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Physicochemical and Textural Properties, and Flavor Compounds of Low-fat Sausages Manufactured with Various Levels and Molecular Weights of Chitosans

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Introduction

In recent days, various functional materials have been developed due to the modern scientific techniques. Among them, chitosan is a common constituent of crustacean and arthropod cell walls, and has been widely used in food industry because it has various functional properties, such as antimicrobial, antioxidative and anticholesterol activities. Most studies related to chitosans in meat products were limited to the antimicrobial activity to several microorganisms and the improving physical properties for food systems, such as color development. However, not many studies have been reported on the physicochemical, textural and flavor properties as affected by various chitosans in meat applications. Thus, the objective of this study was to determine the physicochemical properties and flavor profiles of low-fat sausages with various levels and molecular weights (MWs) of chitosans during storage at 4℃.

Materials and Methods

Water soluble chitosans classified as a low-molecular weight (LMW), desalted chito-oligosaccharide (MW=1.5 kDa, purity 80%), medium MW chitosan (MW=30~50 kDa) treated by lyase and high MW deacethylated (90%) chitosan (MW=200 kDa). They were added in the sausage manufacture followed by the procedure of Choi and Chin[(1)]. Moisture, crude protein and crude fat contents (%) were measured by AOAC[(2)] method. Cooking and vacuum losses (%) were determined and water holding capacity was measured by modified method of Jauregui et al.[(3)]. Texture analyses were measured according to the method of Bourne[(4)], using the Texture meter (TA-XT2, Stable micro system, Hasemere, England). The volatile compounds were isolated by the procedure of simultaneous distillation extraction method (SDE)[(5)]. The extracted volatile compounds were concentrated to the final volume of 1 mL and analyzed by a gas chromatography(HP-6890, Hewlett-Packard, Palo Alto, USA). Concentration of each peak was calculated by relative area of internal standard. Volatile compounds were identified by HP 6890 GC/MS equipped with a 5973 mass selective detector. Statistical analyses were performed using one-way analysis of variance (ANOVA) and Duncan's multiple range test was analyzed with the significance level of 0.05.

Results and Discussion

Regular-fat sausages (RFS) had 64% moisture, 13.4% protein and 15.9% fat, whereas low-fat sausages (LFS) had 76~78% moisture, 14~15% protein and <3% fat. Thus, approximately 14% fat was removed and replaced with the fat replacer and moisture in LFS. RFSs were relatively lower ($P<0.05$) cooking loss (CL), vacuum purge (VP) and expressible moisture(EM), as compared to those with the LFS. The addition of chitosan into the LFS did not affect ($P>0.05$) proximate composition and functional properties, regardless of level and MW of chitosans. LFSs containing MMW or HMW chitosans were harder ($P<0.05$) than LFC. In addition, LFS containing 0.3% MMW chitosan was springer and more cohesive ($P<0.05$) than LFC. These results indicated that the textural properties of LFS were affected by the level and MW of chitosan ($P<0.05$), and significant interactions between level and MW of chitosan were observed. Especially, LFS containing 0.3% MMW chitosan affected the textural properties of LFS, resulting in the highest value among other low-fat sausages.

Approximately 29 volatile compounds were identified. Among them, 9 volatile compounds, which were differences between RFC and LFS, are shown in Table 2. There were mainly in phenols and aldehydes

Table 1. Product characteristics of low-fat sausages with various levels and molecular weights of chitosans

