Project Title: Fatty acid composition, percentage intramuscular lipids, and beef tenderness, juiciness, and flavor

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Background

It is well established that increasing the percentage intramuscular lipid (%IML) increases overall palatability, and that marbling scores are positively correlated with %IML. However, %IML does not always correlate with juiciness and/or flavor. Early research reported no difference between USDA Choice and Select top sirloin steaks for juiciness, although %IML differed between quality grades. Others evaluated USDA Prime, Top Choice, Low Choice, Select, and ungraded rib eye steaks and demonstrated that Prime rib eye steaks rated highest for juiciness; however, juiciness ratings did not differ among steak from the other quality grades, and flavor level was not different among quality grades. Thus, it is difficult to predict eating quality of beef based solely on marbling score. Oleic acid (18:1n-9) is the most abundant fatty acid in beef from grain-fed cattle, and oleic acid contributes positively and significantly to flavor characteristics of beef. As marbling score increases across a broad range of production conditions (days on feed; grass vs grain feeding; calf-feeding versus yearling-feeding; Wagyu versus Angus steers), there is a concomitant elevation in the concentration of oleic acid. Increasing oleic acid in adipose tissue reduces the melting points of lipids, but, paradoxically, even though increasing oleic acid is a liquid at room temperature, there are only weak correlations between the percentage oleic acid in beef and juiciness. This lack of correlation of oleic acid with juiciness may be related in which fatty acid data were reported. Typically, simple correlations are calculated between percentage oleic acid and juiciness. However, not only does the percentage oleic acid increase with increases in %IML, the absolute amount of oleic acid (grams oleic acid/100 grams muscle) increases in muscle. Therefore, the objectives of this study were to develop regression correlations among individual fatty acids and beef juiciness and flavor; and document correlations among intramuscular lipid slip point and beef juiciness and flavor.

Methodology

Source of beef. USDA Select, Choice, and Prime ribeye rolls and Choice ribeye rolls from grass-fed cattle were purchased from a local wholesale company (n = 6 each). To increase the number of observations and increase the power of our statistical analyses, we used ribeye rolls from a recently completed study in which grain-fed heifers were raised to USDA Choice (TAMU Choice). The vacuum-packaged ribeye rolls were aged 21 days at 4°C post-processing date before being hand-cut into 2.5-cm-thick steaks.

Cooking and trained sensory analysis. Steaks were thawed in refrigerated storage at 4°C for 12 to 24 hours and cooked on a 2.5 cm-thick flat top countertop electric griddle with thermostatic controls. Steaks were turned at an internal temperature of 35°C and removed at 71°C (medium degree of doneness). Sensory analysis was conducted by an expert trained beef flavor and texture descriptive attribute panel. Panelists were trained to scale each attribute on a 16-point intensity scale (0 = none and 15 = extremely intense). For sample testing, panelists were served two random and representative cubes. Panelists tested 12 samples/day with a minimum of 4 minutes between each sample, with a break after the sixth sample.

Total lipids and fatty acid composition and lipid melting point. A 1-cm section of the entire surface of each rib muscle was removed from each ribeye steak and the outside fat was trimmed to remove any surface fat. The entire 1-cm section was homogenized in a food blender, and total lipids were extracted and weighed gravimetrically to quantify percent intramuscular lipid (%IML). Fatty acid methyl esters in a gas/liquid chromatograph by standard techniques. Percentage fatty acids (100 X grams fatty acid/100 lipid) and total acids in beef (100 X grams fatty acid/100 grams steak) were calculated. Melting points of trim fat and IML were approximated by determining slip points by standard techniques used in our laboratory.

Findings

Prime strip steaks had the highest %IML (14%), followed by grass-fed (10%), Select and Choice (6%), and TAMU Choice (5%). Prime strip steaks had the lowest percentage stearic acid (18:0) and α-linolenic acid (18:3n-3). Correspondingly, as %IML increased, the percentages of stearic acid and α -linolenic acid decreased (Figure 1). Increasing the percentage of α -linolenic acid decreased positive flavor attributes such as Beef Flavor and Brown/Roasted (Figure 2), and increasing stearic acid had a similar effect (data not shown).

Percentage of stearic acid was negatively correlated with Beef Flavor, Brown/Roasted, Buttery, and Juiciness, and percentage of α-linolenic acid was negatively correlated with Beef Flavor, Brown/Roasted, and Buttery (Table 1). The only fatty acid positively associated with Juiciness was percentage linoleic acid (18:2n-6).
Amounts (grams fatty acid/100 grams strip steak) of intramuscular lipid, stearic acid, oleic acid, and linoleic acid were positively correlated with Beef Flavor, Brown/Roasted, and Buttery. These results indicate that increasing total lipid and most fatty acids increase positive flavor attributes of beef, which the exception of α -linolenic acid. Amount of α -linolenic acid was not correlated with any flavor attribute, but neither amount of intramuscular lipid nor amount of fatty acids were correlated with juiciness.

