

Factors involved in beef palatability

(牛肉の食味性に影響を及ぼす要因に関する研究)

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Beef cattle raised to supply our country's meat has three types of classification, namely meat-only (Japanese black cattle); Holstein (domestic steers); and crossbred (F1). These types are respectively cattle bred only to produce beef; Holstein steers that are a by-product of dairy management and are fattened to produce beef; and cattle from crosses between Japanese black cattle and Holstein bulls. In this thesis my focus is on improving the meat quality of Japanese-produced beef.

All Japanese cattle are fed for 6 months from age 12 months; they are then fattened from an average of age 20 months to 30 months. Therefore, compared with overseas beef cattle raised for meat, Japanese black cattle, especially, are characterized by marbling, in which fat accumulates in the muscles. However, the situation faced by Japan's dairy farmers in recent years is serious; there was a 6.2% decrease in the number of beef cattle bred in 2014 compared with the previous year, with a 2.8% reduction in the number of breeding farms. In future, many cattle farms will be faced with the predicament of needing to comply with the provisions of the Trans-Pacific Strategic Economic Partnership (TPP) Agreement. If the amount of beef imported increases under a future TPP, it will become important to highlight the features of domestic beef from the perspective of methods of preservation and cooking in order to maintain consumption of the local product.

Although there have been many studies of the palatability of beef, the relevance of the intramuscular fat factor, which greatly influences meat quality, as well as aging after slaughter and flavor, has not been reported in detail.

Here, I examine heating method as a factor affecting the palatability of beef. I look at the fat content and long-term aging treatment of beef. Whereas analytical sensory evaluations have been used previously to determine the influence of each factor on palatability, I measured the physicochemical factors relevant to evaluation criteria. I also discuss the relationship

between sensory and instrumental analysis.

Chapter 1 Influence of Heating Method on Palatability of Beef

The Complete Meat Cookbook, one of the most popular cookbooks in the United States, provides information on selecting a heating method. My aim was to clarify the taste and texture characteristics of Holstein loin meat cooked until it reached an internal core temperature of 60 ° by using different methods, namely grilling, roasting, poaching, vacuum-packed low-temperature (VPLT) cooking, and microwaving.

Cooking loss was lowest in grilled or roasted beef, whereas it was highest in microwaved beef. Moisture content after cooking was highest in beef cooked by the VPLT method and low in beef cooked by poaching or microwaving. The fat content that remained after cooking was lowest in beef cooked by the VPLT method. The breaking energy of microwaved beef was the highest. Beef cooked by using the VPLT method contained the highest quantity of total free amino acids. Sensory analysis showed that grilled or roasted beef was judged to possess greater juiciness, a more desirable odor, and greater *umami* intensity. Beef cooked by the VPLT method was tenderer and had greater *umami* intensity but a less desirable odor. Microwaved beef did not receive a high score for any of the above criteria. These results revealed that the differences in sensory properties of cooked beef loin were caused by differences in cooking loss, water content, *umami* compound content, and breaking energy resulting from cooking by different methods.

Chapter 2 Influence of Fat Content on Palatability of Beef

The meat of Japanese black cattle has a high fat content, and this has a great influence on palatability. Increasing the crude fat content is especially likely to improve texture.

I analyzed the sensory characteristics of meat samples with crude fat contents between 23.8% and 48.6% that were taken from 34 Japanese black steers. I also analyzed samples with crude fat contents of 8% to 25% taken from 27 crossbred cattle. We grilled the meat and subjected it to analytical sensory evaluation. We also measured the amounts of moisture, protein, nucleic acid, and glutamic acid.

An increase in crude fat content increased the tenderness, juiciness, and fattiness in the meat quality evaluation. An increase in crude fat content reduced the crude protein and moisture contents; it also slightly reduced the nucleic acid and glutamic acid contents, although when the reductions in these *umami* components were assessed relative to the moisture content they changed little. Increasing the fat content up to a certain point greatly enhanced the *umami* intensity and beef flavor intensity in the meat quality evaluation and raised the overall evaluation score; the peak appropriate crude fat content for these purposes was about 36%.

Chapter 3 Influence of Long-term Aging on Palatability of Japanese Black Cattle Beef from Tajima

After slaughter, beef is generally air- or vacuum-packed and refrigerated or preserved by freezing before being passed on to consumers. (These processes are known as wet aging.) However, boutique butcheries are now selling beef kept at low temperature, constant moisture of about 80%, and wind circulation to surface of block meat that has been dry-aged for a fixed period. Although Tajima beef, which is produced from high-quality Japanese black cattle, is aged for 60 days, the meat quality changes during this period are not clear. My analysis of the quality of highly marbled beef during this 60-day dry-aging period after slaughter showed that the changes in some qualities differed from those of conventional meat.

The tenderness of these meats did not change during aging for 50 days, but thereafter it gradually increased until day 60. The juiciness of these meats, as determined by sensory evaluation, did not change during aging for 60 days, except for a decrease on day 20. The *umami* intensity of these meats in the sensory evaluation, and the calculated glutamic acid and inosine monophosphate quantities, were highest on day 40. This high *umami* intensity was induced by the synergistic effect of *umami* compounds such as glutamic acid and inosine monophosphate.

These results for tenderness, juiciness, *umami* intensity, and flavor intensity suggested that the best duration of dry aging for highly marbled beef was 40 days.

As mentioned above, as a result of examining factors affecting the palatability of beef, in heating lean meat it became clear that grilled and roasted beef were judged to possess greater juiciness, a more desirable odor, and greater *umami* intensity. These findings could form the basis of an index of the optimal heating conditions for beef. Moreover, in highly marbled beef from Japanese black cattle, an increase in crude fat content increased the tenderness, juiciness, and fattiness in the meat quality evaluation. An increase in crude fat content reduced the crude protein and moisture contents; it also slightly reduced the nucleic acid and glutamic acid contents. Increasing the fat content up to a certain point greatly enhanced the *umami* intensity and beef flavor intensity in the meat quality evaluation and raised the overall evaluation score; the peak appropriate crude fat content for these purposes was about 36%. Furthermore, analysis of highly marbled beef aged for between 4 and 60 days showed that the *umami* intensity of these meats in the sensory evaluation, and the calculated glutamic acid and inosine monophosphate values, were highest on day 40. These results for tenderness of highly marbled meats did not change during aging, and flavor intensity evaluation suggested that the best duration of dry aging for highly marbled beef was 40 days.

The knowledge acquired in this thesis has helped to elucidate the best methods of preserving and cooking to highlight the features of domestic beef. These data can be used to establish the status of our marbled beef as a specific major livestock export product of which our country can be proud.