INFLUENCE OF FAT SUBSTITUTION LEVEL ON SENSORY QUALITY OF „BOLOGNA" TYPE SAUSAGE

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Background

Both the rheologic and sensory properties of meat products are affected significantly by fat content, e.g. flavour and juiciness (Berry and Leddy, 1984). Lower fat content affects detrimentally both texture (rigid, floury, pastry-like) and flavour - the product is tasteless (Huffmann, 1993). Studies carried out on fat substitution revealed that low-fat products are evaluated positively if carrageenan, xanthan, starch or their combination with soy protein isolates are used as fat replacers (Solheim, 1993). Senik *et al.* (1994) demonstrated that polisaccharide - protein fat replacer imitated well fat properties in the homogenous sausage structure and it was feasible to substitute at least 75% fat without significant deterioration of sensory quality of the product. The sensory profiling method „Quantitative Descriptive Analysis" (QDA) is particularly useful in the assessment of product texture due to the possibility of quantitative evaluation of partial sensations in regard to their intensity (Beilken *et al.* 1991).

Objectives

The purpose of study was the sensory assessment of „Bologna" type sausage of traditional recipe, modified by added polysaccharide - protein fat replacer in quantities of 50, 75 or 100% of recipe fat content.

Materials and method

Four recipes were used in the preparation of „Bologna" type sausages: control (C) without substitute and three experimental recipes in which the polysaccharide protein fat replacer in amounts of 50% (T1), 75% (T2) and 100% (T3) of recipe fat content was equivalently used. The substitute contained a mixture of 1.5% water solution of carregeenan Satiagel 26, Supro 500E and Supro 595 soy protein isolates mixed at 1:1 ratio and hydrated at 1:5 ratio. The sausage batter was made from raw muscle material (pork shoulder and beef trimmings), seasonings, nitrite salt, water and ice, fat replacer and/or raw fat material (fat trimmings and pork jowl) prepared by chopping. The emulsion was canned (portions of 400g), thermally processed to reach 72°C in the middle of the can and afterwards chilled with cold water. Total protein by Kjeldahl method (Kjeltec Analyser 1026); fat by Soxhlett method (Soxtec Fat Analyser HT-6) and water content by drying were analysed in the product samples. Sensory Analysis by Quantitative Descriptive Analysis (QDA) acc. to Meilgaard *et al.* (1991) was carried out by sensory panel of 7 judges. The following texture characteristics were assessed: firmness, springiness, gumminess, chewiness and wetness. The intensity of each characteristic was assessed on 100mm graphic scale. Samples 3mm thick were given at random to sensory panel members. Samples of the sausage were also subjected to sensory assessment in the hedonic scale to examine the effect of fat substitute on firmness, colour, flavour, texture and overall hedonic rating. Four series of experiments were carried out and the results of chemical analysis and sensory assessment were subjected to the following statistical tests: One-way ANOVA Analysis, Multiple-Variable Analysis, and Principal Component Analysis (PCA) using the statistical package Statgraphics Plus for Windows ver. 2.

Results and discussion

Changes in the chemical composition of sausage samples caused by fat substitution are shown in Table 1. With the increasing amount of added fat replacer the content of fat in the samples was significantly decreasing with concomitant increase of water content. On the other hand, the protein content was found to be at constant level.

The results of sensory analysis (QDA) are presented in Table 2. Fat substitution in „Bologna" type sausage decreased significantly ($p<0.05$) the following characteristics: firmness from 48.0 (T1) to 29.8 (T3); springiness from 49.7 (T1) to 34.4 (T3) and chewiness from 45.8 (T1) to 29.0 (T3). Simultaneously a statistically significant increase was noted in fatness from 34.6 (T1) to 43.3 (T3) and in wetness from 41.0 (C) to 63.0 (T3). The changes observed in gumminess were statistically insignificant (Table 2). The experimental samples T2 and T3 compared with T1 and C samples were found less hard and less springy and demonstrated a lower level of chewiness an increasing wetness feeling. Simultaneously, despite the declining fat content in the successive experimental sausage samples a growing fatness feeling was observed (Table 2).

The results of the hedonic assessment in Table 3 demonstrate that the increasing level of fat substitution caused statistically significant ($p<0.05$) decline in colour, flavour and texture desirability in the samples of T1, T2 and T3 groups of sausages, compared with the control group (C). On the other hand, it was found very characteristic that the overall hedonic rating in C, T1 and T2 groups was maintained on a constant level and only in T3 group was significantly lower. Sausage having 50% of fat substitute T1 was found to be most close to the control sample (C) in sensory assessment both in regard to QDA test and to the hedonic assessment. On the other hand, T2 and T3 samples having the highest level of fat substitution (75% and 100%) were rated lower. The fat replacer used in high amounts (75% and 100%) influenced detrimentally sausage texture.

