Effect of end-point temperature and degree of doneness on sensory and instrumental properties of beefsteaks

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Abstract

Previous research showed that flavor and tenderness of beef are equal drivers in determining overall liking at the consumer level and that top loin, top sirloin, and top round are preferred by consumers when cooked to less than a medium degree of doneness. However, a section of the population prefers these meat cuts when cooked to greater than medium-well degree of doneness. Because the consumer attribute of flavor desirability followed the same degree of doneness, these results might be explainable by the flavor attributes being the drivers of overall liking scores. Thus, this project investigated the effect of six different end point temperatures (55ºC, 60ºC, 63ºC, 71ºC, 77ºC and 82ºC) on consumer liking, sensory characteristics, Warner-Bratzler shear and headspace analysis values. Beef rib eye (60) and strip loin steaks (60) from three animals of the same age and USDA quality grade were randomly assigned (18 rib eye steaks each) to Warner-Bratzler shear force determination, descriptive analysis and instrumental analysis, and the remaining steaks were assigned to a consumer study. Warner-Bratzler shear force values increased as end point temperature increased, and steaks cooked to 82ºC and 77ºC were significantly different from steaks cooked to 55, 60, 63 and 71ºC. Descriptive analysis of the steaks was conducted by 10 panelists who developed attributes, namely beefy, roasted, burnt, blood, fatty, tender, grainy, juicy, fibrous, bite and crisp, during training sessions. There was a significant effect of end point temperature on all the attributes except fibrous and bite. Steaks cooked to 82ºC were characterized by burnt and crisp while those cooked to 71ºC and 77ºC were characterized by roasted, tender, beefy, and bite and those cooked to 63ºC and less were characterized by juicy, blood and fibrous. Consumers (n=96) evaluated each steak for overall liking (OLIKE), liking of tenderness (TLIKE), liking of juiciness (JLIKE) and liking of flavor (FLIKE) using a 9-point hedonic scale. Liking scores were not significantly different for OLIKE and FLIKE. TLIKE and JLIKE scores were lower for steaks cooked to 71ºC and above. External preference mapping was done to relate descriptive sensory data to consumer liking data. PC1 accounted for 92% of the variance and separated texture attributes such as grainy, fibrous and crisp from tender and juicy, while PC2 accounted for only 5% of the variance and separated flavor attributes such as roasted and beefy from burnt. Also, Warner-Bratzler shear force values were negatively correlated to tender and juicy attributes showing that more juicy and tender steaks had lower Warner-Bratzler shear values. Headspace volatiles were extracted by dynamic headspace analysis and analyzed by GC-MS. Some of the identified flavor compounds included 3-ethyl-2,5-dimethyl pyrazine, acetophenone, 2,6-dimethyl-5-ethyl pyrazine, pentenal, (Z)-2-octenal, 1-octanal 2-acetylpyrrole, 2-pentylfuran, 2-nonanone, decanal, 2-octanone, benzene, acetaldyhyde, dimethyldisulfide, 2-decenal, benzyl methyl ether, 6-ethyl-2,3-dimethyl pyrazine, 2-pentanone and 3-octanone. In conclusion, consumers related their liking of steaks more with tenderness attributes like juicy and tender rather than flavor attributes.

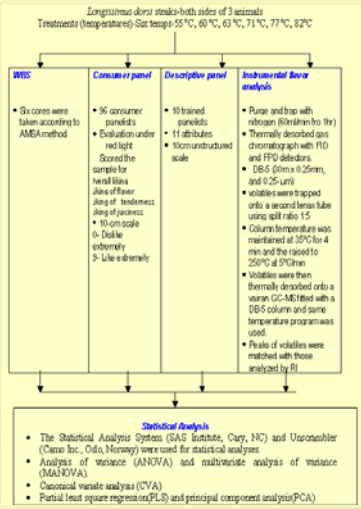
Objective

•Determine changes in sensorial and instrumental flavor profile as well as tenderness in top loin steaks cooked to different degrees of doneness.

•Determine degree of liking by consumers of top loin steaks cooked to different degrees of doneness.

• Correlate sensorial and instrumental flavor profiles and tenderness measurements with degree of liking to identify sensory attributes and flavor compounds that are drivers for degree of liking and determine importance of tenderness as compared to flavor for degree of liking.

