CORRELATING SENSORY AND INSTRUMENTAL TEXTURE ANALYSES OF COOKED SAUSAGE WITH DIFFERENT CONTENTS OF FAT, SALT, MOISTURE AND STARCH

Q.L. Dong[1,2], X. Luo[3], K. Tu*[1] and L.Y. Guo[1]

[1] *College of Food Science and Technology, Nanjing Agricultural University, Nanjin 210095, China*
[2] *Institute of Food Science and Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China*
[3]*College of Food Science and Engineering, Shandong Agricultural University, Taian 271018, China*

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Introduction

Cooked sausages are prepared from one or more kinds of raw skeletal muscle meat within or without raw or cooked poultry meat. They are then seasoned and cured, using one or more of the curing agents. Examples of cooked sausage are Frankfurter, Hotdog, Wiener, Vienna, Bologna, Knockwurst, etc. To assess the texture of cooked sausage, both sensory evaluation and instrumental measurement have been widely used in previous studies, and the correlation between them has been analyzed (Beilken et al., 1991; Carballo et al., 1996; Cáceres et al., 2004).

Fat of raw meat is an important ingredient among the formulation of cooked sausage. Moreover, salt, water and starch are often added into the mixed meat during the processing of cooked sausage. It has been proved that some ingredients affect the textural properties of cooked sausage significantly. However, previous studies have seldom focused on the interactive effect of fat, salt, moisture and starch on the texture of cooked sausage, furthermore, data is still scant on correlation analysis between objective and subjective evaluation of texture. This research was designed to investigate textural properties of cooked sausage with different combinations of fat, salt, moisture and starch; moreover, relation between sensory and instrumental texture measurements was studied on the basis of the correlation analysis.

Materials and Methods

The back fat and trimmed pork meat, cut from back-leg, were obtained from a local supermarket, after 24 h slaughtering. The formulation and processing of cooked sausage like Frankfurter-type were prepared in the laboratory. Different combinations of fat, salt, moisture and starch were applied as factorial design with 4-factor and 3-level shown in Table 1. Other formulations commonly used in meat industry were added per kg of meat mixture in each treatment as following: salt 300 g, mixed phosphate 40 g, and sodium iso-ascorbic 0.5 g before curing for 48 h at 0-4ºC; ground black pepper 1 g, ginger power 1 g, monosodium glutamate 1.5 g, and isolated soy protein 20 g (mixed with water 100 g) during chopping.

Textural properties of cooked sausage were evaluated by subjective and objective methods, respectively. Subjective method was carried out with 7-point hedonic rating (from 1-dislike to 7-like-very-much) on sausage texture of hardness, cohesiveness, chewiness and juiciness as described by Pérez-Cacho et al. (2005). Comparatively, in the objective measurement of sausage texture, Texture Analyzer TA-XT2i (Stable Micro Systems, Surrey, UK) with a load cell of 5 kg was used in the texture profile analysis (TPA). All samples were cut into cylinder with 2-cm in height and 1-cm in diameter, and then compressed twice with 50% deformation with a stainless compression probe of 5 cm in diameter. Parameters of hardness, springiness, cohesiveness and chewiness from the force-time curves were determined as described by Bourne (1978).

Data collected for textural properties with sensory and instrumental measurement were analyzed by ANOVA with Statistical Analysis System 8.02 for Windows (SAS Institute Inc., Cary, NC, USA). Multiple comparisons were performed by Fisher's least significant difference (LSD) to determine significant differences between mean values of the different treatments. Relations between two methods were analyzed by calculating the correlation parameters.

Results and Discussion

Sensory evaluation of sausage texture. As shown in Table 1, differences of hardness, chewiness and juiciness between different combinations of 4 factors tended to be more significant than that of springiness and cohesiveness ($P < 0.05$). It indicated that sensory springiness and cohesiveness of cooked sausage with different fat, salt, moisture and starch contents were similar and evaluators cannot tell the differences among them.

Instrumental measurement of sausage texture. Texture profile analysis parameters of different combinations were shown in Table 1. In general terms, the double compression test did not show great differences of springiness and cohesiveness between 9 batches, which were consistent with the analysis of sensory evaluation. Furthermore, it was found that the hardness and chewiness of cooked sausage tended to decrease noticeably when fat contents changed from 10% to 30%. These results were similar to the study of Cáceres et al. (2004),

while not similar to those of Mittal and Barbut (1994) who concluded opposite results. This discrepancy is probably due to differences in composition, and a different relationship between the components of the emulsion (fat, moisture and starch) and the consistency of the gel. Besides fat content, starch added into the sausage was another significant factor affecting the texture of cooked sausage. Similar conclusion also could be found in the report of Carballo et al. (1996).

