is  
complex!**

**The Flavor Compositions and  
Characteristics of Beverages  
Depend on the Distillery**

**Where Art Meets Science**

## The Flavors/Classes

Acetaldehyde [Aldehydes]  
Butanedione - Diacetyl [Ketones]  
Butyric Acid [Acids/Fatty acids]  
DMS [Sulfur – sulfides]  
Ethyl Acetate/Ethyl Hexanoate [Esters – aliphatic]  
Eugenol [Phenols]  
Fusel Oils [Higher Alcohols]  
Phenethylacetate [Aliphatic-Aromatic group Ester]  
Whiskey Lactone [Lactone]

## Thoughts - I

- “A characteristic and sound flavor in distilled beverages can only rarely be associated with specific compounds.”
- “Perceived odor sensation - evoked by many different compounds together.” [Quality/flavor complex]
- But if flavors are out of specification or unpleasant?

## Thoughts - II

- ❑ **Flavors – desirable/undesirable or in/out of specification –depends on concentration and detection thresholds. Synergy/Antagonistic.**
- ❑ **The actual amount of each component is less important than its aroma threshold. Yet volatility is important.**
- ❑ **“Beauty is in the olfactory system of the beholder.”**

## The Flavors - Intro

**We start the presentation of 10 key flavors in the form of aroma bottles. The assessments are spread out through the presentation.**

**Please carefully evaluate (a couple sniffs) of each compound and relate to the notes provided in the handout.**

## First Three Flavor Notes

- Acetaldehyde – of Apples and Florists!
- 2,3-Butanedione (Diacetyl) Where is the Butter Popcorn?
- Butyric Acid – Ah, Cheesy Babies!

## On the Origins of Flavors

- Raw Materials
- Water
- Yeast and Fermentation
- Microbial Flavors – desirable use of or contaminant organisms.
- Stills, shape-structure, materials
- Maturation/Aging

## **Raw Materials**

- Barley**
- Corn**
- Rye**
- Wheat**
- Grapes**
- Stone Fruits**

## **Microbiological Issues**

- Microbiological issues**
  - Desirable organisms – Lactic acid bacteria**
    - Bourbon – sour mash**
    - Rum – butyric flavors**
  - Contaminating organisms – unwanted flavors**
  - Choice of yeast strain**

## Water

- pH, minerals, taints
- Excess or deficit both cause stress...not necessarily a bad thing

## Flavor Notes 4 to 6

- Dimethyl sulfide – of Corn and Oysters!
- Ethyl acetate – Painting the House?
- Ethyl hexanoate (caproate) Turning Cheese to Fresh Red Apples and Spice – nice!

## Fermentation

### □ Yeast and Fermentation

- > Most important source congeners or congener precursors
- > Conditions important/yeast strain

### □ Microbial contaminants

BOURBON: Yeast strains selected for producing congeners (flavor) not alc. yield. Enough need to produce 6%+

## Fermentation - Congeners

### □ Congeners production:

Yeast and flavor metabolism – volatile congeners:

