Japanese Shorthorn steer meat tenderization using sarunashi (*Actinidia arguta*) juices extracted at different ripening stages

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Objectives: Beef of Japanese Shorthorn cattle, one of the Wagyu breeds, is lean meat; therefore, the demand for tough parts is low. It is well known that the juice of kiwifruit containing actinidin, a proteolytic enzyme, can tenderize the muscle. Sarunashi (*Actinidia arguta*) is the same genus as kiwifruit. Muramoto *et al.* (2020; 2021) reported that the application of sarunashi juice to the supra- spinatus muscle of Japanese Shorthorn steers lowers the water holding capacity during cooking, and they noticed that the meat was also softened. The actinidin activity of kiwifruit increases with ripening (Lewis and Luh, 2007). However, the effects of juice from sarunashi ripened by different methods on the textural properties and water-holding capacity of Japanese Shorthorn beef has not been clarified. The aim of this study was to explore these effects and establish significant correlations between the various stages of ripe sarunashi fruit juice.

Materials and Methods: The sarunashi fruits were divided into unripe, force-ripe, ripe, and over-ripe groups. In the unripe group, fruit was harvested before being ripened. In the force-ripe group, unripe fruits were harvested and stored in a room for ripening. In the ripe group, fruits were allowed to ripen on the trees. In the over-ripe group, fruits were ripened on the tree and harvested after a deliberate delay. Sarunashi juice was prepared by individually crushing whole fruits. We cut muscle samples of 30 × 30 × 5 mm from each supraspinatus muscle of Japanese Shorthorn steers (n = 6). Each muscle sample was weighed and placed in a nylon bag with sarunashi juice of equivalent weight. Next, the nylon bags containing muscle samples and juice were stored for 1 h in a water bath set at 40°C and the drip loss was calculated. Next, the muscle sample was placed in another nylon bag, cooked in a water bath at 60°C for 3 min, and the cooking loss was calculated. Texture profile analysis was performed to determine the maximum load, gumminess load, cohesiveness, and adhesiveness of the muscle samples.

Results and Discussion: The maximum load and gumminess load of the supraspinatus muscle from Japanese Shorthorn steers were significantly lower in the over-ripe group than in the unripe group ($P < 0.05$); however, no significant differences were observed between the other groups ($P > 0.05$). Therefore, the tenderizing effect differed depending on the ripening method; the best meat tenderization was achieved by using juice from overripened fruit. Moreover, the tenderizing effect of juice from force-ripened and ripened fruit was similar to that of juice from over-ripened fruit. No significant differences in cohesiveness or adhesiveness were observed between all treatment groups ($P > 0.05$). Tezuka and Muramoto (2014) reported that a decrease in cohesiveness causes over-tenderization. Shinagawa *et al.* (2015) reported that the meat becomes harder to swallow and the residual feeling becomes stronger as adhesiveness decreases. Therefore, we speculate that the application of sarunashi juice to beef does not cause over-ten- derization, difficulty swallowing, or a residual feeling during eating, regardless of the method and presence or absence of ripened sarunashi. No significant differences in drip loss were observed among groups ($P > 0.05$). Therefore, we suggest that the drip loss of beef with sarunashi juice applied was not affected by the ripening method. The cooking loss of the over-ripe group was significantly higher than that of the other groups ($P < 0.05$); however, no significant differences were observed between the other groups ($P > 0.05$). Therefore, it was suggested that the cooking loss of beef treated with juice from over-ripened fruit was higher than that of beef ripened by other methods.

Conclusions: Our study suggested that over-ripened sarunashi juice tenderized Japanese Shorthorn beef better than unripened sarunashi juice did.

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Key words: Japanese Shorthorn beef, Ripening stage, Sarunashi juice, Tenderization, Water-holding capacity