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Identification of Off-Flavor Compounds in Beef Round and Chuck Muscles

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Summary

Volatile off-flavor compounds are present in beef. Using purge and trap gas chromatography and mass spectrometry, some volatile compounds were shown to have different concentrations in normal-flavored beef, compared to samples with liver-like off-flavor. Most of the compounds, like pentanol, hexanal, hexanol, 1–octen–3–ol, and nonanol, are associated with lipid oxidation. The compounds, β-pinene and 1-octen-3-ol were in higher concentration in the liver-like samples in all muscles tested. Several, small, unidentified peaks also differed between samples. Determination of the possible origins of these compounds may improve the quality and consistency of beef products.

Introduction

Flavor is an important factor in beef palatability. With the increased use of individual muscles from the chuck and round, quality and consistency becomes essential to maintain consumer acceptability. Meat flavor is typically developed through reactions between amino acids and carbohydrates in addition to the flavor created by the fatty acid profile. Volatile compounds formed during heating also contribute to flavor and off–flavor in meat. To minimize undesirable volatile off-flavors, an understanding of the compounds being produced in off-flavored samples compared to normal samples is worthwhile. The objective of this research was to identify differences in volatile compounds between steaks with liver–like off–flavors and normal samples.

Procedure

Infraspinatus (Flat Iron; INF), Triceps brachii (Clod Heart; TRI), Rectus femoris (Knuckle Center; REC), Vastus lateralis (Knuckle Side; VAL), and Vastus intermedius (Knuckle Bottom; VAI) were evaluated. These muscles from USDA Select carcasses were identified as "liver–like" or "normal" by a trained taste panel with "normal" classification having an off–flavor rating of 5 or above on an 8–point scale. "Normal" INF were not available at the time of testing. Five grams of the raw, homogenized sample and 10 mL of distilled water analyzed with a O-I- Analytical Eclipse 4660 purge and trap gas chromatograph (GC) system (Hewlett Packard 6890) from 86°F to 176°F. An 11-minute purge was collected in the 86°F trap and allowed to desorb for four minutes. The volatile compounds were auto-injected into the GC and run through a Hewlett Packard 5MS column (98 ft, 0.25 mm ID, and 0.25 µm film thickness), starting at 104°F for four minutes, raised to 482°F at 46.4°F/minute, and held for 10 minutes. Compounds were identified with a mass spectrometer (Hewlett Packard 5973). Samples were kept at refrigerated temperatures (<12 hours) until analyzed.

Table 1. Compound concentration differences between the liver-like and normal beef muscles

	TRI[c]		REC[c]		VAL[c]		VAI[c]	
Compound[a, b]	Liver-like	Normal	Liver-like	Normal	Liver-like	Normal	Liver-like	Normal
2,3-Dimethyl Oxirane							↓	↑
Pentanal	↑	↓					↑	↓
Heptanol	↑	↓			↑	↓	↑	↓
Hexanal	↑	↓			↑	↓	↑	↓
Hexanol					↑	↓	↑	↓
2-Heptanone	↑	↓					↑	↓
Heptanal	↑	↓					↑	↓
Benzaldehyde	↑	↓					↑	↓
β-Pinene	↑	↓	↑	↓	↑	↓	↑	↓
1-Octen-3-ol	↑	↓	↑	↓	↑	↓	↑	↓
2-Methyl-3-Octanone or N-Caproic Acid Vinyl Ester	↑	↓			↑	↓	↑	↓
2-Pentyl Furan	↑	↓					↑	↓
Octanol	↑	↓					↑	↓
α-Pinene	↑	↓					↑	↓
2-Octenal	↑	↓					↑	↓
1-Octenal	↑	↓					↑	↓
Nonanal	↑	↓			↑	↓	↑	↓
Hydroxymandelic Acid							↑	↓
Cyclotetrasiloxane	↑	↓			↑	↓	↑	↓
1,3-bis (1,1-Dimethylethyl)-Benzene							↑	↓

[a]Compounds listed revealed concentration differences in chromatograms.
[b]↑ indicates that a higher concentration of the compound was found in that type of sample; ↓ indicates that a lower concentration of the compound was found in that type of sample.
[c]TRI = Triceps brachii, REC = Rectus femoris, VAL = Vastus lateralis, and VAI = Vastus intermedius.

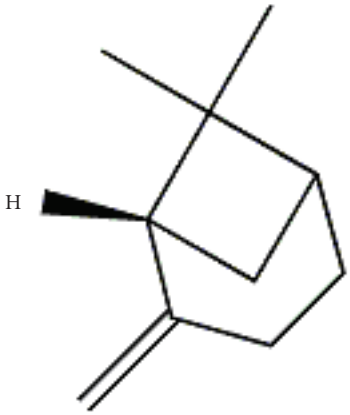

Figure 1. Structure of β-pinene.

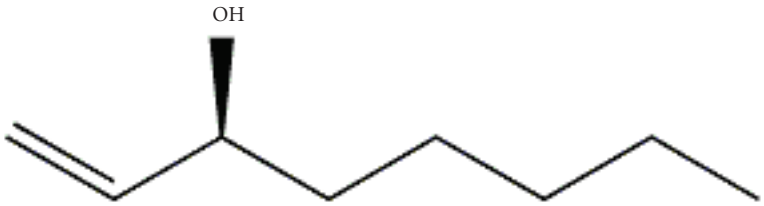

Figure 2. Structure of 1-Octen-3-ol.

Results

Thirty–eight to 74 volatile compounds were present in the samples with normal TRI having the least number of compounds and liver-like VAI having the most. Differences in the presence and concentration of compounds were noted between liver–like and normal samples, as well as among muscles. Several small, unidentified peaks were absent in liver–like samples, but present in the normal. Approximately four peaks were present in the liver-like samples, but absent in the normal samples. When the concentration of the compounds was different, the normal samples, in most cases, had lower concentration in the muscles (Table 1). Most of the compounds found in greater amounts in the liver–like samples are associated with lipid oxidation, such as pentanol, hexanal, hexanol, 1–octen–3–ol, and nonanol. The compounds, β-pinene and 1-octen-3-ol (Figure 1 and 2, respectively), were in higher concentration in the liver-like samples in all muscles tested. As mentioned previously, 1-octen-3-ol is related to lipid oxidation, while β-pinene is an oxidation product of limonene (a common citrus aromatic terpene) found in pine trees and their berries in addition to many plants and forages.

Differences were observed in volatile compounds between liver–like and normal beef muscles from the chuck and round. A combination of compounds, not a single compound, likely contributes to the undesirable flavor. Research to determine the possible origins of these compounds in the beef system is necessary to ensure that quality and consistency of meat from these muscles is acceptable to consumers.

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