Rise with an increase in inoculation size

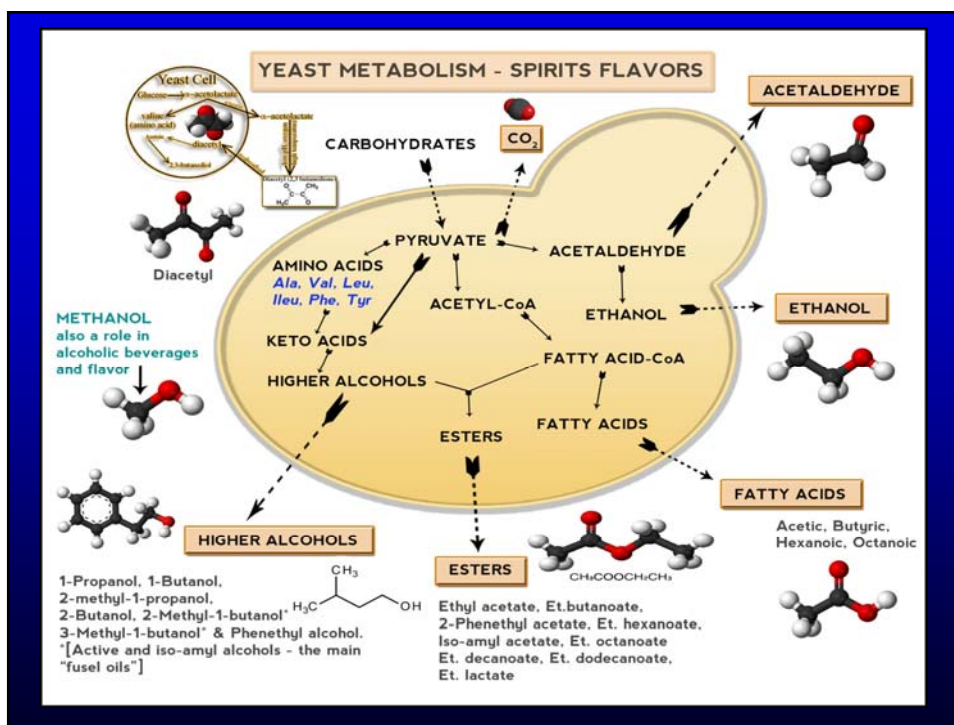
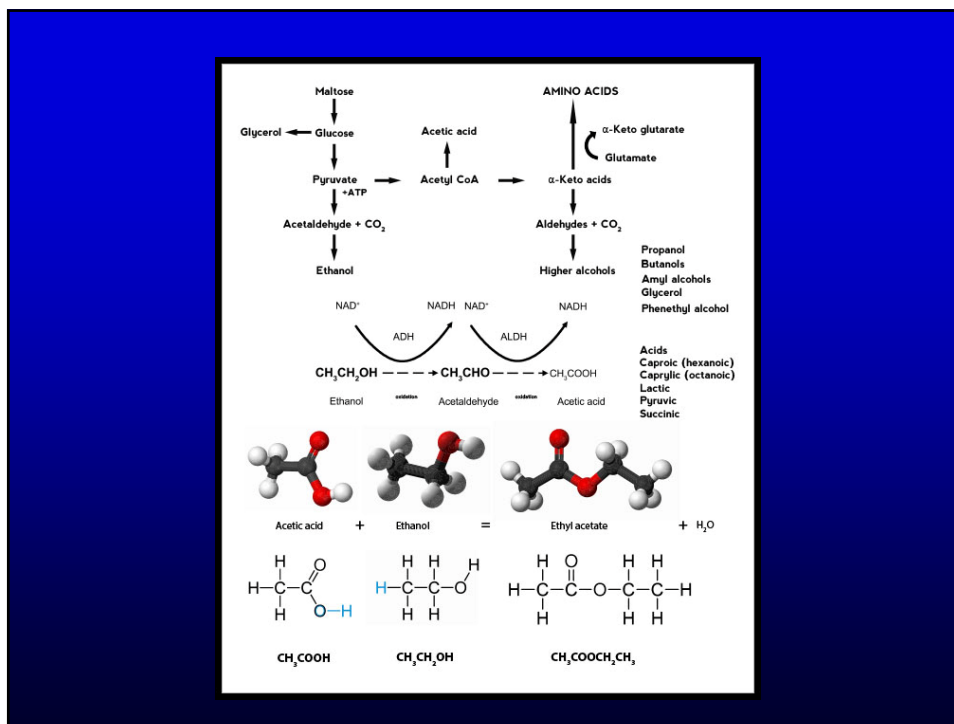
Rise with an increase in agitation

