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THE QUALITY OF FRANKFURTERS AS INFLUENCED BY FAT TYPE AND AMOUNT AND BY PARTIAL REPLACEMENT OF NaCl WITH KCl

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INTRODUCTION

Consumer desire for low fat and low salt meat products has increased not only to avoid obesity but also to reduce the risk of developing cardiovascular diseases. It is known that the ingestion of most saturated fatty acids increases the plasma concentration, low density lipoprotein (LDL)-cholesterol in humans, and elevated levels of plasma LDL-cholesterol have been correlated with an increased risk of coronary heart disease. Substitution of monounsaturated or polyunsaturated fatty acids for saturated fatty acids decreases plasma LDL-cholesterol (Park *et al.*, 1989). The effect of reduced fat (Hand *et al.*, 1987; Park *et al.*, 1989; Mittal and Barbut, 1992), partial replacement of NaCl with KCl (Hand *et al.*, 1982; Baccus-Taylor *et al.*, 1991) and substitutions of animal fat for vegetable oils (Hammer, 1991, 1992) on the textural and sensory properties of meat products have been investigated. However, the effects of all three factors have not been well determined. The objective of this work was therefore to study the effect of different sorts of fat, percentage of added fat and partial replacement of NaCl with KCl on the sensory, chemical and physical properties of frankfurters.

MATERIAL AND METHODS

Samples of frankfurters differed in fat type (pork fat or sunflower oil), percent of added fat (15-20% or 25-30%) and salt type (1.7% NaCl or 1.1% NaCl + 0.6% KCl). Thus, 8 groups of frankfurters were made (each group in 6 repetitions), as shown in Table 1. Samples with lower fat percentage contained on this account more lean meat and water so this ratio (lean meat : water) remained approximately 2:1.

Meat emulsions were made using a vacuum chopper in the usual way. Afterwards they were filled in natural casings, smoked and cooked to an internal temperature of about 70°C. They were evaluated in terms of sensory properties using an analytical descriptive test based on a 7-point scale for various attributes, as they are described in Table 2. Fatty acids were qualitatively and quantitatively analyzed using a gas chromatograph (Varian 3700) according to the IUPAC method II.D.19. The colour was instrumentally analyzed with a chromometer (Minolta CR 200 B) in L- (lightness), a-(redness) and b-(yellowness) "colour analysis system". The texture of 1.5 x 1.5 samples cm was also instrumentally analyzed with a "Universal Testing" machine (model 1111 Instron) equipped with a 1000N load cell. The cutting strength (= force required to cut; crosshead speed = 5cm/min), compression strength (= force required to fracture; compression for 80% of samples' original height; crosshead speed = 5cm/min) and compression resistance (= force required for the compression; compression for 33% of samples' original height; crosshead speed = 2cm/min) were measured as described by Plestenjak (1983). All textural properties were reported in N using a chart speed of 5cm/min.

RESULTS AND DISCUSSION

Sensory properties

Frankfurters prepared with pork fat were found have better external appearance, cross-section colour characteristic

and intensity than frankfurters with sunflower oil (Table 2). Hammer (1991) and Park *et al.* (1989) affirmed that replacement of animal fats by the oils had little effect on emulsion stability. Our investigation confirmed this statement, and we can add that all groups of frankfurters prepared with oil in this study were even more stable in comparison with those with pork fat. None of the samples were oily, irrespective of the type and percentage of the added fat. Also, this result further supports the results of Hammer (1991). As a rule, frankfurters prepared with oil tend to be more gummy, and they also tend to have higher elasticity and firmness values than corresponding frankfurter that contain pork fat. Oils are more finely distributed in the meat mixture and produce smaller fat droplets than does pork fat; so frankfurters prepared with oil are firmer than other with pork fat. (Hammer, 1992). All frankfurter groups with less fat were found to be firmer to tongue and more gummy than those with a higher percentage of fat. The firmness and gumminess of a sausage product depend on the lean meat content and the fat content, which softens the product (Park *et al.*, 1989). All three factors influenced juiciness: samples with pork fat, higher percentage of fat, and NaCl were more juicy than corresponding frankfurters with oil, lower percentage of fat and NaCl partially replaced with KCl. Frankfurters with pork fat had better smell and flavour than frankfurters with sunflower oil, most probably because of pork fat's specific flavour that originates from amino acid and carbohydrate fractions of pork fat (Gillett, 1987). All groups containing more fat demonstrated higher smell and flavour scores than groups with less fat. This is not surprising since we know that fat is a carrier of aromatic substances. The flavour of all frankfurters with added KCl scored lower than adequate groups prepared just with NaCl. Aftertastes (bitterness and rancidity) were not ranked very high (up to 1.5 points). In spite of this, frankfurters with oil exhibited more expressive aftertastes than those with pork fat. Groups with added KCl also had more expressive aftertastes than groups prepared just with NaCl. Frankfurters with HFNaCl were optimally salty; all other samples were estimated to be not salty enough. As a rule, all frankfurters with pork fat, higher percentage of fat, and NaCl were generally more acceptable than corresponding frankfurters with oil, lower percentage of fat, and added KCl.

