DYNAMICS OF SALT PENETRATION DURING DRY CURING OF PORK *M.longissimus lumborum et thoracis*

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BACKGROUND Nowadays, a great deal of information on the curing process has been related to salt penetration, as well as its final effects on the preservation and desirable sensory properties, especially on colour and flavour, of a variety of meat products. It is well known that the production of the specific "cured meat" colour and aroma requires a fairly slow process, but nowadays this process is constantly being made faster. For some gropus of meat products, owing to innovative technologies (injection; massage; vacuum tumbling) and using modernized equipment, it has become possible to speed up the process fairly successfull. So, penetration of salt/brine into meat under these conditions (resembling tank curing) has been well studied, as well as dry curing, but with the use of raw meat model pieces (Körmendy and Ganter, 1958; Andujar and Tarrazo, 1981; Djelveh and Gros, 1988; Leutenschlager, 1995). However, dry curing under the real production conditions, particulary during the processing of traditional dry meat products, as an additional activity of farmers' households, has not been fully investigated.

OBJECTIVES The objective of our work was to study the dynamics of salt penetration into pork *M.longissimus lumborum et thoracis* during dry curing and the effects of this process on weight changes, chemical composition, colour characteristics and selected texture properties of the final product.

METHODS The investigations were conducted using pork *M.longissimus lumborum et thoracis* (MLT) from 4th thoracic to 6th lumbar vertebrae.The selected muscles were of normal pH (5.4 5.7) and were not affected by PSE (Trout, 1992). Each muscle was well trimmed of fat and connective tissue. Coarse-grained sea salt (2-3 mm) was used for dry curing. Salting was carried out using the surface massage of the previously formed muscles - in the ratio of 3.5% salt to muscle weight. Curing was done for 7 days at 2-4 ^{0}C. Data for weight changes (%) were determined by weighing one half of 12 MLT each - daily during a 7-day curing. Average initial weight of this group of the examined muscles amounted to 2.347 g. The dynamics of salt diffusion, chemical composition, colour characteristics and selected texture properties were monitored on 12 MLT samples of the second half, the average weight being 2.280 g. The investigated muscle slices 20 mm thick were taken daily for the analysis of the contents of water (%), salt (% NaCl) and proteins (%) and for determination a_w values, respectively. From each slice, three layers - a, b, and c - were separated and investigated. The first two concentric layers (a, b) were 10 mm thick each. The last layer (c) was the central remnant of the muscle. Also, a sample was taken daily of a spontaneously separated exudate for determination protein content. Measurements of water activity (a_w) were made in homogenized samples of slices of 12 muscles each (at 25 ^{0}C, Thermoconstanter TH2, Novasina). Based on the results obtained, daily calculations were performed of the corresponing mean values. In the same fashion, samples for determination basic chemical composition were prepared - prior to and after the curing process (AOAC, 1990). On the samples of all 12 muscles, instrumental measurements ("INSTRON" - 4301) were made (0th, 3rd and 7th day) for texture assessment (tenderness; firmness; plasticity/compressibility). Determination of colour characteristics in MLT samples was carried out using photoelectrical tristimulus colorimetry (the MOM Color - D). The values for psychometric lightness (L^*), psychometric hue - redness (a^*) and psychometric chroma - yellowness (b^*) are expressed based on the CIELAB, 1976 system (Robertson, 1977). Data statistical analysis was carried out by standard methods (Snedecor and Cochran, 1980).

RESULTS The data for weight changes during dry curing of pork MLT are presenterd in Fig.1. Average weight increase after 7-day curing amounted to 6 g (0.25%) relative to the initial weight of the investigated muscles ($p>0.05$). Decrease in average weight is evident only after 1st day of curing (approx. 1.3%), while the further course of the process is accompanied by a constant, though slight, weight increase ($p>0.05$).