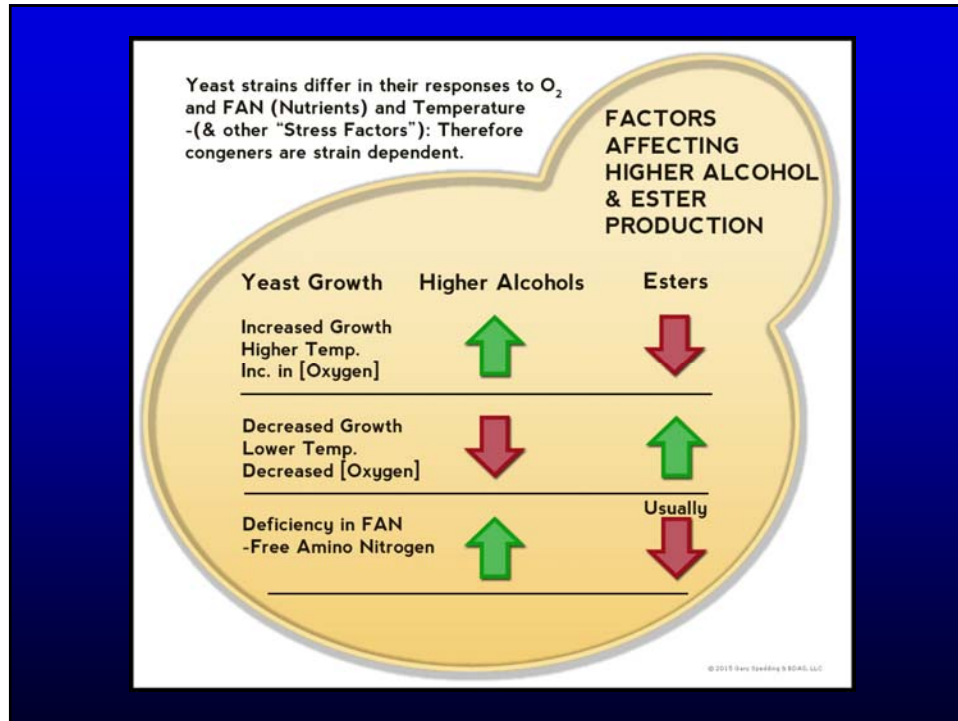
Rise with higher fermentation temps

Any increase in fermentation rate will favor congener production

Leads us to >> Flavor metabolism







## Stills

- ❑ (Pot or Column): shape-structure, materials (copper)
- ❑ Operation of (The art and skill of each distiller:
  - Extent of heads and tails removed during first cut/ # of distillations, recycling of cuts
- ❑ Different flavors/different concentrations from Continuous distillation?

## Stills

### □ DISTILLATION:

Aerated wash – more reactive with copper surfaces of the stills -- reduces the amount of sulfury off-notes

Soluble copper compounds and complexes form with oxygenated mash that react with and remove sulfur compounds

Location of copper as most sulfur removal occurs at phase change

## Heads or Tails?

### □ Heads (Fore-shots):

SO<sub>2</sub>, Acetaldehyde, Ethyl acetate

### □ Tails (Feints or After-shots):

Cutting out the fats

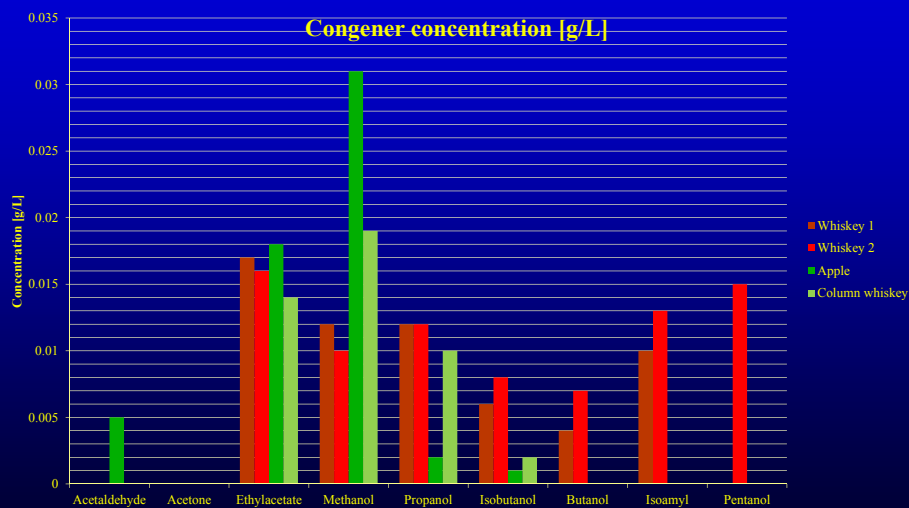
Ethyl esters of caprylic and caproic acids

