THE PHYSICO-CHEMICAL AND SENSORY QUALITIES OF *KIMCHI*-FERMENTED SAUSAGES WITH DIFFERENT PART OF *KIMCHI*-ADDITIVES

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Introduction

Kimchi is a general term for Korean natural fermented vegetables with various spices such as garlic, red pepper, onion, ginger, and mustard. The various strains such as *Leuconostoc, Lactococcus, Pediococcus,* and *Lactobacillus* (*L. sake, L. brevis, and L. plantarum*) involve in *Kimchi* fermentation (Lee et al., 1992). These lactic acid bacteria (LAB) are either psychrophilic or psychrotrophic, facultatively anaerobic organisms, and resistant to salt. They are the similar to species which are most commonly used as lactic acid starter cultures in the production of fermented sausages.

Kimchi-fermented sausage has been originally developed by Lee et al. (1990) who studied the quality comparison of fermented sausages added with *Kimchi*, commercial starter culture (*L. plantarum*), and GDL during ripening. Recently, the effects of *Kimchi* on the antioxidant properties of fermented sausages during ripening have been studied by Lee and Kunz (2005). However, the different quality of *Kimchi*-fermented sausages with different addition-form of *Kimchi* has not been reported in the literature. Therefore, the objective of this study was to investigate the physico-chemical and sensory qualities of *Kimchi*-fermented sausages with different part of *Kimchi*-additives, i.e. whole, precipitate, and supernatant of *Kimchi*.

Materials and Methods

The whole of *Kimchi* (pH 4.43) was prepared by homogenizing 1200 g of home-ripened *Kimchi* made of Chinese cabbage including about 400 mL of extract. And then it was separated into precipitate (pH 4.47) and supernatant (pH 4.31) by centrifuging at 4℃ and 5,000 rpm for 30 min.

Kimchi-fermented sausages were prepared according to the following recipe: Hanwoo lean beef 1400 g, pork backfat 600 g, salt 34.14 g, prague powder 5.0 g (salt 4.66 g, sodium nitrite 0.295 g, and sodium carbonate 0.05 g), FOS/ENR 4.0 g (sodium polyphosphate 1.6 g, sodium pyrophosphate dehydrate 1.2 g, and acid sodium pyrophosphate 1.2 g), sodium erythorbate 2.0 g, several spices and additives 126, and *Kimchi*-additive (mixture, precipitate, or supernatant, respectively) 100 g. Ingredients were mixed and stuffed into 80 mm diameter cellulose casings. All types of sausages were fermented at 24℃ and RH 90%, until the pH value of those attain to 4.9-5.0 (supernatant: 29 hr, mixture: 33 hr, and precipitate: 39 hr). Those were smoked at 73□ for 2 hr and then dried at 10□ and 80-85% for 6 days.

The pH value, water activity, and CIE color values were measured using a pH meter (SevenEasy pH, Mettler-Toledo GmbH, Switzerland), Aquaspector (AQS-2, Nagy, Germany), and chroma meter (CR-400, Konica Minolta Sensing Inc., Japan), respectively. TBARS was performed as described by Sinnhuber and Yu (1977). Texture profile analysis (TPA) was done in a texture analyzer (TA-XT2i, Stable Micro Systems, UK) following the method described by Bourne (1978). Fatty acid methyl esters (AOAC, 1995; Folch et al., 1957) were analyzed using the Agilent 6890N GC equipped with a HP-Innowax column and FID. Sensory attributes were evaluated by 10-trained panelists. Panelists gave scores for each sample with respect to their perceptions of flavour, color, and texture as 1 (worst) and 10 (best). The overall liking was calculated by Bozkurt and Erkmen (2004) as (flavour×0.50)+(color×0.25)+(texture×0.25). Data was analyzed using the GLM (General Linear Model) procedure of SAS (1999) program. Differences among means at the 5% level were determined by the Duncan's multiple range tests.

