# AGEING DURATION AND OFF-FLAVOUR DEVELOPMENT OF VENISON

**Akira Watanabe [a], Yasuko Okabe [a], Megumi Segawa [b], Koichi Hodate [c], Mitsuto Matsumoto [c] and Hiroshi Sato [d]**
[a] Tohoku National Experiment Station, Morioka, Iwate, Japan. [c] National Institute of Animal Industry, Tsukuba Norin kenkyu danchi, Ibaraki, Japan. [b] Iwate-ken Animal Industrial Experiment Station, Takizawa, Iwate, Japan. [d] Rakunougakuen university, Ebetsu, Hokkaido, Japan.

## BACKGROUND and OBJECTIVES

Damage to crops is increasing as the numbers of feral Japanese Sika Deer (*Cervus Nippon Centralis*) are getting larger. The number of exterminated or hunted deer has also increased: from 28606 head in 1986 to 69631 head in 1994 according to the annual census. With the increase in numbers of deer that have been captured and reared, deer farms are expected to become important for village economies because of the possibilities of increased levels of venison processing and marketing. Studies of optimal processing for venison quality are still few in number. The objectives of the present study are to determine the optimal ageing period of venison and the changes in lipid stability during storage.

## METHODS

Experiment 1: Determination of ageing duration.

Three male Japanese Sika deer were slaughtered and placed in a chiller at 3 ℃. The *M.Biceps femoris* was excised from each carcass and cut into ca.100 g blocks at 24 hours later, and then stored at 3 ℃. Changes of toughness (Graafhuis et al., 1991), myofibrillar fragmentation index (Takahashi et al., 1967) and the appearance of 30kDa protein (Laemmli, 1970) were evaluated at 3, 5, 7, 9 and 13 days after slaughter. The same cut from three Japanese Shorthorn cattle, which were slaughter and chilled in the same way, were used for a comparison.

Experiment 2: Off-flavour and lipid peroxidation

Four male Japanese Sika deer were used and prepared as experiment 1. The *M.Longissimus lumborums* were cut into 1-cm thick slices, and were either aerobically (AP) or vacuum-packed (VP). These samples were then stored in dark at 2.5 ℃ for 3,5,7 and 9 days. Similarly treated AP beef was also prepared as reference material. Off-flavour intensity was scored by three trained panellists on a five-point scale (0 to 4), and surface bacterial counts were measured by standard techniques on agar plates. The stability of lipids was evaluated as Tiobarbituric Acid Reactive Substance (TBARS) numbers according to the method of Witte et al (1970).

## RESULTS and DISCUSSIONS

Experiment 1

Figure 1-(a) shows the changes in shear force value (SFV) during storage. Venison was more tender than beef throughout the storage period, and the progress of tenderization was effectively completed at 9 days in beef and at 7 days in venison. The index of tenderisation (myofibrillar fragmentation index, MFI) was faster in venison than in beef (Fig.1-(b)). The venison MFI reached the maximum value at 9 to 13 days after slaughter, but that of beef increased more gradually over the whole storage period. The appearance of 30kDa protein is shown as a ratio to the actin band measured by densitometry (Fig.1-(c)). This protein arises from the degradation of troponin T, and can be used as the marker of the progress of ageing (Penny & Dransfield, 1979; Negishi et al., 1991). Similarly, a rapid increase of this protein was observed up to 7 days in venison and only a gradual increase was observed in beef throughout the whole storage period. Similar results were obtained on *M.Longissimus lumborum* (data were not shown). From these results, it was concluded that the progress of tenderization was faster in venison than in beef, and a recommended ageing duration would be 7 days at 3 ℃.

Experiment 2

Figure 2-(a) shows the differences in intensity of off-flavour between the two venison treatments, or the single beef treatment. Off-flavour in AP (Aerobically Package) venison was just detected at 3-5 days storage, and a pronounced off-flavour was recognized after 7 days storage. Off-flavour in both VP (Vacuum Package) venison and AP beef at these times was very weak and could be regarded as negligible during storage. The numbers of TBARS extracted by 20% TCA increased from 0.13 to 0.76 mg/kg in AP venison, but that of VP venison or AP beef was under 0.04 mg/kg , and remained stable throughout the storage period (Fig.2-(b)). A marked increase in bacterial growth was observed for AP beef only (Fig.2-(c)). The reasons of the higher counts in AP beef could not be determined by this experiment. These results suggest that the off-flavour in raw venison during ageing would be due to lipid oxidation, rather than bacterial spoilage.

Development of off-flavour in cooked meat during storage is widely known as Warmed Over Flavour and it is generally accepted that the off-flavour is primarily due to the peroxidation of the polyunsaturated fatty acids of phospholipids. However, there are few reports concerning the off-flavour development in raw meat during storage, because of the oxidation progress of raw meat is much slower than that of cooked meat. In the present study, however, considerable off-flavour was recognized in venison during ageing processes. This increase might be due to the higher concentration of myoglobin and phospholipid in venison and the higher content of polyunsaturated fatty acids in the phospholipid fraction. The off-flavour development arising from lipid oxidation should be reduced in practical situations by feeding anti-oxidant such as vitamin E before slaughter.