Fatty acid composition

A qualitative fatty acid analysis of HONaCl given in Table 3 found that fatty acids were not as prevalent in comparison with HFNaCl. The unsaturated to saturated fatty acid ratio in HFNaCl was 65.6:34.4 (i.e., 1.9; Table 4). As expected HONaCl contained more unsaturated fatty acids than did the HFNaCl, and the HONaCl unsaturated to saturated fatty acid ratio was 86:14 (i.e., 6.1). The exchange of pork fat with sunflower oil in frankfurters increased the content of linoleic acid by a factor of seven times (Table 3).

Instrumental analyses of colour

All samples prepared with sunflower oil had higher L-values (more light), lower a- (less red) and lower b-values (less yellow) than frankfurters prepared with pork fat (Table 5). Hammer (1992) also reported that the use of sunflower oil instead of pork fat results in brightening and in a reduction in the red shade of frankfurters. The L-value (lightness) was determined to be directly proportional to fat level (Table 5), which is not surprising since more fat provides a whiter colour. The increasing fat content decreased the a-value. This was also expected since frankfurters with a higher percentage of fat contain less lean meat, which contributes the myoglobin.

Instrumental properties of texture

As a rule all groups prepared with oil have higher cutting and compression strength, but lower compression resistance than those with pork fat (Table 6). Frankfurters with lower percentage of added fats had higher values for compression strength and even compression resistance than corresponding groups with more added fat. These results correspond to those of Hand *et al.* (1987), Park *et al.* (1989) and Mittal and Barbut (1992). Latter authors reported that the fat is much less resistant to force than the coagulated protein matrix, and furthermore, the higher the fat content the lower the force.

CONCLUSIONS

The fat type has the greatest and most significant influence on the all of the investigated frankfurters' properties. Frankfurters prepared with pork fat are in comparison with those with sunflower oil, given better sensory scores, although all frankfurter types would appear to be fully acceptable. The exchange of pork fat with the sunflower oil in frankfurters causes an increase of unsaturated to saturated fatty acid ratio from 1.9 to 6.1. Frankfurters with a higher addition of fat have better overall sensory acceptability, which is due to their lower scores for gumminess, and higher scores for juiciness and smell. Partial replacement of NaCl (up to 35%) with KCl significantly influences the sensory properties of frankfurters. Although the overall acceptability of samples with added KCl was worse, we can still say that such rate of replacement is possible since all samples in this study were found to be sensorially acceptable.

REFERENCES

BACCUS-TAYLOR, G., GARCIA, H.S., and MAURER, A.J. 1991. Preparation of a low-fat reduced sodium turkey Braunschweiger. *Poul. Sci.* 70:1998-2001.

GILLETT, T.A. 1987. Adipose and connective tissue. In: PEARSON, A.M., and DUTSON, T.R. (eds). Advances in Meat Research. *Restructured Meat and Poultry Products, Vol. 3.* Van Nostrand Reinhold Company, New York. pp.73-124.

HAMMER, G.F. 1991. Processing of cooked sausages containing unsaturated vegetable oils. *Proc. 37th ICMST.* Kulmbach, Germany. 2:720-723.

HAMMER, G.F. 1992. Processing vegetable oils into frankfurter-type sausages. *Fleischwirtschaft.* 72:1258-1265.

HAND, L.W., TERRELL, R.N., and SMITH, G.C. 1982. Effects of chloride salts on physical, chemical and sensory properties of frankfurters. *J. Food Sci.* 47:1800-1802, 1817.

HAND, L.W., HOLLINGSWORTH, C.A., CALKINS, C.R., and MANDIGO, R.W. 1987. Effect of preblending, reduced fat and salt levels on frankfurter characteristics. *J. Food Sci.* 52:1149-1151.

IUPAC, Standard methods for the analysis of oils, fats and derivatives. 1979. 6th ed. Pergamon Press, Oxford. pp.96-102.

MITTAL, G.S., and BARBUT, S. 1992. Role of fat in pork breakfast sausages. *Proc. 38th ICMST.* Clermont-Ferrand, France. 5:1147-1149.

PARK, P., RHEE, K.S., KEETON, J.T., and RHEE, K.C. 1989. Properties of low-fat frankfurters containing monounsaturated and omega-3 polyunsaturated oils. J. Food Sci. 54:500-504.

PLESTENJAK, A. 1983. A study of mechanical properties and components of sensory texture in various types of meat emulsion coagula and their interrelations. Dissertation. Biotechnical faculty, Ljubljana, Slovenia, pp. 28-29.

Table 1. Groups of prepared frankfurters.