Results and Discussion

The pH value was the lowest in sausages with supernatant of *Kimchi* (*P*<0.05) and it was lower in those with whole of *Kimchi* as compared to those with precipitate of *Kimchi* (*P*<0.05). The water activity was significantly lower in sausages with whole of *Kimchi* than those with precipitate and supernatant of *Kimchi* (*P* <0.05). In CIE color values, the L* (lightness) value was significantly higher in sausages with whole of *Kimchi* and supernatant of *Kimchi* than those with precipitate of *Kimchi* (*P*<0.05). The a* (redness) value was the highest in sausages with supernatnat of *Kimchi* (*P*<0.05) and it was higher in those with whole of *Kimchi* as compared to those with precipitate of *Kimchi* (*P*<0.05). The b* (yellowness) value showed higher tendency in sausages with whole and supernatant of *Kimchi* than those with precipitate of *Kimchi*. In TPA, the hardness showed higher tendency in sausages with whole and supernatant of *Kimchi* than those with precipitate of *Kimchi*. The cohesiveness and

gumminess were significantly higher in sausages with whole of *Kimchi* than those with precipitate of *Kimchi* ($P<0.05$). The chewiness was significantly higher in sausages with whole and supernatant of *Kimchi* as compared to those with precipitate of *Kimchi* ($P<0.05$). The level of TBARS was significantly lower in sausages with whole and precipitate of *Kimchi* as compared to those with supernatant of *Kimchi* ($P<0.05$). In fatty acid composition, sausages with whole and supernatant of *Kimchi* had lower SFA content than those with precipitate of *Kimchi* ($P<0.05$), whereas, higher MUFA and PUFA contents ($P<0.05$). In sensory attribute, the flavour showed higher tendency in sausages with whole and supernatant of *Kimchi* than those with precipitate of *Kimchi*. The color, texture, and overall liking were significantly higher in sausages with whole and supernatant of *Kimchi* than those with precipitate of *Kimchi* ($P<0.05$).

Table 1. The physico-chemical and sensory qualities of *Kimchi*-fermented sausages with different part of *Kimchi*-additives at the end of ripening

Items	*Kimchi*-additives		
	Whole	Precipitate	Supernatant
pH	5.08 ±0.05[b]	5.18 ±0.04[a]	4.97 ±0.02[c]
Water activity	0.925±0.006[b]	0.937±0.001[a]	0.934±0.003[a]
CIE color value			
L^*	52.80 ±2.50[a]	51.64 ±1.91[b]	53.12 ±1.70[a]
a^*	15.49 ±0.99[b]	13.45 ±1.00[c]	16.42 ±0.80[a]
b^*	12.64 ±0.90	12.43 ±1.01	12.63 ±0.89
TPA			
Hardness, kg	3.30 ±0.62	2.73 ±0.25	3.09 ±0.45
Cohesiveness	0.61 ±0.03[a]	0.54 ±0.07[b]	0.58 ±0.04[ab]
Gumminess	2.02 ±0.40[a]	1.48 ±0.29[b]	1.81 ±0.28[ab]
Chewiness	1.60 ±0.30[a]	1.10 ±0.30[b]	1.48 ±0.22[a]
TBARS, mg MA/kg sample	1.33 ±0.08[b]	1.35 ±0.09[b]	1.61 ±0.10[a]
Fatty acid			
SFA, %	47.37 ±0.71[b]	47.24 ±0.80[b]	48.90 ±0.38[a]
MUFA, %	51.04 ±0.68[a]	51.15 ±0.81[a]	49.56 ±0.37[b]
PUFA, %	1.59 ±0.04[a]	1.61 ±0.03[a]	1.54 ±0.02[b]
Sensory attribute			
Flavour	6.13 ±0.64	5.38 ±1.69	6.63 ±1.19
Color	8.00 ±0.76[a]	6.63 ±0.92[b]	7.88 ±0.83[a]
Texture	7.25 ±0.71[a]	4.75 ±0.71[b]	6.75 ±0.46[a]
Overall liking	7.34 ±0.40[a]	5.84 ±0.63[b]	7.28 ±0.67[a]

[a-c] Means±SD in same row with different superscripts are significantly different ($P<0.05$).

Conclusions

Addition of whole and supernatant of *Kimchi* improved the color, texture, and sensory quality of *Kimchi*-fermented sausages.

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