THE INFLUENCE OF FAT CONTENT AND OTHER CHEMICAL COMPOSITION ON COLOUR AND TEXTURE OF DRY FERMENTED MEAT PRODUCTS

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Abstract – The effect of fat content and other chemical composition on colour and texture of dry fermented meat products was studied. Fat is the major component in dry fermented sausages and affects the quality of the final products. Colour (L* – lightness, a* – redness, b* – yellowness), maximum force in Texture profile analysis, Warner-Bratzler shear force and chemical composition (dry matter, fat, collagen, protein) was measured on commercial produced dry fermented sausages (n = 498) during storage (0, 28, 56, 84, 112, 140, and 168 days). Fat values were within the range between 32 and 48%, dry matter between 64 and 76%, collagen 1 – 4% and protein 14 – 24%. Fat level affected the L* value (P < 0.01), maximum force in Texture profile analysis and Warner-Bratzler shear force (P < 0.001). Higher fat contents resulted lighter sausages. Protein statistically significant correlated with L*, a* and b* (P < 0.001) and texture parameters (P < 0.001).

Key Words – CIELAB, Warner-Bratzler, Texture profile analysis

I. INTRODUCTION

Dry fermented sausages are an important product group in the meat processing industry. The quality of food products, in conformity with consumers' requirements and acceptance, is determined by their sensory attributes, chemical composition, physical properties, and level of microbiological and toxicological contaminants, shelf life, packaging and labelling [1]. Dry fermented sausages are meat products with high fat content, commercial sausages have fat contents around 30 – 50 % [2] and fat is responsible for various properties of dry fermented sausages. Fat acts as a source of essential fatty acids and fat soluble vitamins and constitutes the most concentrated source of energy in the diet. Also fat contributes to the flavour, texture, mouthfeel, juiciness, and lubricity, which determine the quality and acceptability of dry sausages [2, 3].

The objective of this study was to investigate the effect of fat level and other chemical composition on colour and texture of dry fermented sausages.

II. MATERIALS AND METHODS

Samples preparation. One batch (150 kg) of dry fermented sausages was prepared at a production plant according to the company recipe. This recipe was composed of 63% lean pork meat, 4% lean beef meat and 33% pork backfat. Dextrose (0.3%), a starter culture, spices and 2.4% nitrite salting mixture were added to this mixture. The mixture was filled into 55-mm diameter fibrous casings. Fermentation started at a temperature of 24°C. After a week the temperature was reduced to 16°C, and was maintained at this level until the end of the maturing process (3 weeks). The relative humidity of the air was set at 94%, before being reduced to < 80% after a week. Following the prescribed maturing and the attainment of shipping maturity, the products were packed on a Webomatic APS ML 7100 vacuum packing machine (Webomatic Maschinenfabrik GmbH, Bochum, Germany) with the use of the upper foil AV 80µ (PA/PE 20/60) and lower foil AV 230µ (PA/PE 80/150) and stored at 15 ± 2°C. The sausages at the end of ripening (0 day) and sausages stored for a period 28, 56, 84, 112, 140 and 168 days were analyzed.

Chemical parameters. The sample parameters (dry matter content, fat content, collagen content and muscle protein) were established using standard methods. The sausages samples (100 g) were homogenised. The following parameters were subsequently determined: amount of dry matter [4], muscle protein (after elimination of non-protein n-compounds by hot tannin) protein content was measured on a KJELTEC (FOSS

Tecator, Denmark), nitrogen was converted to protein using a factor of 6.25 and fat was analysed on a SOXTEC (FOSS Tecator, Sweden) with diethyl ether as the extraction agent [5]. Collagen content was measured by spectrophotometric method at 550 nm, equalized to 4-hydroxyprolin content.

Instrumental parameters. Colour measurement was taken with a Konica Minolta model CM-2600d spectrophotometer (Konica Minolta, Japan) using a 3 mm port size, illuminant D65 and a 10° standard observer. CIELAB L*, a* and b* values were determined as indicators of lightness, redness and yellowness. Five measurements were taken on the surface of three, 2 cm long pieces of sausage.

