## **Project Summary**

# **Product Quality**

**Project Title:** Development of Relative Aroma Intensity Values for Aroma

Chemical Compounds Using Published Aroma Thresholds for

Important Aroma Chemicals

**Principle Investigator(s):** Chris Kerth, Ph.D. and Rhonda Miller, Ph.D.

**Institution(s):** Texas A&M University

**Completion Date:** June 2015

## **Background**

Beef flavor is incredibly complex, and it is not completely understood how flavor influences palatability of beef. Although previous research studies have done an admirable job of reviewing current literature and describing many of the factors involved in determining beef flavor, much still needs to be accomplished to gain a full understanding of the subject. In the development of quantitative descriptions of the chemical compounds responsible for beef flavor, one research study described over 100 chemical compounds that were found to influence beef flavor, with their resulting aroma thresholds and aroma descriptors. Furthermore, numerous studies have described methods of determining an odor activity value (OAV) derived from the quantity of an aroma chemical compound found from gas chromatography/ mass spectroscopy/olfactory (GC/MS/O) and its detection threshold. This OAV then describes the relative contribution of each aroma chemical to the overall aroma/flavor of the meat. It was then hypothesized that a similar value (Relative Aroma Intensity Value) could be calculated using only the total ion counts from GC/MS/O and the thresholds reported in the literature.

The objective of this study is to determine if converting a quantitative measurement of each chemical responsible for beef flavor into a Relative Aroma Intensity Value (RAIV) will prioritize the aroma chemicals by their relative contribution to overall aroma/flavor of beef.

#### Methodology

Aroma chemical compounds derived from GC/MS/O analyses were analyzed from 3 different checkoff-funded projects: 1) Beef flavor attributes and consumer perception I (heavy beef eaters), 2) Beef flavor attributes and consumer perception II (light beef eaters) and 3) Consumer attitudes of predicted flavor aromas in steaks created with different steak thickness, quality grade and cooking surface temperature. Total ion counts were taken for each aroma chemical compound and subsequently divided by its aroma threshold value to derive a Relative Aroma Intensity Value. Each chemical was then ranked based on the RAIV to determine the relative contribution of each chemical compound to the overall aroma/flavor of the beef.

#### **Finding**

The resulting RAIV for heavy beef eaters are reported in Table 1. DL-Limonene (lemon-like, citrus), Nonanal (citrus/soapy), hexanal (green/grassy), E-2-noneneal (fatty/green), methanethiol (vegetable oil/creamy), heptanal (fatty), octanal (citrus/green) and 1-octen-3-ol (mushroom/earthy) ranked among the highest RAIV for heavy beef eaters for all treatment groups. Hexanal is a fixture near the top of all three tables as hexanal is almost universally found in the highest quantities in cooked meat, and has a moderately high detection threshold, resulting in a high RAIV.

2,3-butanedione (buttery) has been shown to be significantly related to consumer like. This compound's rank declined as the severity of cooking method increased as shown with higher



degrees of doneness on the grill compared to lower degrees of doneness in the slow cooker. This is an indication that 2,3-butanedione is favored in low-heat, slow cooking scenarios as opposed to high heat grilling. In contrast, pyrazines as a whole, and trimethyl pyrazine (raw/ musty) in particular ranked higher as degree of doneness and grilling increased. Pyrazines are Ffa product of the Maillard reaction and also tend to be characterized as caramel or roasted in nature. Maillard reaction products would be expected to be higher in concentration in higher heat cooking methods, which agree with the findings of this study.

## **Implications**

The use of RAIV is a useful tool to determine the relative contribution of aroma chemical compounds to the development of beef flavor and is another tool to describe beef flavor. Additional efforts need to be developed to use relative aroma intensity values as a modeling tool to synthesize experimental beef flavor profiles as a method to research the impact of influencing one or more step in the development of aroma chemical compounds.



**Table 1.** Heavy beef eaters (Relative Aroma Intensity Values were calculated and each aroma chemical was ranked form the highest to the lowest with the highest RAIV being at the top of each column and lowest at the bottom).