Tab.1 presents data for average chemical composition of homogenized samples of the investigated muscles, established at the start (day 0) and the end of curing (day 7). NaCl content of 3.8% at the process termination demonstrates that during a 7-day curing the desired salt concentration has been ashieved. This is associated with water content decrease at the process termination, on average, by approx. 2.9% ($p<0.05$). For the content of total proteins, the difference between initial and final means values has not been statistically confirmed ($p>0.05$). In exudate, the final protein content amounted to 4.6%. The results established for water content (within three investigated layers) during dry curing of pork MLT are given in Fig.2. In the surface layer *(a)*, during the first three days of the process, the share of water rises slightly (approx. 1% - $p>0.05$), and on the day 4 it declines significantly - by 4.2% ($p<0.01$). For the equal time lenght, in the other two layers *(b* and *c)*, water content declines constantly: *b* - by 4.49% ($p<0.01$) and *c* - by 4.12% ($p<0.01$). In the next three days (4th-7th), in the two surface layers *(a* and *b)* , water content rises slightly *(a* - 2.25%; *b* - 0.91% *)*, a slight rise by day 6 is also noticeable in the central layer *(c* - 0.13*)*, although on the final day of curing there occurs a slight water content decline - by 0.60%. Observed per layer, the highest water content decrease is in the central layer *(c)* - by 4.57% ($p>0.01$), then in the mid-layer *(b)* - by 3.62% ($p<0.01$) and the last is in the surface layer *(a)* of the investigated muscles - by 1.16% ($p<0.01$). Generally, water content per layer, throughout the entire curing process, has a regular schedule: it is highest in the central (73.75 - 70.38%) and the lowest in the surface layer (69.74 - 68.93%). The data related to water activity (a_w) range within a relative small scope thus demonstrating nearly regular tendency towards decreasing average a_w values during dry curing: from day 0 (0.982) to day 7 (0.971) - p<0.01. This is in full agreement with the results reported by Ventanas et al., 1989. Fig.3 show the data for changes in salt content (% NaCl). Average values in the investigated layers evidence that salt content in the central layer *(c)* constantly increases - from 0.70 to 3.5% (p<0.01). The surface *(a)* and mid-layer *(b)* reach maximal salt content on day 4 - 4.69 and 3.95% (p<0.01), respectively, which is followed by minimal water content - 67.41 and 69.31%, respectively (Fig.2). By the end of the process (day 7) salt content in the stated layers decreases: in the surface layer *(a)* - by 18.34% (p<0.01), whilst in the mid-layer *(b)* - by 10.34% (p<0.01), which is in agreement with data reported by Fox (1980), Andujar and Tarrazo (1981) and other authors.

Average values parametars determining the characteristics of colour in the investigated muscles (L*; a*; b*) are given in Tab.2. During three time periods of instrumental measurements, lightness (L*) of samples constantly increases: from 40.86 to 47.96, or by 17.4% (p<0.01). Simultaneously, the share of redness (a*) increases from 6.96 to 10.73, or by 54.2% (p<0.01); the share of yellowness (b*) also rises from 7.10 to 8.52, but the difference found is not statistically significant (p>0.05). The results of texture assessments are given in Tab.3. For all investigated properties, the decrease of mean values has been established, which may affect the quality of the final product and consumer satisfaction during consumption: firmness decreased by 39.5% (p<0.01), plasticness/compressness by 28.1% (p<0.01), and tenderness by 18.7% (p<0.01).

CONCLUSIONS The results of our investigations point out that during dry curing of chilled pork *M.longissimus lumborum et thoracis (MLT)*, using 3.5% of salt, at 2-4 °C, satisfactory results are achieved as early as after day 5 of dry curing. It should be emphasized that MLT muscle has a small but not significant weight increase - 0.25% (p>0.05). The penetration of salt into the muscle centre (3.85% NaCl - p<0.01), water loss (2.86% - p<0.05) and a_w value decrease (p<0.01), is quite satisfactory. Concurrently, good results were established for some more important colour characteristics (L*; a*; b*), as well as for some more significant parameters of texture (firmness; plasticity/compressibility; tenderness) in the investigated MLT samples (p<0.01). So, it may be stated that all favourable tendencies have been expressed to a higher degree by extending the dry curing process from 5th to 7th day.