			LMC		MMC		HMC	
	RFC	LFC	0.3%	0.6%	0.3%	0.6%	0.3%	0.6%
Moisture	64.1^{b}	76.4^{a}	76.7^{a}	77.9^{a}	76.9^{a}	76.7^{a}	77.7^{a}	76.3^{a}
Protein	13.4^{b}	14.9^{ab}	14.3^{ab}	14.1^{ab}	15.1^{a}	15.1^{a}	14.9^{ab}	15.3^{a}
Fat	15.9^{a}	2.1^{b}	2.2^{b}	2.2^{b}	2.3^{b}	2.2^{b}	2.2^{b}	2.1^{b}
CL	9.1^{b}	13.9^{ab}	15.6^{a}	15.1^{a}	15.3^{a}	17.9^{a}	16.7^{a}	18.9^{a}
VP	3.0^{b}	4.5^{a}	4.5^{a}	4.0^{a}	4.3^{a}	4.3^{a}	4.6^{a}	4.3^{a}
EM	22.4^{c}	33.7^{b}	37.3^{a}	34.4^{b}	35.3^{ab}	35.3^{ab}	34.7^{ab}	34.9^{ab}
FR	3819^{abc}	4028^{ab}	2444^{d}	3413^{bcd}	3099^{bcd}	3022^{bcd}	2811^{cd}	4635^{a}
HA	4383^{d}	6205^{c}	6432^{c}	6064^{c}	7118^{b}	7467^{ab}	7125^{b}	7572^{a}
SP	0.21^{c}	0.30^{b}	0.29^{b}	0.29^{b}	0.37^{a}	0.33^{ab}	0.30^{b}	0.31^{ab}
CO	0.16^{c}	0.23^{b}	0.27^{ab}	0.24^{b}	0.33^{a}	0.29^{ab}	0.27^{ab}	0.28^{ab}
CH	146^{e}	416^{d}	538^{c}	420^{d}	627^{b}	732^{a}	611^{bc}	609^{bc}
GU	685^{d}	1378^{c}	1788^{b}	1529^{c}	1982^{ab}	2206^{a}	1941^{b}	1913^{b}

[a-c] Means with same row having same superscript are not different($P>0.05$).

RFC : Regular-fat sausage, LFC : Low-fat sausage, LMC : LFC with Low MW(1.5 kDa) of chitosan, MMC : LFC with Medium MW(30-50 kDa) of chitosan, HMC : LFC with High MW(200 kDa) of chitosan, CL : Cooking loss(%), VP : Vacuum purge(%), EM : Expressible moisture(%), FR : Fracturability (g), HA : Hardness (g), SP : Springiness (cm), CO : Cohesiveness CH : Chewiness, GU : Gumminess

Table 2. Quantitative and qualitative analysis (ppm) of volatile compounds from low-fat sausage with various levels and molecular weights of chitosans by GC and GC/MS.(ppm)

Compounds	RFC	LFC	LMC 0.3%	LMC 0.6%	MMC 0.3%	MMC 0.6%	HMC 0.3%	HMC 0.6%
2,6-Dimethyl phenol	53[a]	31[bc]	32[ab]	45[bc]	30[bc]	30[bc]	29[bc]	30[bc]
2,4-Dimethyl phenol	336[a]	104[b]	164[b]	182[b]	176[b]	142[b]	148[b]	68[b]
3,5-Dimethyl phenol	127[a]	63[b]	80[ab]	84[ab]	72[ab]	62[b]	56[b]	71[ab]
2-Methoxy-6-methyl phenol	104[a]	53[b]	50[b]	84[ab]	49[b]	50[b]	45[b]	49[b]
2-Methoxy-4-methyl phenol	1650[a]	909[b]	813[b]	1340[ab]	930[b]	847[b]	786[b]	893[b]
2,3-Dimethoxy toluene	89[a]	41[b]	43[b]	65[ab]	42[b]	42[b]	40[b]	43[b]
4-Ethyl-2-methoxy phenol	842[a]	444[ab]	408[b]	716[ab]	457[ab]	414[b]	376[b]	436[ab]
Pentadecanal	417[b]	1642[a]	2133[a]	3292[a]	2468[a]	1858[a]	2090[a]	2232[a]
Octadecanal	42[b]	235[a]	327[a]	548[a]	425[a]	260[a]	340[a]	393[a]

[a-c] Means with same row having same superscript are not different(P>0.05).

RFC, LFC, LMC, MMC and HMC were the same as Table 1.

compounds. The concentration of aldehydes were lower (P<0.05) in RFC rather than in the LFS (P<0.05), whereas phenols compounds were opposit trend of aldehyde. No differences in other volatile compounds were observed between RFC and LFC. However, the addition of chitosan in LFS formulation did not affect the volatile compounds, regardless of level and MW of chitosans.

Summary

Functional properties such as CL, VP and EM did not affected by the addition of chitosans, however, level and MW of chitosans affected textural properties of LFSs, resulting in harder and springer texture of LFSs containing 0.3% MME chitosan as compared to others. Approximately 9 flavor compounds were different between RFC and LFS, and the addition of chitosans did not affected volatile compounds in the LFSs.

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