Districtions   Dist	Crock pot 137°F	Clamshell 137 °F	Grill 137°F	Crock pot 176°F	Clamshell 176 °F	Grill 176°F
Hearnal   2-Nomenal(f):	Dl-Limonene	Dl-Limonene	DI-Limonene	Dl-Limonene	Dl-Limonene	DI-Limonene
Personal	Nonanal	Nonanal	Nonanal	Nonanal	Nonanal	Nonanal
NORTHAL   NORT	Hexanal	2-Nonenal,(E)-	2-Nonenal,(E)-	Methanethiol	Hexanal	Hexanal
NONENAL   NONENAL   Passaria	2-Nonenal,(E)-	Hexanal	2-Acetyl-2-thiazoline	Hexanal	NHEPTANAL	2-Acetyl-2-thiazoline
Methanethiol   1-OCTRA-3-CL   Hexanal   Octanal   Octa	NHEPTANAL	NHEPTANAL	NHEPTANAL	Disulfide, dimethyl	2-Nonenal,(E)-	2-Nonenal,(E)-
Octanal   Octanal   Octanal   Methanethicis   1.OCTRN-3.OL   NONENAL	NONENAL	NONENAL	NONENAL	2-Nonenal,(E)-	Disulfide, dimethyl	NHEPTANAL
Methanethiobbs   Methanethiol   1-OCTEN-3-OL   Octanal	Methanethiol	1-OCTEN-3-OL	Hexanal	NHEPTANAL	2-Acetyl-2-thiazoline	Methanethiol
1-OCTEN-3-OL 2-Seturacelone 2-Recenal(E) 3-Recenal(E) 4-Recenal(E) 4-R	Octanal	Octanal	Octanal	Methane,thiobis-	1-OCTEN-3-OL	NONENAL
2-Decental(E)   Methane, Phiobic   2-Decental(E)   2-Betrandine   2-Decental(E)   2-Betrandine   2-Decental(E)   2-Betrandine   2-Decental(E)   2-Betrandine   2-Decental(E)	Methane, thiobis-	Methanethiol	1-OCTEN-3-OL	Octanal	Octanal	Octanal
2-Acetyl-2-hiszoline   2-Acetyl-2-hiszoline   2-Decensis[G]-   2-Butanedione   1-OCTANO   2-Butanedichies   2-Butanedione   1-OCTANO   2-Butanedichies   3-Butanedione   1-OCTANO   2-Butanedione   3-Butanedione   1-OCTANO   2-Butanedione   3-Butanedione	1-OCTEN-3-OL	Disulfide, dimethyl	Dodecanal	NONENAL	NONENAL	Disulfide, dimethyl
2-Decenal(E)-   Methanchiclobs   2-3-Butanedione   1-OCTRA-3-OL   2-3-Butanedione   Styrene   1-Heptanel   Styrene   1-Heptanel   Styrene   1-Heptanel   Styrene   Styrene   1-Heptanel   Styrene   Styrene   1-Heptanel   Styrene   1-Heptanel   Styrene   1-Heptanel   Styrene   1-Heptanel   Styrene   1-Heptanel   Dodecanal   Styrene   1-Heptanel   Dodecanal   Styrene   1-Heptanel   Dodecanal   3-Heptanel   3-Decenal(E)-   Dodecanal   3-Heptanel   3-Decenal(E)-   Dodecanal   3-Heptanel   3-Decenal(E)-   Dodecanal   Styrene   2-Decenal(E)-   Dodecanal   Styrene   Noranolcacid   Pertanal   Pertanal   Pertanal   Styrene   Noranolcacid   Pertanal   Pertanal   Pertanal   Styrene   Noranolcacid   Propanal, 3-Imethylthio)-   Decenal   Propanal, 3-Imethylthio)-   Propanal, 3-Imethylthio -   Propanal, 3-Imethylthio	2,3-Butanedione	2-Decenal,(E)-	Methane, thiobis-	2-Acetyl-2-thiazoline	Styrene	1-OCTEN-3-OL
Dodecanal   Styrene   Heptanal   Pentanal   Styrene   Heptanal   Dodecanal	2-Acetyl-2-thiazoline	2-Acetyl-2-thiazoline	2-Decenal,(E)-	2,3-Butanedione	Methane, thio bis-	2-Decenal,(E)-
Dodecanal   Styrene   Heptanal   Pentanal   Styrene   Heptanal   Dodecanal	2-Decenal,(E)-	Methane,thiobis-	2,3-Butanedione	1-OCTEN-3-OL	2,3-Butanedione	Methane,thiobis-
Disablifed, dimethy						