LITERATURE *1. Andujar, G., Juana Tarrazo, 1981.* Fleischwirtschaft, 61, 9, 1366. *2. AOAC, 1990.* Official Method of Analysis, 15th ed., Washington, DC. *3. Djelveh, G., Gros, J.B.,1988.* Meat Sci., 23, 11. *4. Fox, J.B.*, 1980. J.Food Sci., 45, 1740. *5. Kormendy, L., Gantner, G.Y, 1958.* Lebensmittel-Untersuchung und -Forschung, 107(4), 313. *6. Leutenschlager, R. 1995.* 41st ICoMST. Proceedings, Vol.II, 507. San Antonio, USA. *7. Robertson, A.R., 1977.* The CIE 1976 Color-Difference Formulae. Color Research Applied, 2, 7. *8. Snedecor, G.N., Cohran, W.G., 1980.* Statistical Methods. The Iowa State University Press, Ames, USA. *9. Trout, G.R., 1992.* 38th ICoMST. Proceedings, Vol.5, 983. Clemont-Ferrand, France. *10. Ventanas, J. et al., 1989.* 35th ICoMST. Proceedings, Vol.III, 707. Copenhagen, Denmark.

Fig. 1. Weight changes of pork MLT during dry curing

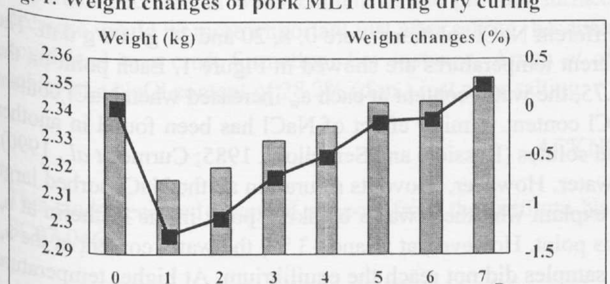
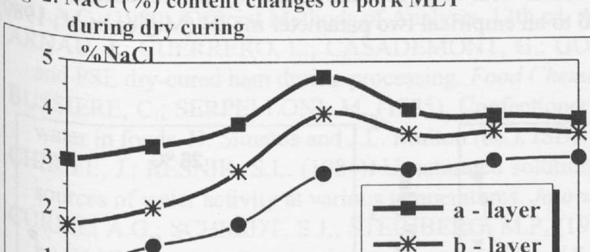


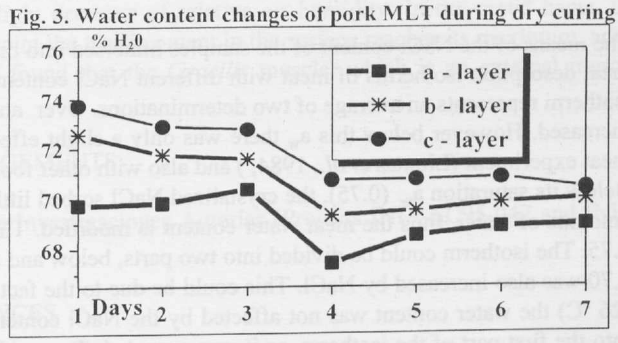
Fig. 2. NaCl (%) content changes of pork MLT during dry curing



Tabl. 3. Texture values of pork MLT during dry curing

Days	Firmness	Plasticness/ Compressibility	Tenderness
0. day	0.0185	0.2062	0.0691
3rd day	0.0173	0.1849	0.0679
7th day	0.0112	0.1482	0.0562

Fig. 3. Water content changes of pork MLT during dry curing



Tabl. 1. Chemical composition of pork MLT at the beginning (B) and at the end (E) of dry curing

		$\bar{x}$	SD	Cv
Water	B	71.62	1.46	2.04
(%)	E	69.57	0.506	0.73
Proteins	B	21.72	0.933	4.29
(%)	E	22.27	0.823	3.69
Fat	B	5.72	1.075	29.61
(%)	E	3.35	0.561	16.78
Ash	B	1.14	0.087	7.67
(%)	E	3.905	0.327	8.37
NaCl (%)	E	3.58	0.364	10.17

Tabl.2. CIELAB (1976) L*(lightness), a*(redness) and b*(yelowness) values of pork MLT during dry curing

	Days			Significance		
	0	3rd	7th	0:3	3:7	0:7
L*	40.86	42.89	47.96	1.36^{NS}	3.73^{**}	4.46^{**}
a*	6.96	8.93	8.06	2.53^{*}	1.51^{NS}	3.23^{**}
b*	7.10	8.06	8.52	1.03^{NS}	0.46^{NS}	