Materials & Methods



Results

Table 1: Cooking loss and cooking time

	Average Cooking loss %	Cooking time (min)
Temp-55	17.2	11.3
Temp-60	21.4	13.6
Temp-63	24.9	15.0
Temp-71	31.5	20.7
Temp-77	35.7	24.7
Temp-82	36.8	26.3

•Cooking loss and time increased with increase in temperature

Table2a: Descriptive Flavor Attributes

	Beefy	Roasted	Burnt	Blood	Fatty
Temp-55	5.1 c	3.2 d	0.49 b	5.3 a	4.9 a
Temp-60	5.7 abc	4.0 cd	0.73 b	4.9 ab	4.4 ab
Temp-63	5.7 abc	4.1 bcd	0.81 b	4.0 b	4.1 ab
Temp-71	6.1 ab	5.1 ab	0.97 b	2.7 c	3.6 bc
Temp-77	6.2 a	5.0 abc	1.06 b	2.9 c	3.7 bc
Temp-82	5.3 bc	5.3 a	3.5 a	1.1 d	2.6 c

abcd Values that lack same superscript differ significantly at p<0.05

•Beefy, roasted and burnt flavors increased (P<0.05) with increasing temperature

•Blood and fatty decreased (P<0.05) with increasing temperature

Table2b: Descriptive Tenderness Attributes and Warner-Bratzler Shear Force

	Crisp	Tender	Grainy	Juicy	WBS
Temp-55	0.63 c	6.5 a	2.5 d	6.8 a	3.8 b
Temp-60	0.63 c	6.0 ab	2.9 cd	6.3 ab	4.0 b
Temp-63	1.3 bc	5.2 bc	3.9 bc	5.4 b	4.0 b
Temp-71	1.8 b	4.5 c	4.1 b	4.0 c	4.2 b
Temp-77	1.6 b	4.9 bc	4.0 b	4.2 c	4.8 a
Temp-82	4.3 a	2.7 d	5.6 a	2.0 d	5.3 a

abcd Values that lack same superscript differ significantly at p<0.05

•Tenderness decreased (P<0.05) with increase in temperature as determined by trained panel and mechanical measures

•Juiciness decreased (P<0.05) with increase in temperature.

Table 3: Consumer Liking Scores

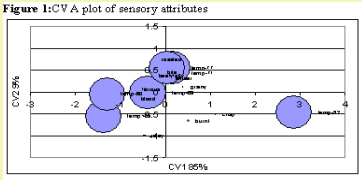
	Overall liking*	Tenderness like	Juiciness like	Flavor like
Temp-55	5.8	6.2 a	6.1 a	5.5
Temp-60	5.8	6.2 a	6.0 a	5.5
Temp-63	5.9	6.4 a	6.1 a	5.4
Temp-71	5.8	5.6 b	5.1 b	5.6
Temp-77	5.7	5.4 bc	5.0 b	5.6
Temp-82	5.2	4.9 c	4.3 c	5.3

abc Values that lack same subscript differ significantly at p<0.05
*Indicates samples were not significantly different from each other at p<0.05

•Temperature had no effect (P>0.05) on overall liking and liking of flavor

•Tenderness liking and liking of juiciness decreased with (P<0.05) increase in temperature. This agrees with decrease in tenderness from trained panel and mechanical measures

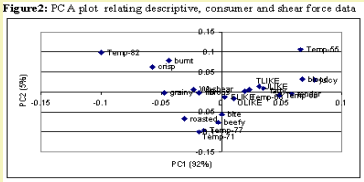
Figure 1: CVA plot of sensory attributes



•CV1 (85%) axis was defined by the texture attributes and the second axis CV2 (9%) was defined by the flavor attributes.

• Steaks cooked to 82ºC were characterized by burnt and crisp while those cooked to 71ºC and 77ºC were characterized by roasted, tender and beefy, and those cooked to 63ºC and less were characterized by juicy and blood

Figure2: PCA plot relating descriptive, consumer and shear force data



• PC1 explained for 92% and separated texture attributes like tender and juicy, which correlated with liking of tenderness (TLIKE) and liking of juiciness (JLIKE), from grainy and fibrous.

• PC2 explained 5% and separated flavor attributes like roasted and beefy from burnt. Warner-Bratzler shear values were negatively correlated with the sensory attributes juicy, tender, liking of tenderness and liking of juiciness and positively correlated to burnt, crisp, grainy and fibrous

• Steaks cooked to 82ºC are characterized as burnt and crisp, while steaks cooked to 55ºC, 60oC and 63ºC were characterized as being juicy, tender and fatty This shows that as the Warner-Bratzler shear values increased, juiciness and tenderness decreased. Also, overall liking (OLIKE) and flavor liking (FLIKE) were positively correlated with beefy and roasted flavor attributes for steaks cooked to 71ºC and 77ºC but negatively correlated to fatty and blood.