Samples were tested by Texture Profile Analysis using an Instron Universal Testing Machine (model 5544) (Instron Corporation, High Wycombe, UK). For TPA cylinder, samples (2 cm high, 2.5 cm diameter) were compressed twice to 50% of their original height with a compression platen of 36 mm in diameter. Force time curves were recorded at a crosshead speed of 50 mm. min^{-1}. Hardness (TPA) – the peak force required for the first compression was evaluated [6, 7]. Warner-Bratzler shear test measures the force necessary to shear a piece of meat products. Samples (2.5 x 2.5. x 2.0 cm) were cut with V blade; the test speed was 50 mm. min^{-1}.

Data analysis. Statistical data analyses were conducted using the statistical program STATISTICA 7 CZ (StatSoft, Prague, Czech Republic).

III. RESULTS AND DISCUSSION

The results of the instrumental and chemical analyses of dry fermented sausages samples stored at 15°C are shown in Tables 1–2. The data are expressed as the means of the analysed values, including standard deviations, maximum and minimum in each group of samples divided according storage days.

Texture parameters changes during storage, after 28 days of storage, the hardness and maximum shear force value was higher in comparison with the value obtained after maturing had been completed. From the 56^{th} day of storage, hardness and maximum shear force was decreased. During storage L* values were similar, the decrease in a* values and increase in b* values was found.

Fat values were within the range between 32 and 48%, dry matter values were within the range between 64 and 76%, collagen contents were within the range between 1 and 4% and muscle protein values were within the range between 14 and 24%. There are no significant changes during storage in amount of fat, dry matter, collagen content a muscle protein.

Table 1 Instrumental characteristics of dry fermented sausages

Day		TPA	WB	L*	a*	b*
0 (n=72)	Mean	69.41	23.75	47.33	17.65	10.67
	S.D.	12.21	4.31	1.49	0.77	0.80
	MAX	88.24	30.09	51.49	19.31	12.47
	MIN	42.81	17.63	44.45	15.52	8.76
28 (n= 72)	Mean	89.40	30.36	46.14	17.15	10.81
	S.D.	26.97	7.36	2.25	0.98	1.04
	MAX	148.83	45.57	51.83	19.00	13.17
	MIN	56.59	20.57	42.46	12.83	8.01
56 (n=72)	Mean	82.68	26.18	46.19	16.88	11.26
	S.D.	23.77	5.02	2.62	0.69	1.22
	MAX	124.46	35.76	52.95	18.44	14.48
	MIN	49.67	19.92	40.13	15.30	9.11
84 (n=72)	Mean	77.59	23.95	47.07	16.08	11.43
	S.D.	26.81	6.28	2.61	1.11	1.68
	MAX	131.41	37.18	53.25	18.85	15.90
	MIN	38.46	15.73	43.09	14.10	8.65
112 (n=72)	Mean	76.57	25.87	47.39	15.80	11.50
	S.D.	24.21	6.12	2.82	0.95	1.42
	MAX	117.68	34.88	55.30	17.85	14.45
	MIN	35.29	17.18	42.25	13.25	8.60
140 (n=72)	Mean	75.87	24.72	46.98	15.67	11.57
	S.D.	22.30	6.60	2.99	1.08	1.42
	MAX	125.52	35.90	53.82	18.60	14.78
	MIN	32.74	13.89	39.54	13.35	9.16
168 (n=66)	Mean	74.58	21.94	46.92	15.23	11.72
	S.D.	29.45	7.10	2.13	1.19	1.34
	MAX	137.92	36.39	51.71	18.05	15.05
	MIN	34.45	13.48	42.91	12.43	9.06

S.D. – standard deviation, TPA – hardness [N], WB – maximum shear force [N], L* – lightness, a* – redness, b* – yellowness

