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Existence of Two Desirable Odor, the Conditioned Raw Beef Aroma and the Conditioned Boiled Beef Aroma

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BACKGROUND

We[1] reported at 44th ICoMST that the preferable odor, the conditioned raw beef aroma (CRBA), was generated during in-air storage of beef. This aroma was suggested to be produced by some kinds of bacteria at the site containing both leans and fats in the presence of oxygen. As a result of screening such bacteria, one of those was presumed to be *Brochothrix thermosphacta* (BRT).

OBJECTIVES

The first aim of this work was to investigate the correlation between the intensity of CRBA and the viable count of BRT in various commercial beef samples or experimentally-conditioned beef samples. This investigation revealed that some beef possessed preferable beefy odor after heating in spite of the low count of BRT. Since this aroma was assumed to be different from CRBA, we secondly aimed at examining conditions for the generation of this aroma.

MATERIALS AND METHODS

Beef samples used were as follows: commercial beef slices (twelve Japanese Black (Wagyu) beef loins, two Holstein beef loins and four imported beef loins), Wagyu beef inside rounds prepared from dressed carcasses stored at –1to –2°C for 59 (sample A, ca. 1.3kg) or 37 (sample B, ca. 1.7 kg) days postmortem, Wagyu beef loins prepared from dressed carcasses stored at 0–4°C for three (sample C, beef marbling grade 5) or six (sample D, beef marbling grade 3) days postmortem, and a Wagyu beef loin (sample E, beef marbling grade 5) stored in the state of a dressed carcass and vacuum-packaged cut meat at 0–4°C for about one month.

Trained panelists sniffed raw beef samples at room temperature to evaluate orthonasal odor. They also ate sliced samples heated on a hot plate at 200°C or sliced samples and beef patties cooked in 1% NaCl solution at 80°C to evaluate retronasal odor.

Five grams of minced beef samples was suspended in 20 ml of sterile saline solution (0.9%) and shaken at room temperature for 30 min. The obtained beef suspension was diluted arbitrarily and the diluted suspension (0.1 ml) was spread on the STAA medium (500 µg/ml streptomycin/ 50 µg/ml thallous acetate/ 50 µg/ml actidione/ 0.2 % peptone/ 1.5 % glycerol/ 0.1 % K_2HPO_4/ 0.1 % $MgSO_4 \cdot 7H_2O$/ 1.3 % agar, pH 7.0) After incubation at 25°C for 48 hr, oxidase-negative and catalase-positive colonies were counted for BRT.

RESULTS AND DISCUSSION

The evaluation of CRBA before or after heating and BRT counting were performed on commercial beef slices. In two of eighteen samples the scores of CRBA strength were higher than 1.0 and the count of BRT reached about 10^7/g meat. Some samples contained near 10^7/g meat BRT, but those CRBA scores were lower than 0.5. Some other samples contained only 10^5/g meat BRT, but those CRBA scores were close to 1.0. Moreover, some samples had stronger CRBA after heating than before heating.

After samples were collected from five portions of the surface and the inside of Wagyu beef blocks (samples A and B) conditioned for 1–2 months, CRBA strength before or after heating was evaluated and BRT was counted. As a result, in both samples A and B CRBA before heating was stronger in surface portions than in inside portions and the count of BRT was higher in surface portions than in inside portions (Table 1). Therefore, BRT was demonstrated to grow mainly in beef surface exposed well to oxygen and to produce CRBA. The strength of CRBA after heating appeared to be raised in all the portions. Thus, the near-upper surface inside portion of sample A showed a high value of 1.3 as the score of CRBA strength, although the count of BRT was lower than 10^3/g meat.

These results allowed us to conceive the existence of another aroma, which was the retronasal aroma generated without BRT and perceived only after heating of beef. The quality of the aroma was sweet, fatty and beefy, which was similar but not equal to that (sweet and milk-like) of CRBA. In the odor evaluation of conditioned Holstein beef reported previously[1], some of our panelists had recognized this aroma. However, they had thought that it had been CRBA remaining after heating, because they had always experienced this aroma sensation when they had eaten the heated beef samples which had had CRBA before heating. Preliminary experiments showed that this aroma was recognized in almost all commercial Wagyu beef slices after cooking but not in such raw slices even put in the oral cavity. It was also more easily perceived in boiled beef than in roasted beef. Therefore, we propose to call this aroma the conditioned boiled beef aroma (CBBA).

Panelists ate commercial Wagyu beef slices and sliced imported beef samples cooked in 1 % NaCl solution at 80°C, and assessed preference of taste (with pinching their noses) or taste and odor (without pinching their noses). As a result, there was no difference in taste between both samples, but taste and odor of Wagyu beef slices was significantly preferable to those of imported beef slices. At that time, CBBA was perceived in the Wagyu beef slices but not in the imported beef slices. Therefore, one of the reason for the superior palatability of Wagyu beef after heating was assumed to be the existence of CBBA.