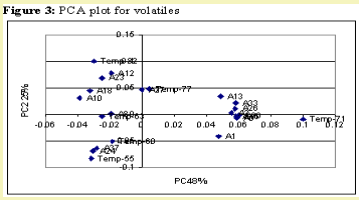
Results

Table 4: Discriminators selected by StepDisc analysis

Step	Comp Abbr	Volatile Compound	Partial R^2
1	A16	3-ethyl-2,5-dimethylpyrazine	0.9836
2	A20	Acetophenone	0.9715
3	A5	2,6-dimethyl-5-heptenal	0.9596
4	A1	(Z)-2-octenal	0.9837
5	A6	2-Acetylpyrrole	0.9642
6	A2	1-Octanal	0.9207
7	A13	2-Pentylfuran	0.9057
8	A8	2-Nonanone	0.9633
9	A26	Decanal	0.9834
10	A10	2-Octanone	0.9766
11	A23	Benzene acetaldehyde	0.9556
12	A27	Dimethyl disulfide	0.9999
13	A37	2-Decenal	0.9892
14	A24	Benzyl methyl ether	1
15	A33	6-ethyl-2,3-dimethylpyrazine	1
16	A12	2-Pentanone	1
17	A18	3-Octanone	1

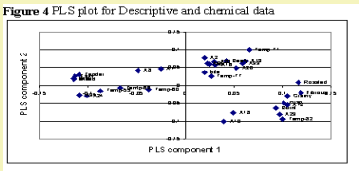
• A total of 37 different volatiles compounds have been identified during the volatile analysis of steaks. These volatiles were analyzed using stepwise discriminant (step disc) technique in SAS to select the volatiles that function as discriminators among the samples. 2,6-dimethyl-5-heptenal was eliminated from further analysis as it was only present in one treatment (55ºC) and therefore it obviously discriminated among samples. The discriminating volatiles and their R^2-values are shown

Figure 3: PCA plot for volatiles



• PC1 explained 48% of the variance and PC2 explained 25% of the variance. For example, volatiles compounds 2-Acetylpyrrole (A6), 3-ethyl-2,5-dimethylpyrazine (A16), Acetophenone (A20), 1-Octanal (A2), Decanal (A26) and 6-ethyl-2,3-diemthylpyrazine (A33) are the flavor volatiles associated with steaks cooked to 71ºC

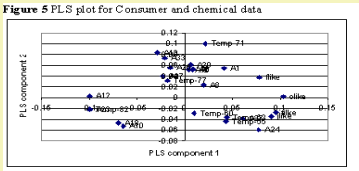
Figure 4 PLS plot for Descriptive and chemical data



• For the dependent variables (descriptive data) it can be seen that the first component (76% of the variation) contrasts the texture descriptors and the lower temperatures from the higher temperatures. The second component (14% of the variation) contrasts the flavor descriptors and differentiates the higher temperatures.

• Burnt is associated with the end point temperature 82ºC and the flavor volatiles A12, A23, A18 and A10, while beefy and crisp are associated with endpoint temperatures 71ºC and 77ºC and flavor volatiles A2, A6,A13,A16,A20, A26, A27 and A33 and A37.

Figure 5 PLS plot for Consumer and chemical data



• The first component, explained by 66% of the variance, contrasts steaks cooked to 55ºC, 60ºC and 63ºC, associated with liking of tenderness (tlike) and liking of juiciness (jlike) with steaks cooked to 82ºC.

• The second component, explained by 15% of the variance, contrasts steaks cooked to 71ºC, associated with liking of flavor (flike), overall liking (olike) and flavor volatiles A1, A16, A20, A2 and A6 with steaks cooked to 55ºC, 60ºC and 63ºC and flavor volatiles A37 and A24.

Conclusions

•As expected, steaks cooked to lower temperatures had higher scores for liking of tenderness and liking of juiciness and lower Warner-Bratzler shear values, indicating that these steaks are more tender and more liked than those cooked to higher temperature.

•Also overall liking and flavor liking was closely related to steaks cooked to 71ºC, which corroborates the literature citing that consumers tend to prefer steaks cooked to a medium to well done degree of doneness.

•In general, steaks cooked to medium to higher temperature were as associated with flavor volatiles, such as 1-octanal, 3-ethyl-2,5-dimethylpyrazine, acetophenone, and 6-ethyl-2,3-dimethylpyrazine.

Acknowledgements

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