There are a lot of studies about level of fat (low and high level) and its effect on texture and colour. We have only small differences among samples (the day of storage) in chemical composition and the aim of our study was to find similarity or differences with other studies. Lightness (L*), redness (a*) and yellowness (b*)

of the sausages were significantly affected by fat level, ripening temperature, and time and the interaction of ripening temperature and time [8]
The batches with higher amount of fat had the highest lightness (L*) and yellowness (b*) and the lowest redness (a*) [3].
Fat level affected the L* value ($P < 0.01$), maximum force in Texture profile analysis and Warner-Bratzler shear force ($P < 0.001$). Higher fat levels resulted in lighter sausages, this also reported in sausages observed by Muguerza et al. [9], Soyer et al. [8] and Olivares et al. [2]. The L* value was significantly positively correlated with dry matter and muscle protein (Table 3). Lorenzo et al. [3] found negative correlation L* value with protein.

Table 2 Chemical characteristics of dry fermented sausages

Day		Fat [%]	Dry matter [%]	Collagen [%]	MP [%]
0 (n=72)	Mean	39.81	69.13	1.98	19.31
	S.D.	2.77	2.10	0.61	2.38
	MAX	46.22	74.13	4.35	23.51
	MIN	34.32	64.06	1.11	15.74
28 (n=72)	Mean	40.19	69.89	1.74	18.40
	S.D.	2.29	2.21	0.26	2.07
	MAX	45.25	75.68	2.21	23.68
	MIN	36.49	65.95	1.19	14.85
56 (n=72)	Mean	40.45	70.38	1.64	17.85
	S.D.	2.62	1.83	0.26	1.55
	MAX	47.95	75.44	2.22	21.77
	MIN	36.05	67.50	1.09	14.97
84 (n=72)	Mean	40.09	69.58	1.83	17.38
	S.D.	2.13	2.28	0.26	1.50
	MAX	45.97	76.05	2.69	20.61
	MIN	36.18	65.60	1.37	14.73
112 (n=72)	Mean	39.98	70.00	1.80	17.31
	S.D.	2.39	2.27	0.28	1.18
	MAX	46.76	75.68	2.45	20.68
	MIN	35.97	66.42	1.15	14.90
140 (n=72)	Mean	40.21	70.34	1.85	17.56
	S.D.	2.58	2.33	0.36	1.62
	MAX	46.14	75.16	3.65	22.17
	MIN	35.60	65.80	1.24	15.07
168 (n=66)	Mean	39.49	69.49	1.73	17.04
	S.D.	2.30	1.92	0.26	1.08
	MAX	43.65	73.90	2.46	20.23
	MIN	32.03	65.52	1.27	15.36

MP – muscle protein, S.D. – standard deviation

According Olivares et al. [2] b* value was not affected by fat level. The fat level and storage time significantly affected lightness (L*), redness (a*) and yellowness (b*) of sausages [10].
Textural properties in meat products are related to fat, dry matter, collagen and protein. Hardness and maximum shear force significantly correlated with fat level. Hardness decreased with increasing fat in dry fermented sausages [2, 3]. In our study there were found positive correlation, the variance may be cost by changes in the quality of fat.
The composition of fat changed during long storage. Fat level significantly affected the chemical composition, colour, textural traits, and sensory properties of dry-cured sausages. The fat reduction in dry fermented sausages had a significant effect on sausage texture because of an increase in hardness [3].

Table 3 Correlation coefficient among chemical characteristics and instrumental characteristics of dry fermented sausages

	Fat [%]	Dry matter [%]	Collagen [%]	MP [%]
TPA	0.26***	-0.56**	0.59**	-0.47**
WB	0.23***	-0.52**	0.54**	-0.46**
L*	0.13**	0.26***	-0.25***	0.20***
a*	0.03	-0.21***	0.21***	-0.18***
b*	0.10	0.27***	-0.25***	0.25***

*** P<0.001, ** P<0.01, *P<0.01, TPA – hardness [N], WB – maximum shear force [N], L* – lightness, a* – redness, b* – yellowness, PM – muscle protein

IV. CONCLUSION

Fat level affected the L* value maximum force in Texture profile analysis and Warner-Bratzler shear force. Higher fat contents resulted lighter sausages. Protein, dry matter and collagen content statistically significant correlated with L*, a* and b* and texture parameters.

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