Caproic (C6), Caprylic C8) and Capric (C10) acids

Fatty acids: Soapy, goaty, fatty aromas

Ethyl esters: Sweet, fruit, oily

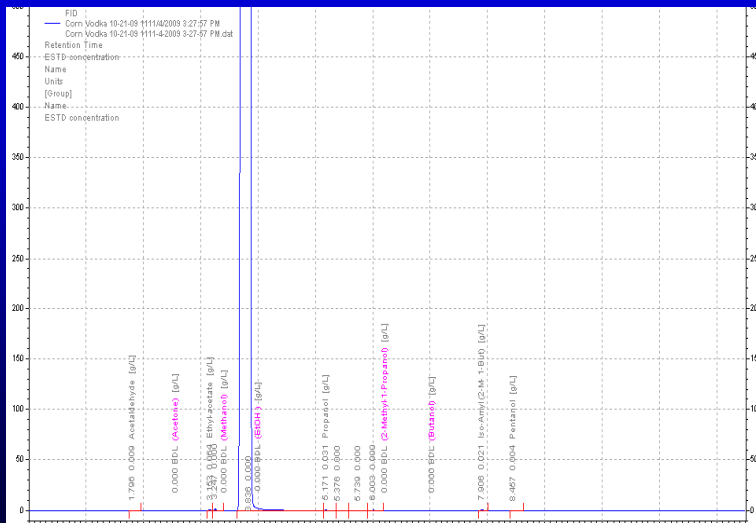
## Substrate and Distillation Dependent



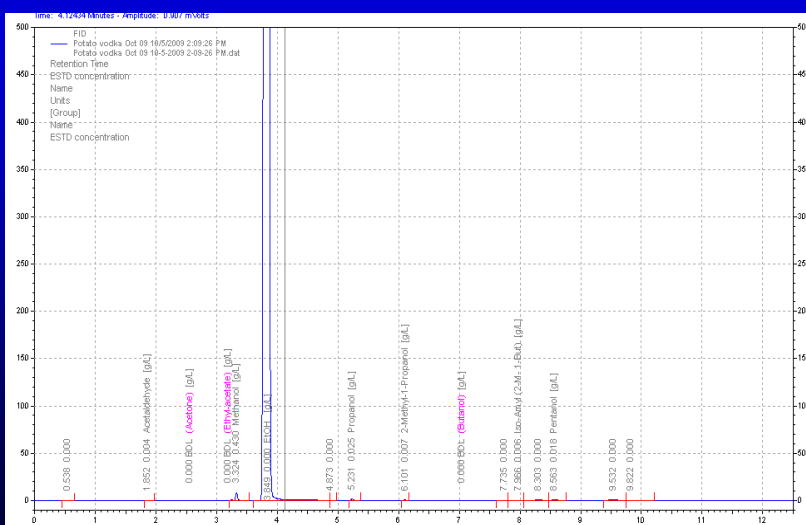
## More protein = Higher Fusels

Total protein	% by weight
Yellow dent corn	9.64%
White sweet corn	3.20%
Hard red winter wheat	15.00%
Organic soft wheat	2.70%
Barley	12.00%
Apple	0.30%
Grape	0.65%

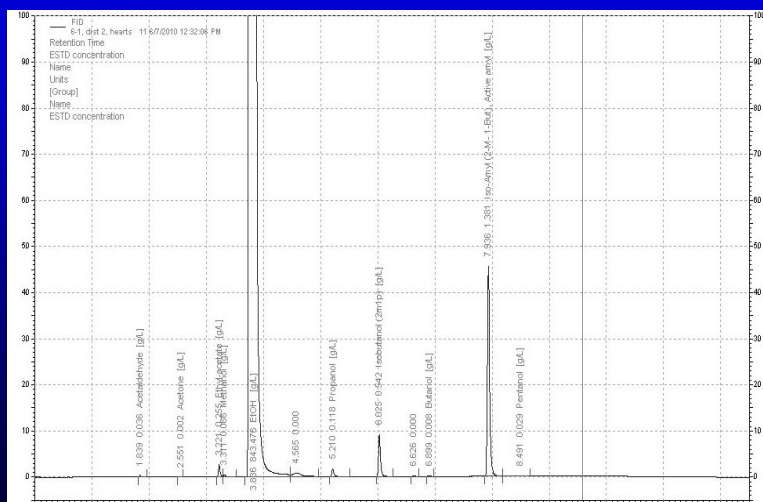
# Corn Vodka GC



# Potato Vodka GC



## Whiskey GC



## Maturation

**“The specific combination of one type of distillate with any one type of cask leading to the development of a flavor profile relative to time.”**

