EFFECTS OF FEEDING PERIODS OF DIETARY *RHUS VERNICIFLUA* STOKES ON MEAT QUALITY CHARACTERISTICS OF HANWOO (KOREAN CATTLE) BEEF DURING REFRIGERATED STORAGE

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Introduction

Rhus verniciflua Stokes (RVS) belongs to Anacardiaceae and has been used traditionally for medicinal purposes and for the protection of antiquities in Korea for a long time (Kim 1996). Recently, it was shown that RVS has an antioixdant function. Antioxidant activity of RVS has been reported to correspond to well known enzymatic and non-enzymatic antioxidants in model linoleic emulsion experiments (Lim and Shim 1997). The stem bark of *Rhus verniciflua* contains a high level of urushiols, which are polymerized formation of a lacquer film by the radical-chain reaction (Hirota et al. 1998). The exudate was previously found to have anti-AIDS, a strong antioxidant and immune-enhancing activities (Miller et al. 1996). However, urushiol was the main irritating component of exudate constituents of *Rhus verniciflua.* The heartwood of *Rhus verniciflua* dose not cause this type of allergenic action, which implies that it dose not contain urushiols (Park et al. 2004). However, information on the application of RVS is still limited.

Objectives

The objective of this study was to determine the effects of feeding periods (0, 3, 4, 5, and 6 months) of dietary *Rhus verniciflua* Stokes with 4%/feed on meat color, water-holding capacity, lipid oxidation and fatty acid composition in *M. Semimembranosus* from Hanwoo (Korean cattle) beef during refrigerated storage.

Methodology

Animals, diets and treatments

Rhus verniciflua Stokes of 8 years was obtained from Wonju, Kangwon province, Korea. The stem bark and heartwood of RVS were naturally dried and reduced to sawdust by an electrical mill. Hanwoo (Korean cattle) steers were divided into five

groups. Control group (n = 3) was fed a common basal diet for 28 months. The other groups (n = 3/group) were fed a supplemented concentrate diet with a RVS supplement of 4%/feed for 3-6 months before slaughter. The *Semimembranosus* muscles were sliced (1.2 cm thickness), then overwrapped in polyethylene wrap film (oxygen transmission rate 35,273 cc/m^2/24hr/tm, thickness 0.01 mm). Samples were then held 7 days at 3℃.

Analytical procedures

CIE L^*, a^*, and b^* values for Illuminant C were measured by a color difference meter (CR-310, Minolta Co., Tokyo, Japan). Also, chroma (C^*) and hue-angle (h^o) values were calculated as $C^* = (a^{*2}+b^{*2})^{1/2}$, and $h^o = \tan^{-1}(b^*/a^*)$, respectively. The relative content of metmyoglobin at the meat surface was calculated by the method of Kryzwicki (1979) using reflectance at 525, 572, and 730 nm. Reflectance readings were converted to absorbance[2-log(% reflectance)] and used in the equation (Demos et al., 1996). The pH value was determined by homogenizing 10 g sample with 100 ml distilled water for 1 min. A press technique reported by Grau and Hamm (1953) was used to determine water-holding capacity (WHC). Thiobarbituric acid reactive substances (TBARS) was measured according to the modified method of Sinnhuber and Yu (1977). Total lipids for fatty acid analysis were extracted from muscle using the method of Folch et al (1957). Fatty acid methyl esters were prepared according to the procedure of Sukhija and Palmquist (1988). Data were analyzed as a 5 (feeding period) by 4 (storage day) factorial design using the General Linear Model procedure of SAS.