% and fat type	salt type	abbreviation
25-30% pork fat	1,7% NaCl	HFNaCl
15-20% pork fat	1,7% NaCl	LFNaCl
25-30% pork fat	1,1% NaCl + 0,6% KCl	HFKCl
15-20% pork fat	1,1% NaCl + 0,6% KCl	LFKCl
25-30% sunflower oil	1,7% NaCl	HONaCl
15-20% sunflower oil	1,7% NaCl	LONaCl
25-30% sunflower oil	1,1% NaCl + 0,6% KCl	HOKCl
15-20% sunflower oil	1,1% NaCl + 0,6% KCl	LOKCl

Table 2. Sensory properties of frankfurters (mean values, analysis of variance)

Property (scores)	HFNaCl	LFNaCl	HFKCl	LFKCl	HONaCl	LONaCl	HOKCl	LOKCl	F-value
external appearance (1-7)	5.67	5.38	5.54	5.44	5.44	5.34-	5.25	5.27	2.77**
cross-section colour characteristic (1-7)	5.31	5.33	5.46	5.42	5.13	5.02	4.90	4.88	6.79***
cross-section colour intensity (1-4-7)	3.56	3.73	3.56	3.81	3.13	2.92	2.52	2.73	22.01***
stability (1-7)	5.42	5.69	5.65	5.75	6.27	6.42	6.50	6.50	27.22***
oiliness (1-7)	1.02	1.00	1.02	1.00	1.00	1.00	1.00	1.02	0.71
fragility-gumminess (1-4-7)	4.56	4.90	4.46	5.04	5.33	5.42	5.35	5.44	10.76***
elasticity to tongue (1-7)	5.40	5.56	5.40	5.54	5.77	5.77	5.73	5.79	1.99*
firmness to tongue (1-7)	5.31	5.75	5.35	5.75	5.96	6.00	6.04	6.08	4.48***
juiciness (1-7)	5.50	5.33	5.42	5.13	5.08	4.92	4.94	4.90	9.58***
smell (1-7)	5.96	5.73	5.96	5.83	5.65	5.63	5.38	5.50	6.39***
flavour (1-7)	5.56	5.38	5.33	5.25	5.23	5.06	5.00	4.81	11.42***
aftertastes (1-7)	1.04	1.04	1.13	1.25	1.23	1.15	1.46	1.50	4.96***
saltness (1-4-7)	4.00	3.88	3.75	3.67	3.60	3.44	3.73	3.65	7.24***
overall acceptability (1-7)	5.75	5.44	5.50	5.25	5.35	5.15	5.06	4.75	18.72***

external appearance (1=uncharacteristic colour with faults, 7=characteristic colour), cross-section colour characteristic

(1=uncharacteristic colour, 7=characteristic colour), cross-section colour intensity (1=not enough intensive colour, 4=optimal intensive, 7=too much intensive), stability (1=unstable, 7=stable), oilness (1=not oily, 7=very oily), fragility-gumminess (1=crumbly, 4=optimal texture, 7=gummy), elasticity to tongue (1=not elastic, 7=extremely elastic), firmness to tongue (1=extremely soft, 7=extremely firm), juiciness (1=extremely dry, 7=extremely juicy), flavour (1=uncharacteristic, 7=characteristic), aftertastes (1=none, 7=extremely strong), saltness (1=unsalty, 4=optimal salty, 7=too much salty), overall acceptability (1=unacceptable, 7=excellent)
* $p \leq 163$ \f "Symbol"} 0,05; ** $p \leq 0{,}01$; * ** $p \leq 0{,}001$;

Table 3. Fatty acid composition of frankfurters HFNaCl and HONaCl (N = 3).

Fatty acid	Number of C-atoms	HFNaCl (%)	HONaCl (%)
myristic	C 14:0	1.21	-
palmitic	C 16:0	23.76	10.12
palmitooleic	C 16:1 (9)	3.88	-
stearic	C 18:0	9.40	3.87
oleic	C 18:1 (9)	52.56	23.69
linoleic	C 18:2 (9,12)	9.08	62.32
linolenic	C 18:3 (9,12,15)	0.07	-

Table 4. Unsaturated to saturated fatty acid ratios (in %) in frankfurters HFNaCl and HONaCl.

Sample	unsaturated : saturated fatty acids
HFNaCl	65.6 : 34.4 ≈ 1.9
HONaCl	86 : 14 ≈ 6.1

Table 5. Instrumental values of frankfurters' colour (mean values, analysis of variance).

Value	HFNaCl	LFNaCl	HFKCl	LFKCl	HONaCl	LONaCl
L-	66.79	64.41	68.36	64.83	73.81	73.08
a-	14.71	15.81	14.06	15.79	11.59	12.06
b-	13.77	13.42	13.57	12.41	12.55	12.83
Value	HOKCl	LOKCl	F-value			
L-	76.18	72.98	202.68***			
a-	10.40	12.08	75.02***			
b-	12.37	12.89	21.32***			

Table 6. Instrumental properties of franks' texture (mean values, analysis of variance).

Property	HFNaCl	LFNaCl	HFKCl	LFKCl	HONaCl	LONaCl	HOKCl	LOKCl	F value
cutting strength (N)	4.07	3.85	4.18	5.18	5.38	5.77	4.78	5.88	4.09 ***
compress-ion strength (N)	47.35	52.55	49.37	52.95	67.20	68.15	62.15	65.73	27.46 ***
compress-ion resist. (N)	10.13	10.85	8.97	10.52	7.90	8.47	7.88	8.80	14.46 ***