## Flavor Notes 7, 8 and 9

- Eugenol – Cloves and cinnamon – toasted staves!
- Fusels – spicy pungency – keep it down please.
- Phenylethanol – smell the roses - fusels not so after all? A mask in disguise?

## Maturation

- Maturation Time, rxns, temperature
- Fill strength-extraction
- Wood composition and preparation (toast/char)
  - Casks: #Times used/Previous contents!
- New compounds – flavor congeners in maturing spirit
  - Storage wooden casks gives rise to whisky lactone, vanillin, guaiacol, eugenol, cresols >> migrate from the wood to the spirit
- Loss of Compounds (e.g., sulfurs lost)

## Who is in the Wood?

Acids – hint of vinegar!

Aldehydes – leafy and floral

Sulfury – meaty and rubbery

Oily – nutty butter anyone?

Sweet – honey and vanilla – nice!

Woody – resinous and piney

Lactones – coconut and more

Phenolics – wood smoke, cloves and medicinal

Faint of heart – a tail here? – leather and tobacco and goats?

Don't lose your heads. Estery – fruity and fragrant

A lot goes into the barrel and a lot of action goes on in the barrel – who goes where – who goes there? Who stays to play with your taste buds and delight your aroma sensors?

## Very low thresholds for oak compounds

..... Odour qualities and threshold values of aroma impact compounds from toasted oak wood

Compound	Odour quality	Threshold (mg L <sup>-1</sup> water)
Furfural	Smoky, almond	8
Guajacol	Smoky	0.005
<i>cis</i> -Methyl- $\gamma$ -octalactone/ <i>trans</i> -Methyl- $\gamma$ -octalactone	Oak, wood	0.02
Vinylguajacol	Phenolic, clove	0.03
4-Methylguajacol	Smoky, burnt wood	0.01
4-Ethylguajacol	Smoky, phenolic	0.02
4-Ethylphenol	Stable-like, horse	0.13
Eugenol	Spicy, clove	0.007
Vanillin	Vanilla, spicy	0.1
<i>o</i> -Cresol	Medicinal, tar	0.04
<i>m</i> -Cresol	Medicinal, smoky	0.2