Table 1. Sensory and instrumental measurement of textural properties of cooked sausage

No.	Fat (%)	Salt (%)	Moisture (%)	Starch (%)	Sensory texture					Instrumental texture			
					Hd	Sp	Co	Ch	Ju	Hd (g)	Sp (mm)	Co	Ch (g·mm)
1	10	1	10	5	6.23^{a}	4.43^{ab}	4.77^{a}	6.03^{a}	2.40^{a}	720.92^{a}	0.74^{ab}	0.26^{a}	138.65^{a}
2	10	2	20	10	4.53^{b}	4.63^{ab}	4.93^{b}	4.73^{b}	4.20^{b}	568.96^{b}	0.76^{ab}	0.27^{ab}	117.49^{b}
3	10	3	30	15	3.57^{c}	4.07^{a}	5.00^{b}	3.50^{c}	3.53^{c}	443.71^{c}	0.73^{ab}	0.29^{bc}	94.62^{cd}
4	20	1	30	10	4.40^{b}	3.50^{d}	4.90^{d}	4.60^{b}	4.70^{b}	504.47^{d}	0.64^{c}	0.31^{c}	97.85^{cd}
5	20	2	10	15	4.83^{d}	5.80^{e}	4.30^{a}	4.90^{b}	4.47^{b}	512.76^{d}	0.84^{ab}	0.34^{d}	146.18^{a}
6	20	3	20	5	3.17^{e}	6.10^{f}	4.33^{a}	3.80^{c}	4.47^{b}	401.32^{e}	1.08^{e}	0.34^{d}	146.08^{a}
7	30	1	20	15	3.90^{b}	5.67^{e}	4.10^{c}	3.30^{e}	3.33^{c}	401.58^{e}	0.87^{d}	0.27^{ab}	97.74^{cd}
8	30	2	30	5	3.73^{b}	3.03^{de}	4.47^{d}	4.03^{c}	3.37^{c}	459.32^{e}	0.67^{bc}	0.29^{ab}	89.88^{d}
9	30	3	10	10	3.43^{b}	4.17^{a}	4.70^{d}	4.00^{c}	4.70^{b}	441.88^{c}	0.71^{bc}	0.29^{bc}	92.12^{cd}

Hd: hardness; Sp: springiness; Co: cohesiveness; Ch: chewiness; Ju: juiciness.
$^{a–f}$ Means in the same row without a common superscript letter differ significantly ($P < 0.05$).

Correlation analysis. As shown in Table 2, the correlation analysis revealed that textural measurement with sensory and instrumental methods showed high Pearson coefficients, especially hardness and springiness, with 0.94 (P <0.01) and 0.89 (P <0.05), respectively. Similar results were found by Beilken et al. (1991). Texture profile analysis (TPA) has been widely used as an instrumental method, providing information on both the deformation and fracture properties of sausage under large strains. In practice, these results would be valuable in controlling and modifying the textural properties of cooked sausage with different fat, salt, moisture and starch addition. In addition, it demonstrated that there were not high correlative relation between sensory juiciness and any instrumental TPA attributes. In the study of Beilken et al. (1991), similar results were also found as described in this study. As one of the most important attributes affecting the textural acceptability, juiciness in cooked sausage strongly depends on the subjective evaluation according to current research.

Table 2. Pearson correlation coefficients between sensory and instrumental texture of cooked sausage

		Sensory texture				
		Hd	Sp	Co	Ch	Ju
Intrumental texture	Hd	0.94**	-0.18	0.42	0.94**	-0.47
	Sp	-0.27	0.89*	-0.32	-0.25	0.13
	Co	-0.35	0.38	0.61	-0.15	0.66
	Ch	0.44	0.68*	-0.26	0.53	-0.003

Hd: hardness; Sp: springiness; Co: cohesiveness; Ch: chewiness; Ju: juiciness.
** P <0.01，* P <0.05.

Conclusions

As a result, textural properties of cooked sausage changed significantly according to different concentrations of fat, salt, moisture and starch, especially hardness and chewiness. Moreover, correlation analysis showed that hardness and springiness of sensory evaluation were highly correlated with those of instrumental analysis, respectively. As one of important objective measurements, texture profile analysis (TPA) would be useful and convenient in textural evaluation of cooked sausage associated with subjective methods in meat industry.

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