## CONCLUSIONS

1) Seven days were required to optimally age venison, as determined by SFV, MFI and 30kDa protein changes.
2) Pronounced off-flavours was recognized at 7 days after slaughter in aerobically packed venison.
3) Off-flavour development was effectively depressed by vacuum-package.
4) Off-flavour in raw venison is likely to be due to lipid peroxidation, rather than bacterial spoilage.

Further studies on feeding of anti-oxidant such as vitamin E pre-slaughter should be tried for the control of off-flavour development during ageing.

**REFERENCES**
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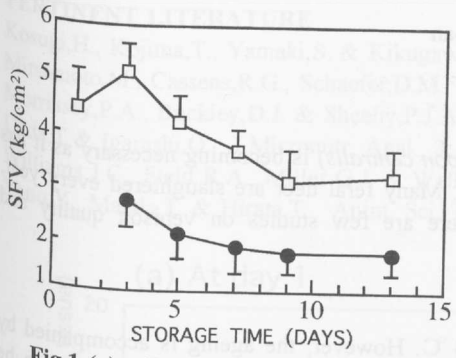


**Fig.1-(a); Changes in SFV during storage.**

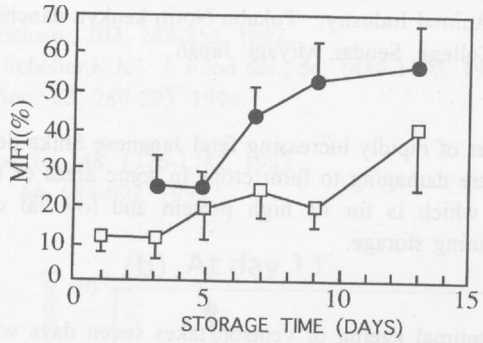


**Fig.1-(b); Changes in MFI during storage.**

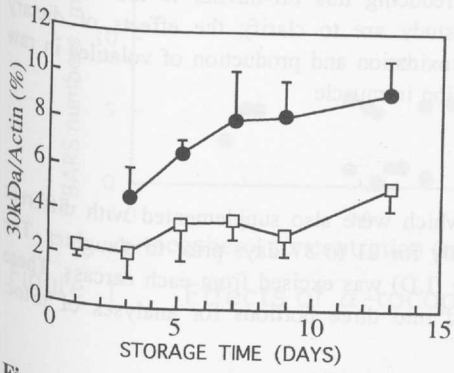


**Fig.1-(C); Changes in 30kDa protein consentration for actin during storage.**

Figure 1 compares the changes in (a); shear force value (SFV), (b);mypfibrillar fragmetation index (MFI) and (c); the proportion of 30 kDa protein concentration for venison (●) and beef (□) during storage at 3℃. Data are shown a means for three animals.

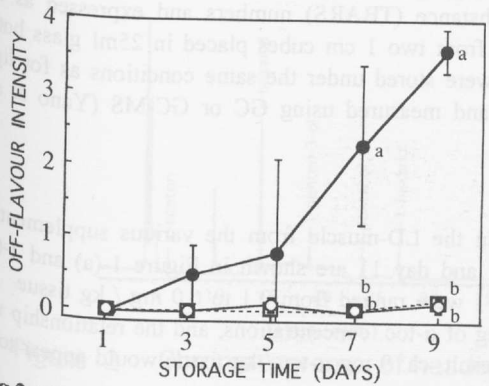


**Fig.2-(a); Changes in off-flavour intensity during storage.**

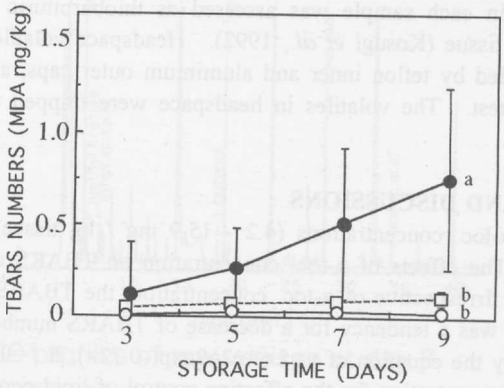


**Fig.2-(b); Changes in TBARS numbers during storage.**

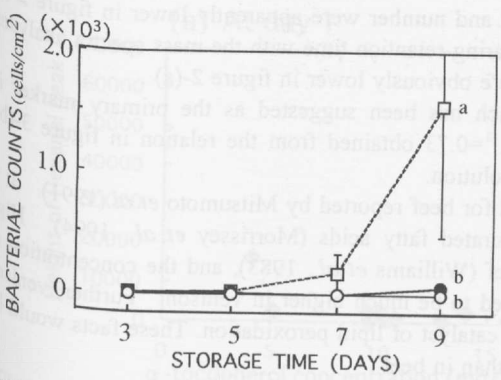


**Fig.2-(c); Changes in surface bacterial counts during storage.**

Figure 2 shows the effects of package on changes in (a); off-flavour intensity, (b); thiobarbituric reactive substance (TBARS) numbers and (c); surface bacterial counts during storage of raw meat at 2.5℃.
●:Aerobically packed venison, ○:Vacuum-packed venison, □:Aerobically packed beef.
[a,b] Means in the same day with different letters are significantly different ($p<0.05$).