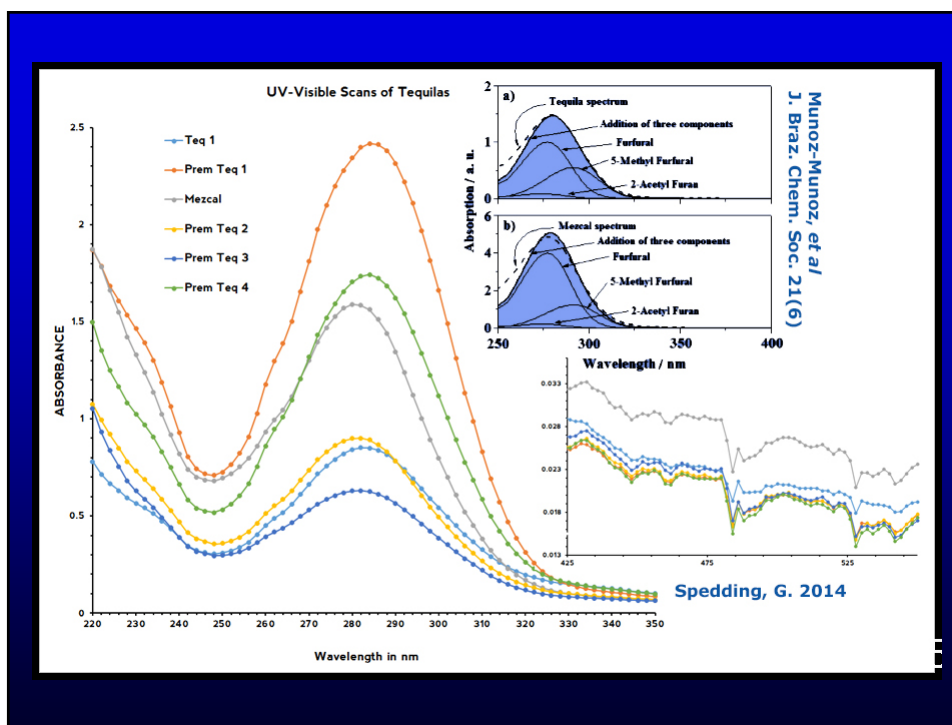
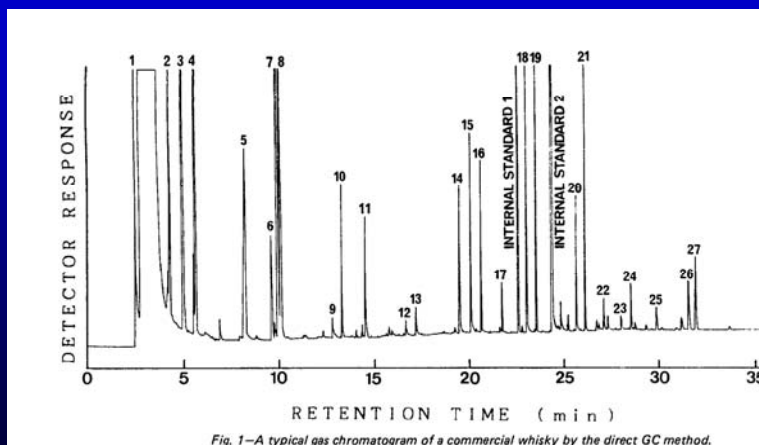
## Synergistic Thresholds are Lowwww!

Barrel size	Day to surpass syringaldehyde taste threshold	Day to surpass syr/van threshold
2	56	7
3	70	7
5	150	14
10	202	7

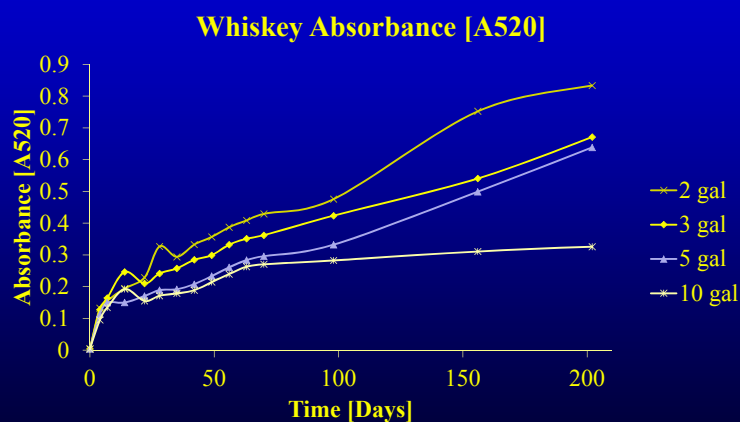
### What Johnny said:

- Johnny indicated today the use of GC and Mass Spec techniques in evaluating distilled spirits
- But wait there is more...
- How about consistency and authentication through Spectroscopy?
- Being used also for maturation studies
- Who is hiding under the curves?

## GCMS, cool but probably unnecessary



## Quick and easy Spectrophotometer



## Last But Not Least Flavor Note # 10

- Whisky lactone – let's hear it for the coconuts

Where the wood hits a positive lipid note

But the benchmark must be right – isomers at play

Wrapping up the maturation

## Summary

We presented 10 key flavors in the form of aroma bottles. **Aroma bottles with a cotton plug soaked in alcohol to give a spirit base-note and “spiked” with pure compounds provide a starting point for sensory evaluation of flavors**

The origins of many of these flavors were discussed during the aroma evaluation sessions

Thank you for your participation today

Gary Spedding and Johnny Jeffery