EVALUATION OF FERMENTED SAUSAGES MANUFACTURED WITH FUNCTIONAL STARTER CULTURES AND VARIOUS FAT LEVELS

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Introduction

Fermented meat products are manufactured with comminuted meat and fat, mixed with salt, curing agents, sugar, spices and inoculated lactic acid bacteria, and formed by changes that occur during the ripening. Since lactic acid bacteria produces lactic acid, pH values are decreased. As a result, undesirable microbial growth is inhibited, and these safety products have a sourish taste during ripening. However, consumers tend to avoid purchasing a fermented sausage if it contains a high salt content and excess fat. Dry fermented sausages normally have a high fat content. In the case of research by Wirth *et al.*, (1998), sausages with a 32% fat content in the initial mixture, had a fat content of approximately 40~50% after 4 months. Thus, overeating fat, which leads to obesity, is one of the main reasons for cardiovascular disease, such as high blood pressure and arteriosclerosis. Therefore, the objectives of this study were to assess the effect of a fat replacer on the product quality of low-fat fermented sausages, as compared to regular-fat counterparts and to determine the addition of inoculated functional lactic acid bacteria having anti-cholesterol and anti-hypertension activity on the functionality of the fermented sausages.

Materials and Methods

Sausage mixtures containing fresh pork ham, back fat, other ingredients and lactic acid bacteria were stuffed into fibrous casings (diameter 45mm) and placed in the ripening chamber. The fat replacer used in the low-fat fermented sausage was prehydrated soy protein isolate (1:4 ratio). Starter cultures containing ACE inhibitory and cholesterol assimilation activities were prepared and compared to the commercial one (LK-30 plus, Gemurzmueller Co., Germany). The mixed lactic acid bacteria, *Lactobacillus plantarum* L167 and L155 were added to the initial mixture of these sausages. Samples from each treatment were taken for analysis on day 0, 2, 3, 6, 14 and 21. Moisture, fat and protein were determined according to standard AOAC (1990) methods. Colour, pH, weight loss and shear force values were determined during the 21-day ripening time. In addition, microbiological analysis, total bacterial counts, lactic acid bacteria and *Enterobacteriaceae* were evaluated. Sensory evaluation of fermented sausages was performed after 21 days of ripening using a seven-member sensory panel. ACE inhibitory activity of sausage was measured by method of *Cushman et al.* (1971). The cholesterol assimilation activity of sausages was determined by the method of Searcy and Bergquist (1960). Data were analysed using two-way analysis of variance (ANOVA) in the SPSS program (12.0). Means were separated by the Duncan's multiple range test.

Results and Discussion

The fat content and M:P ratios of fermented sausages with various fat levels are shown in Table 1. Reaching a weight loss of 30%, RFC (regular-fat control, ~40% fat) and RFT (regular-fat with cholesterol treatment) took approximately 14 days of ripening, whereas MFC (medium-fat control, ~28%) and LFC (low-fat control, ~6%) and LFT (low-fat with anti-hypertension treatment) took 6~14 days, and 6 days of ripening, respectively (Table 2). The lower the fat level the higher the weight losses over the same processing time (Muguerza, 2002). The pH of fermented sausage was decreased during the fermentation period, and the lowest pH value was observed at the 3rd day of ripening (Table 3). Yellowness of the sausages decreased with increased ripening time (Table 3). However, shear force value and cholesterol content were increased with increasing ripening time. Hunter-L values of regular-fat sausages were higher than those of other fermented sausages. Hunter-b values of low-fat fermented sausages were higher than those of other sausages. Fermented sausage containing high fat had higher cholesterol content compared to the reduced-fat counterparts. Although ACE inhibitory activity was not affected by various starter cultures, it increased with increased ripening time, until 6 days of ripening. In sensory evaluation, colour and flavour in MFC, texture in RFC, saltiness and juiciness in RFT had the highest scores.

Conclusions

The ripening time of low-fat fermented sausages was shortened approximately two weeks, as compared to regular-fat counterparts. LFT containing functional lactic acid bacteria had similar ACE activity to LFC. Cholesterol content of the sausages decreased with decreased fat level. In sensory evaluation, MFC (~28%, fat) had the highest score for overall acceptance. Further studies will investigate the anti-microbial activity of these sausages with inoculated pathogens.