Implications

We conclude that, contrary to our hypothesis, the amount of oleic acid in beef is not responsible for steak juiciness, but neither does the amount of total intramuscular lipid have any effect on beef juiciness. However, production practices that decrease the percentages of stearic acid and α -linolenic acid strongly increase positive beef flavor attributes.

Images

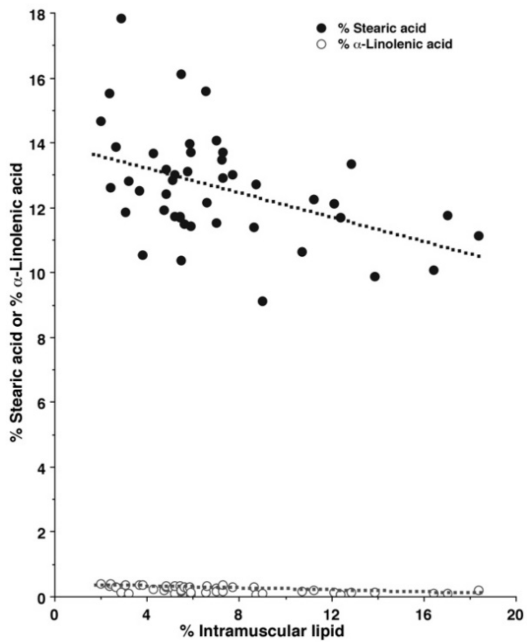

Figure 1. Percentage stearic acid or α-linolenic acid as a function of percentage intramuscular lipid.

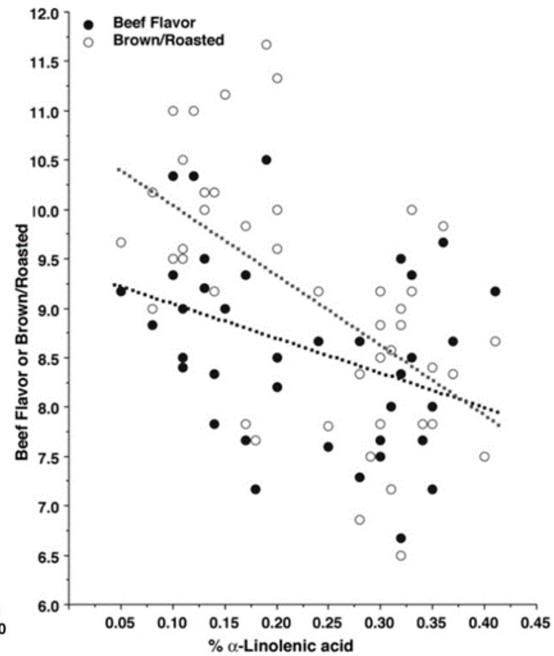

Figure 2. Beef Flavor and Brown/Roasted taste panel attributes as a function of percentage α-linolenic acid.

Tables/Figures

Table 1. Simple linear correlations among percentage and amount fatty acids with taste trained sensory panel flavor attributes of strip steaks from Angus heifers grain-fed to USDA Choice and for Grass-fed, Select, Choice, and Prime strip loins purchased at a local wholesale outlet[1]

Item	Fatty acid				
Percentage, grams fatty acid/100 grams lipid					
Flavor attribute		Stearic acid	Oleic acid	Linoleic acid	a-Linolenic acid
Beef Flavor		-0.421**	0.039	-0.163	-0.390**
Brown/Roasted		-0.333*	0.078	-0.236	-0.581***
Umami		-0.344*	-0.104	0.073	-0.087
Buttery		-0.338*	-0.119	-0.083	-0.403**
Juiciness		-0.260‡	-0.088	0.387*	0.168
Amount, grams fatty acid/100 grams steak					
Flavor attribute	IML	Stearic acid	Oleic acid	Linoleic acid	a-Linolenic acid
Beef Flavor	0.415**	-0.359**	0.395**	0.430**	0.100
Brown/Roasted	0.384**	0.351**	0.384**	0.390**	0.030
Umami	0.174	0.134	0.187	0.217	0.067
Buttery	0.371**	0.294*	0.322*	0.315*	-0.040
Juiciness	0.014	-0.043	-0.004	0.153	0.023

[1]Values are means for *n* = 21 TAMU Choice, *n* = 6 Grass-fed, *n* = 6 Select, *n* = 6 Choice, and *n* = 6 Prime ribeyes. ‡*P* < 0.10; **P* < 0.05; ***P* < 0.01; ****P* < 0.001.