The optimum heating temperature for the generation of CBBA was determined. The strength of CBBA of commercial Wagyu beef

slices cooked at 40, 60, 80 or 100 °C was found to be ordered as: 80°C > 60°C > 40°C = 100°C. We examined whether there was CBBA in the Wagyu beef stored within one week postmortem. Sliced beef samples were prepared from blocks of samples C and D, and then these CBBA strength was compared with that of commercial Wagyu beef slices or imported beef. As a result, CBBA of both samples was weaker than that of commercial Wagyu beef and was as weak as that of imported beef, suggesting that CBBA was almost absent in Wagyu beef immediately after slaughter. Furthermore, we investigated whether the in-air storage was necessary to generate CBBA likely to CRBA . The strength of CBBA of Wagyu beef slices or blocks additionally-stored in 4°C-air was compared with that of blocks additionally-stored in –80°C-air. The strength of CBBA of Wagyu beef slices stored in 4°C-air was also compared with that of slices stored in 4°C-vacuum. As shown in Table 2, in the experiment I using sample C with beef marbling grade 5 the slices stored in 4°C-air for 5 or 11 days had stronger CBBA than the blocks in –80°C-air, but there was no difference between the blocks in 4°C-air and the blocks in –80°C-air. Moreover, the slices in 4°C-air had stronger CBBA than the slices in 4°C-vacuum after 1 day-storage. In the experiment III using sample E with beef marbling grade 5, the slices in 4°C-air had stronger CBBA than the blocks in –80°C-air and the slices in 4°C-vacuum after 5 days-storage, as similarly as in experiment I. On the other hand, in the experiment II using sample D with beef marbling grade 3, the slices in 4°C-air did not have stronger CBBA than the blocks in –80°C-air or the slices in 4°C-vacuum even after 5 days-storage. These results suggested that in-air storage of sliced Wagyu beef, which was highly marbled, was necessary for the generation of CBBA.

CONCLUSION

CRBA was presumed to be produced by BRT at the surface of beef blocks. There was another aroma, CBBA, which was perceptible after heating, and the existence of this aroma was considered to be one of the reason why Japanese people present higher palatability for Wagyu beef than for imported beef. Precursors of CBBA was assumed to be generated by the in-air storage of highly-marbled Wagyu beef slices, and then to change into aroma compounds on heating at 80°C.

REFERENCES

1) Matsuishi, M., Fujimori, M. and Okitani, A. (1998) Generation of the desirable aroma, the conditioned raw beef aroma, induced by storage of meat in air. Proceed. 44th Int. Congr. Meat Sci. Technol. (Barcelona). pp.764–765.

Table 1. The strength of CRBA and the viable count of BRT in conditioned Wagyu beef block

Sample	Portion	Strength of CRBA[a]		Viable count
		Before heating	After heating[b]	(count/g meat)
A	Upper surface	0.50	1.0	1.1×10^6
	Near-upper surface inside	0.50	1.3	4.8×10^2
	Core	0.25	0.67	0
	Near-lower surface inside	0.25	0.42	4.3×10^1
	Lower surface	0.42	0.75	6.5×10^4
B	Upper surface	0.35	0.90	3.0×10^5
	Near-upper surface inside	0.10	0.20	9.3×10^1
	Core	0	0.20	0
	Near-lower surface inside	0	0.10	0
	Lower surface	0.10	0.50	1.1×10^5

a: This shows average scores of the strength of CRBA evaluated by six (sample A) or five (sample B) panelists as follows: absent, 0; slight, 0.5; weak, 1.0; medium, 2.0; strong, 3.0.

b: The one side of beef samples (about 4 x 4 x 1 cm) was heated on a hot plate at 200°C for 1 min, and then the other side was heated for 30 sec.

Table 2. CBBA of Wagyu beef (sample C) stored additionally in air or vacuum and then cooked[a] (experiment I)

Storage period (day)	Panelist number	Numbers of samples judged to have stronger CBBA								
		Slice in 4°C-air	Block in –80°C-air[b]	No difference	Block in 4°C-air[c]	Block in –80°C-air[b]	No difference	Slice in 4°C-air	Slice in 4°C-vacuum	No difference
1	5 or 4	3	2	0	1	3	0	4	0	0
5	5	4	1	0	2	3	0	4	1	0
11	7	6	1	0	–	–	–	–	–	–

a: cooked in 1 % NaCl solution at 80°C for 2 min.

b: After storage, a frozen block was thawed in tap water and sliced for cooking.

c: After storage, a block was sliced for cooking.