Table 1: Changes of fat level and M:P ratios of fermented sausages as affected by various starter cultures during ripening.

		Ripening time (day)			
	TRT[1]	0	6	14	21
Fat (%)	RFC	21.5^{bX}	-	36.5^{aW}	39.5^{aX}
	RFT	22.5^{bX}	-	33.0^{aX}	36.5^{aX}
	MFC	13.5^{cY}	-	23.0^{bY}	28.0^{aY}
	LFC	2.50^{aZ}	4.00^{b}	6.00^{cZ}	-
	LFA	2.00^{bZ}	3.50^{ab}	5.50^{aZ}	-
M:P ratio	RFC	3.82^{aXY}	-	1.49^{bX}	1.32^{b}
	RFT	3.81^{aXY}	-	1.39^{bXY}	1.21^{b}
	MFC	3.72^{aY}	-	1.40^{bXY}	1.09^{b}
	LFC	3.92^{aXY}	2.10^{b}	1.12^{cY}	-
	LFA	4.00^{aX}	1.98^{b}	1.08^{cY}	-

$^{a-c}$Means with same row having same superscript are not different (p>0.05).
$^{X-Z}$Means with same column having same superscript are not different (p>0.05).
TRT[1] = treatment : RFC = regular fat control (LK30); RFT = regular fat treatment (L55); MFC = medium fat control (L55+L67+LK30); LFC = low fat control (LK30); LFA = low fat treatment (L67)

Table 2: Changes of weight loss (WL, %) in fermented sausages with low, medium and regular-fat fermented sausages as affected by various starter cultures during ripening.

		Ripening time (day)					
	TRT[1]	0	2	3	6	14	21
Weight loss (%)	RFC	-	6.78^{d}	9.79^{dY}	19.8^{cZ}	30.0^{bZ}	34.0^{aY}
	RFT	-	6.86^{c}	10.8^{cXY}	20.7^{bZ}	31.1^{aZ}	34.7^{aY}
	MFC	-	7.46^{c}	11.1^{dXY}	24.2^{cY}	36.9^{bY}	41.4^{aX}
	LFC	-	6.92^{d}	13.1^{cXY}	30.5^{bX}	49.6^{aX}	-
	LFA	-	8.90^{d}	14.9^{cX}	32.2^{bX}	51.1^{aX}	-

$^{a-e}$Means with same row having same superscript are not different (p>0.05).
$^{X-Z}$Means with same column having same superscript are not different (p>0.05).
TRT[1] = treatment : RFC = regular fat control (LK30); RFT = regular fat treatment (L55); MFC = medium fat control (L55+L67+LK30); LFC = low fat control (LK30); LFA = low fat treatment (L67)

Table 3: Changes of pH, Hunter colour (L, a, b), bacterial counts (TPC, MRS, VRB), shear force (SF), cholesterol content, and ACE inhibitory activity in fermented sausages as affected by fat content and various starter cultures.

	Treatment[1]				
	RFC	RFT	MFC	LFC	LFA
pH	4.94^{ab}	4.84^{b}	4.93^{ab}	5.03^{a}	5.03^{a}
L	60.0^{ab}	62.3^{a}	57.2^{b}	56.8^{b}	57.8^{b}
a	14.4	14.8	15.4	14.2	13.6
b	5.95^{ab}	5.76^{ab}	4.83^{b}	6.52^{a}	6.79^{a}
TPC (log cfu/g)	7.87^{b}	7.81^{b}	7.94^{b}	8.52^{a}	8.53^{a}
MRS (log cfu/g)	7.65^{b}	7.74^{b}	7.83^{b}	8.33^{a}	8.41^{a}
VRB (log cfu/g)	*^{b}	*^{b}	*^{b}	2.15^{a}	2.11^{ab}
SF (kgf/g)	6.22^{b}	6.46^{b}	9.13^{a}	8.53^{a}	9.91^{a}
Cholesterol	73.9^{a}	73.3^{a}	58.6^{ab}	42.6^{b}	-
ACE inhibition(%)	-	-	-	23.7	23.1

^{a,b}Means with same row having same superscript are not different (p>0.05). *: not detected(< 10^2 cfu/g)
TRT[1] = treatment : RFC = regular fat control (LK30); RFT = regular fat treatment (L55); MFC = medium fat control (L55+L67+LK30); LFC = low fat control (LK30); LFA = low fat treatment (L67)

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