Results & Discussion

As shown in Table 1, the pH value was significantly ($P < 0.05$) lower in RVS-supplemented groups for 3-5 months than in control group. Metmyoglobin (%) was significantly ($P < 0.05$) increased during storage time in all of the groups, but RVS-supplemented groups for 3-5 months had a lower rate of metmyoglobin accumulation during storage. As a whole, TBARS value was significantly ($P < 0.05$) lower in RVS-supplemented group for 6 months than in the other groups, and the TBARS value of day 7 was significantly ($P < 0.05$) higher in control group than in other groups. WHC was significantly increased during refrigerated storage except RVS-supplemented group for 5 months. WHC was significantly ($P < 0.05$) higher in RVS-supplemented groups for 4-5 months than in the other groups. The CIE L^*, a^*, b^* and C^* values of RVS-supplemented group for 4 months were significantly ($P < 0.05$) higher than those of the other groups over time (Table 2). The CIE a^* and C^* values were significantly ($P < 0.05$) decreased during refrigerated storage in all of the groups. In particular, control and RVS-supplemented group for 6 months were more accelerated compared to the other groups. The a^* value of day 7 was significantly ($P < 0.05$) higher in RVS-supplemented group for 4 months than in the other groups. Hue angle increased ($P < 0.05$) as storage time increased. And control group at day 7 had higher ($P < 0.05$) hue angle than the other groups. As shown in Table 3, the proportion of C18:1, was significantly ($P < 0.05$) higher in RVS-supplemented group for 5 months. MUFA was significantly ($P < 0.05$) higher in RVS-supplemented groups for 4-5 months than in the other groups.

Conclusions

The meat from 4% *Rhus verniciflua* Stokes-supplemented Hanwoo (Korean cattle) for 4 months was effective in increasing color stability, WHC and monounsaturated fatty acids (MUFA) than was the other meat.

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Tables and Figures

Table 1: Effects of feeding periods of dietary *Rhus verniciflua* Stokes on pH, memyoglonin, TBARS, and WHC in Hanwoo (Korean cattle) beef during refrigerated storage

Items	Storage days	Feeding periods (Months)				
		Control	3	4	5	6
pH	0	5.56^{abB}	5.49^{aC}	5.45^{CD}	5.41^{aD}	5.62^{aA}
	2	5.63^{aA}	5.41^{bC}	5.40^{C}	5.41^{aC}	5.51^{bB}
	5	5.56^{abA}	5.40^{bB}	5.40^{B}	5.39^{abB}	5.55^{bA}
	7	5.50^{bA}	5.36^{bB}	5.38^{B}	5.37^{bB}	5.50^{bA}
Metmyoglobin	0	16.74^{dB}	17.42^{dAB}	12.84^{dC}	14.23^{dC}	18.69^{dA}
	2	24.32^{cA}	19.01^{cB}	17.84^{cB}	18.81^{cB}	23.78^{cA}
	5	31.17^{bA}	20.54^{bC}	21.60^{bC}	21.80^{bC}	27.39^{bB}
	7	35.29^{aA}	23.38^{aC}	24.23^{aC}	24.53^{aC}	30.77^{aB}
TBARS	0	0.17^{d}	0.16^{d}	0.16^{d}	0.16^{d}	0.16^{d}
	2	0.27^{cA}	0.26^{cA}	0.27^{cA}	0.24^{cAB}	0.23^{cB}
	5	0.38^{bA}	0.32^{bAB}	0.34^{bA}	0.33^{bAB}	0.28^{bB}
	7	0.57^{aA}	0.40^{aB}	0.40^{aB}	0.38^{aB}	0.38^{aB}
WHC	0	37.70^{dC}	34.47^{cD}	40.83^{cB}	46.67^{A}	30.59^{cE}
	2	39.93^{cB}	37.19^{bC}	42.38^{bcA}	42.85^{A}	32.75^{bD}
	5	40.70^{bA}	41.53^{aA}	44.95^{abA}	45.17^{A}	34.03^{abB}
	7	42.51^{aB}	40.85^{aB}	46.65^{aA}	42.85^{B}	34.74^{aC}

^{abcd}Means in the same column with different superscripts are significantly different ($P < 0.05$).
^{ABCDE}Means in the same row with different superscripts are significantly different ($P < 0.05$).