December   Pentanal   Pentanal   Pentanal   2-December   Dedecanal   3-Institute   3	Pentanal		Styrene	Heptanal	Pentanal	
Pentanal				Dodecanal		2.3-Butanedione
Heptanal   Forms 2 pentify    Forms 2 pentify    1-Heptanol   Pentanal					Dodecanal	
Styrene   Nonanoicacid   Propanal,3-(methythio)-   Benzaldehyde   Propanal,3-(methythio)-   Benzaldehyde   Prepanal,3-(methythio)-   Prepanal,3-(methyth				Furan,2-pentyl-		
Styrene   Nonanolacid   Propanal 3-(methylthio)-   Benzaldehyde   Benzaldehyde   Benzaldehyde   Nonanolacid   PHENYLACETALDEHYDE   2-Heptenal(E)-   2-Heptenal(E)-   PHENYLACETALDEHYDE   Phenyala-3-(methylthio)-   1-Octanol   1-Octan				Styrene		
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Nonanoicacid   Heptanol   1-Butanol   1-Octanol   2-Pentanone   2-Pent						
2-Pentanone 1-Butanol 2-Butanone 3-hydroxy- 1-Butanol 2-Pentanone 1-Butanol 2-Pentanone Pyrazine, 2-thyl-3-methyl- 2-Butanone, 3-hydroxy- 2-Nonanone 1-Dodecanol 3-Hexanol Acetophenone 1-Dodecanol 2-Nonanone Hexanolcacid  1-Hexanol Acetophenone						
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2-Butanone,3-hydroxy- Hexanoicacid Ethanone,1-phenyl- Ethanone,1-phenyl- Ethanone,1-phenyl- Ethanone,1-phenyl- Hexanoicacid 1-Hexanol 1-Hexanol Hexanoicacid 2-Nonanone 1-Dodecanol 1-Hexanol Acetophenone 1-Dodecanol 2-Nonanone Hexanoicacid 2-Nonanone 1-Dodecanol 1-Hexanol Acetophenone 1-Dodecanol 2-Nonanone Hexanoicacid 1-Hexanol Acetophenone 1-Dodecanol 2-Nonanone 1-Dodecanol 3-Pentenoicacid,4-methyl- 2-Nonanone 1-Dodecanol 3-Pentenoicacid,4-methyl- 3-Pentenoicacid,4-methyl- Heptanoicacid 1-Hexanol 1-Hexanol Acetophenone 1-Hexanol 3-Pentenoicacid,4-methyl- Heptanoicacid 1-Butanol,3-methyl-(1) 1-Butanol,3-methyl-(1) Heptanoicacid 1-Butanol,3-methyl-(1) 1-Buta						
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Hexanoicacid, butylester   Heptanoicacid   1-Butanol, 3-methyl-()   1-Butanol, 3-methyl-()   3-Pentenoicacid   1-Butanol, 3-methyl-()   3-Pentenoicacid, 4-methyl-   3-Pentenoicacid, 4-methyl-   3-Pentenoicacid, 4-methyl-   3-Pentenoicacid, 4-methyl-   3-Pentenoicacid, 4-methyl-   3-Pentenoicacid, 4-methyl-   3-Pentenoicacid   3-Pentenoicacid, 4-methyl-   3-Pentenoicacid   3-Pentenoicacid   3-Pentenoicacid   4-Pentanoicacid   4-Pentanoicac	2-Nonanone	1-Dodecanol	3-Pentenoicacid,4-methyl-	2-Nonanone	Acetophenone	1-Hexanol
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1-Butanol,3-methyl-() Hexanoicacid,butylester 2-Propanone Hexanoicacid,butylester Octanoicacid Aceticacid  Pyrazine,3-ethyl-2,5- dimethyl- 2-Furancarboxaldehyde Pentanoicacid 1-Propanol Octanoicacid Pentanoicacid Sulfurdioxide  Hexanoicacid,pentylester 2-Propanone Pentanoicacid 2-Propanone 1-Propanol 1-Propanol 1-Propanol Sulfurdioxide 1-Butanol,3-methyl-() 1-Propanol Sulfurdioxide 1-Butanol,3-methyl-() 1-Propanol 1-Propanol 1-Propanol 2-Furancarboxaldehyde 1-Propanol 2-Furancarboxaldehyde Pentanoicacid 3-Propanol 2-Furancarboxaldehyde 1-Propanol 3-Propanol 3-Propan				Pyrazine,3-ethyl-2,5-		