Multiple-Variable Analysis demonstrated that total protein content was not correlated with the other sausage components (fat and water) and with sensory attributes, whereas fatness was correlated with texture desirability ($r=-0.69^{**}$) only. Firmness and wetness were correlated with each other ($r=-0.71^{**}$) and with fat content ($r=0.71^{**}$, $r=-0.88^{***}$); water content ($r=-0.71^{**}$, $r=0.89^{***}$); springiness ($r=0.96^{***}$, $r=-0.72^{**}$); chewiness ($r=0.86^{***}$, $r=-0.67^{**}$) and texture desirability ($r=0.67^{**}$, $r=-0.77^{**}$). On the other hand, texture desirability was correlated with fat content ($r=0.61^{*}$), water content ($r=-0.63^{**}$); firmness ($r=0.67^{**}$); springiness ($r=0.72^{**}$), gumminess ($r=0.58^{*}$); chewiness ($r=0.73^{**}$); fatness ($r=-0.68^{**}$); wetness ($r=-0.77^{***}$); colour desirability ($r=0.73^{**}$) and overall hedonic rating ($r=0.54^{*}$).

The PCA analysis demonstrated that the first principle component (PC1) comprised 56.6% and the second one (PC2) 14.9% of the total variability. In the case of PC1 the most important variables were: fat and water content, firmness, springiness, chewiness, wetness, colour, flavour and texture which all characterized best the sensory quality of the examined sausage samples. In the case of PC2 the most important variables were: protein content, fatness, flavour and overall hedonic rating. On the presented biplot it may be seen how important discriminant function in the sensory analysis plays wetness, highly significantly correlated with water content (r=0.90). For that reason those scores of T3 samples having highest wetness level (63.00) are situated extremaly right on the biplot, whereas scores of T1, T2 and C samples of declining wetness level (57.7; 53.5 and 41.0, respectively) are situated more on the left side of the biplot.

Conclusions

1. „Bologna" type sausage with 50% fat substitute demonstrated sensory quality similar to that in the product without fat substitute used. Fat substitution at the level of 75% and 100% caused appreciable deterioration of sensory quality in the product.
2. Texture discriminants (except gumminess) selected and used in the assessment of sensory quality and all hedonic discriminants were expressing well sensory quality changes caused by fat substitution in „Bologna" type of sausage.
3. The observed deterioration of sensory quality in the experimental samples of „Bologna" type sausage with increasing fat substitution resulted mainly from the changes in its basic composition, i.e. from the increase of water content (70.22% ÷ 79.12%) that replaced the fat component in the sausage.

References

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Table 1 Effect of fat substitution level on chemical constitution of „Bologna" type sausages

Var./fat substitution level [%]	Total protein [%]	Fat [%]	Water [%]
C/0	11,50	15,6 ^{d}	70,22 ^{a}
T1/50	11,68	11,3 ^{c}	74,48 ^{b}
T2/75	11,35	8,9 ^{b}	76,89 ^{c}
T3/100	11,57	6,6 ^{a}	79,12 ^{d}

Means in the same column with different superscript are significantly different ($p<0,05$)

Table 2 Intensity of texture discriminants in „Bologna" type sausages with different fat substitution level

Var./fat substitution level [%]	firmness	springiness	guminess	chewiness	fatness	wetness
C/0	45,6 ^{c}	48,4 ^{b}	50,9	42,0 ^{bc}	36,5 ^{ab}	41,0 ^{a}
T1/50	48,0 ^{c}	49,7 ^{b}	49,5	45,8 ^{c}	34,6 ^{a}	53,5 ^{b}
T2/75	38,2 ^{a}	43,3 ^{b}	45,7	36,6 ^{ab}	37,3 ^{ab}	57,7 ^{b}
T3/100	29,8 ^{a}	34,4 ^{a}	46,3	29,0^{a}	43,3 ^{b}	63,0 ^{c}

Means in the same column with different superscript are significantly different ($p<0,05$)

Table 3 Hedonic rating „Bologna" type sausages with different fat substitution level

Var./fat substitution level [%]	Hedonic rating			
	colour	flavour	texture	overall
C/0	48,4 ^{c}	42,2 ^{b}	49,1 ^{c}	39,4 ^{b}
T1/50	44,1 ^{bc}	37,0 ^{ab}	47,2 ^{bc}	40,7 ^{b}
T2/75	41,3 ^{ab}	36,1 ^{a}	42,5 ^{b}	39,8 ^{b}
T3/100	35,7 ^{a}	34,7 ^{a}	35,4 ^{a}	32,1 ^{a}

Means in the same column with different superscript are significantly different ($p<0,05$)