Table 2: Effect of feeding periods of dietary *Rhus verniciflua* Stokes on meat color in Hanwoo (Korean cattle) beef during refrigerated storage

Items	Storage days	Feeding periods (Months)				
		Control	3	4	5	6
L^*	0	42.65^{A}	40.51^{bB}	42.74^{bA}	41.94^{bAB}	40.47^{bB}
	2	41.51^{B}	43.98^{aA}	43.61^{bA}	42.14^{bB}	41.58^{aB}
	5	43.29^{A}	43.73^{aA}	43.93^{bA}	42.60^{bAB}	41.56^{aB}
	7	43.88^{B}	44.86^{aAB}	45.93^{aA}	44.41^{aAB}	41.69^{aC}
a^*	0	22.52^{aA}	19.39^{abB}	22.63^{aA}	23.30^{aA}	19.60^{aB}
	2	20.92^{bB}	19.47^{abC}	22.05^{aA}	22.20^{abA}	18.01^{bD}
	5	17.92^{cB}	20.08^{aA}	21.32^{abA}	20.94^{bA}	16.56^{cC}
	7	17.14^{cC}	18.97^{bC}	20.00^{bA}	18.34^{cB}	16.13^{cC}
b^*	0	12.27^{aA}	10.47^{bC}	12.18^{A}	11.43^{B}	10.62^{aC}
	2	11.86^{abAB}	11.29^{aB}	12.11^{A}	11.68^{AB}	10.49^{aC}
	5	11.19^{abB}	11.58^{aAB}	12.11^{A}	11.45^{AB}	10.19^{abC}
	7	11.53^{bA}	11.66^{aA}	11.83^{A}	11.31^{A}	9.82^{bB}
C^*	0	25.64^{aA}	22.04^{bB}	25.70^{aA}	25.95^{aA}	22.25^{aB}
	2	24.05^{bA}	22.51^{abB}	25.15^{aA}	25.09^{abA}	20.73^{bC}
	5	21.14^{cB}	23.18^{aA}	24.52^{abA}	23.87^{bA}	19.43^{cC}
	7	20.67^{cB}	22.25^{abA}	23.24^{bA}	21.81^{cAB}	18.74^{cC}
h^0	0	28.60^{bA}	28.37^{cA}	28.22^{cA}	26.04^{cB}	28.43^{cA}
	2	29.51^{bAB}	30.12^{bA}	28.67^{bcBC}	27.73^{bC}	30.38^{bA}
	5	32.03^{aA}	29.96^{bB}	29.52^{abB}	28.64^{bB}	31.57^{aA}
	7	33.80^{aA}	31.56^{aB}	30.53^{aB}	31.69^{aB}	31.56^{aB}

^{abc}Means in the same column with different superscripts are significantly different ($P < 0.05$).
^{ABCD}Means in the same row with different superscripts are significantly different ($P < 0.05$).

Table 3: Effect of feeding periods of dietary *Rhus verniciflua* Stokes on fatty acid composition in Hanwoo (Korean cattle) beef

Fatty acids	Feeding periods (Months)				
	Control	3	4	5	6
C14:0	2.72	3.05	2.58	2.78	2.39
C16:0	24.97	25.27	25.30	25.45	24.97
C16:1	5.26^{AB}	6.82^{A}	6.48^{AB}	6.53^{AB}	5.04^{B}
C18:0	13.19	12.11	10.15	9.71	12.16
C18:1	45.19^{B}	46.92^{AB}	48.69^{AB}	49.16^{A}	45.25^{B}
C18:2	5.41	4.29	4.64	4.38	6.66
C18:3	0.42^{A}	0.18^{C}	0.26^{BC}	0.22^{C}	0.32^{B}
C20:1	0.42^{A}	0.09^{B}	0.14^{B}	0.15^{B}	0.39^{A}
C20:4	1.94^{AB}	1.24^{B}	1.69^{AB}	1.56^{AB}	2.35^{A}
C22:4	0.48^{A}	0.02^{B}	0.08^{B}	0.04^{B}	0.45^{A}
SFA[1]	40.87	40.43	38.02	37.94	39.52
MUFA[2]	50.87^{B}	53.83^{A}	55.32^{A}	55.85^{A}	50.68^{B}
PUFA[3]	8.25^{AB}	5.74^{B}	6.66^{A}	6.21^{B}	9.79^{A}
UFA[4]	59.13	59.57	61.98	62.06	60.48
MUFA/SFA	1.26	1.33	1.46	1.47	1.28

^{ABC}Means in the same row with different superscripts are significantly different ($P < 0.05$).
[1]Saturated fatty acids, [2]Monounsaturated fatty acids, [3]Polyunsaturated fatty acids, [4]Unsaturated fatty acids.