Pyrazine,3-ethyl-2,5-dimethyl-         Aceticacid         2-Furancarboxaldehyde         Aceticacid         2-Propanone         2-Propanone           2-Furancarboxaldehyde         Pentanoicacid         1-Propanol         Octanoicacid         Pentanoicacid         Sulfurdioxide           Hexanoicacid,pentylester         2-Propanone         Pentanoicacid         2-Propanone         1-Propanol         2-Furancarboxaldehyde           1-Propanol         1-Propanol         1-Dodecanol         Sulfurdioxide         1-Butanol,3-methyl-()         1-Propanol           Sulfurdioxide         2-Furancarboxaldehyde         Disulfide,dimethyl         1-Propanol         2-Furancarboxaldehyde         Pentanoicacid           Acetophenone         Pyrazine,3-ethyl-2,5-dime	1-Butanol,3-methyl-()	Hexanoicacid, butylester	2-Propanone	,	Octanoicacid	Aceticacid
2-Furancarboxaldehyde     Pentanoicacid     1-Propanol     Octanoicacid     Pentanoicacid     Sulfurdioxide       Hexanoicacid, pentylester     2-Propanone     Pentanoicacid     2-Propanone     1-Propanol     2-Furancarboxaldehyde       1-Propanol     1-Propanol     1-Dodecanol     Sulfurdioxide     1-Butanol,3-methyl-()     1-Propanol       Sulfurdioxide     2-Furancarboxaldehyde     Disulfide,dimethyl     1-Propanol     2-Furancarboxaldehyde     Pentanoicacid       Acetophenone     Pyrazine, 3-ethyl-2,5-dimethyl-     Methanethiol     2-Furancarboxaldehyde     Sulfurdioxide     1-Dodecanol	Pyrazine,3-ethyl-2,5-					
Hexanoicacid,pentylester 2-Propanone Pentanoicacid 2-Propanone 1-Propanol 2-Furancarboxaldehyde  1-Propanol 1-Propanol 1-Dodecanol Sulfurdioxide 1-Butanol,3-methyl-() 1-Propanol Sulfurdioxide 2-Furancarboxaldehyde Disulfide,dimethyl 1-Propanol 2-Furancarboxaldehyde Pentanoicacid  Acetophenone Pyrazine,3-ethyl-2,5- dimethyl- Methanethiol 2-Furancarboxaldehyde Sulfurdioxide 1-Dodecanol	2-Furancarboxaldehyde	Pentanoicacid	1-Propanol	Octanoicacid	Pentanoicacid	Sulfurdioxide
1-Propanol 1-Propanol 1-Dodecanol Sulfurdioxide 1-Butanol,3-methyl-() 1-Propanol Sulfurdioxide 2-Furancarboxaldehyde Disulfide,dimethyl 1-Propanol 2-Furancarboxaldehyde Pentanoicacid Pyrazine,3-ethyl-2,5-dimethyl- Methanethiol 2-Furancarboxaldehyde Sulfurdioxide 1-Dodecanol	Hexanoicacid, pentylester		·			2-Furancarboxaldehyde
Sulfurdioxide         2-Furancarboxaldehyde         Disulfide,dimethyl         1-Propanol         2-Furancarboxaldehyde         Pentanoicacid           Acetophenone         Pyrazine,3-ethyl-2,5-dimethyl-         Methanethiol         2-Furancarboxaldehyde         Sulfurdioxide         1-Dodecanol						1-Propanol
Acetophenone Pyrazine,3-ethyl-2,5- dimethyl- d						
					,	
	Pyrazine,2-ethyl-3-methyl-		Sulfurdioxide	Pentanoicacid	1-Dodecanol	Octanoicacid

