THE RHEOLOGICAL PROPERTIES OF ROASTED MUSCLES FROM FORCE FATTENED DUCKS.

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In Poland as in other countries the Mullard ducks have been force fattened mostly for fatty livers. The fatty livers and large part of the breast and the leg portions have been exported to France. The huge development of poultry meat processing has been observed in the last decade. In our opinion, this kind of meat should be processed as well. For this purpose the full characteristic of meat is needed. There are no adequate data in the literature on this topic. Therefore we have been working on the Mullard duck muscle characteristic for two years. The full characteristic covers: chemical composition, sensory evaluation, functional properties of breast and leg muscles from male and female Mullard ducks. A part of the obtained results was presented in: Woloszyn at al .(1995 a and b). These contributions cover: basic chemical composition and some functional properties of raw breast and leg muscles from female ducks (Woloszyn et al. 1995a) and the chemical composition and the sensory profiles of roasted breast and leg muscles from drakes and ducks (Woloszyn et al 1995b).

The aim of this work was to investigate : 1/ The influence of sex and kind of muscles on the rheological properties defined by the shear force values (SF) and by the parametres calculated from the creep compliance-time curve (CC-TC) of roasted force fattened duck muscles. 2/ The relationship between the rheological parametres and the chemical composition and the intensity of such sensory descriptors as: juiciness, tenderness, toughness and elasticity.

The experimental materials were: the breast and the leg portions cut out 24h after killing from the industrially slaughtered male and female force fattened ducks. The portions were roasted in the backing foil at 190^0C for 70 min (85^0C in the centre of the sample). After cooling they were stored at 4^0C for 24h, then examined. The bars (diameter -1 cm) and discs (diameter -3,5cm and height -1cm) were cut out from 9 breast (BM) and thigh muscles (TM). The bars were sheared across mascle fibers using the Warner-Bratzler shearometer with 1 knife system. The discs were used for determination of rheological properties. The rheological parametres and the rheological models for all kinds of the muscles were established on the ground of the CC-TC analysis, using procedure described by Skrabka-Blotnicka (1986). The intensity of: tenderness, juiciness, toughness and elasticity were assigned by the 9 trained testers in the way described by Stone et al. (1974 and 1980). The basic chemical composition was determined by the method described by Woloszyn at al (1995b).
The results were subjected to statistical analysis. The T-Student's test was used to evaluate the differences between average values lowest tenderness intensity for TM of female ducks, the relationship between SF and sensory descriptors did not appear. It could be ascribed to the fact that results of instrumental measurements affected by chemical or physical impulses that cause sensory feelings whereas results of sensory analysis inform about feelings caused by these impulses. The lack of differences in SF of male and female boiled breast goose muscles of WD -1 and WD-13 genotypes was noticed as well by Skrabka-Blotnicka et al (1993). From the analysis of CC-TC (fig.1) obtained for each variants of the muscles results that the behaviour of the investigated samples under $31,85 \times 10^4$ Pa stress (σ) is described by 6 element rheological models. However the sex and the kind of muscle effected the values of the particular rheological parametres (tab.1). The CC-TC can be divided into 4 regions which illustrate the following deformations described by the classical models:

1/ instantaneous elastic deformation (ε_0) - Hook's model (modulus E_0);
2/ time dependent retarded elastic deformation (ε_R)- Kelvin - Voit's model (modulus E_R , viscosity η_R);
3/ instantaneous irreversible deformation (ε_{no}) - Gorbatov's model (modulus E_{no});
4/ Newtonian flow- Newton's model (viscosity η_N).

The same model described the behaviour of boiled breast goose muscles under $19,12 \times 10^4$ Pa stress, independently of the sex and the genotype.The explanation of the obtained results is very hard. The sex and the kind of muscles did not effect the Newtonian viscosity. Among the experimental muscles only BM of drakes differed in rheological parametres (except η_N, and E_0, E_R male TM) from the remaining samples. The male and female BM also male TM are different from each other in E_0. There are not straight relationships between the rheological parametres calculated from CC-TC and SF, chemical composition and sensory descriptors. It was not surprising, because nonlinear dependence between rheological parametres and SF of boiled goose breast muscles was observed by Skrabka-Blotnicka et al (1993).

In conclusion: the relationships between rheological parametres and SF or chemical composition are very complicated. Much more data is necessary to establish mathematical models of those dependencies.

Literature.

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Table 1 Reological parametres of roasted muscles.

Parametres	E_0 [10^6 Pa]	E_{no} [10^6 Pa]	η_N [10^8 Pa s]	E_R [10^6 Pa]	η_R[10^8 Pa s]	t_R [s]	SF [N]
Muscles							
TM Drake	4,28[b]	0,79[a]	25,21	3,76[ab]	1,35[a]	36[a]	35,9[a]
TM Duck	6,29[a]	0,86[a]	25,42	3,61[a]	1,52[a]	42[a]	45,9[b]
BM Drake	4,75[b]	1,73[b]	22,57	4,42[b]	2,65[b]	60[b]	38,2[a]
BM Duck	10,00[c]	0,78[a]	25,64	3,27[a]	1,24[a]	38[a]	39,8[a]

The data are average values from 7-9 tests.

a,b,c - within the kind of parametre, values with different letters differ at $P < 0,05$

Table 2.Chemical composition and sensory descriptors of roasted muscles.

Muscles	TM Drake X	TM Drake SD	TM Duck X	TM Duck SD	BM Drake X	BM Drake SD	BM Duck X	BM Duck SD
Components								
Protein [%]	29,3	2,28	32,0	1,12	32,6	0,55	34,2	0,85
Fat [%]	10,2	2,18	8,2	1,42	9,4	1,55	6,9	0,95
Moisture [%]	57,2	2,43	60,5	0,11	57,0	1,33	58,7	1,10
Descriptors								
Juiciness	6,07	0,39	6,6	0,41	6,61	0,59	5,54	0,47
Toughness	3,97[a]	0,29	4,29[d]	0,43	1,45[b]	0,27	2,25[c]	0,36
Elasticity	5,64	0,52	5,65	0,61	5,70	0,20	5,26	0,50
Tenderness	5,27[a]	0,31	5,29[a]	0,67	7,90[c]	0,36	6,72[b]	0,47

X - average values from 9 tests - chemical composition; 27 tests- sensory descriptors. SD - standard deviation.

a,b,c,d - within the kind of descriptors, values with different letters differ at $P \leq 0,05$

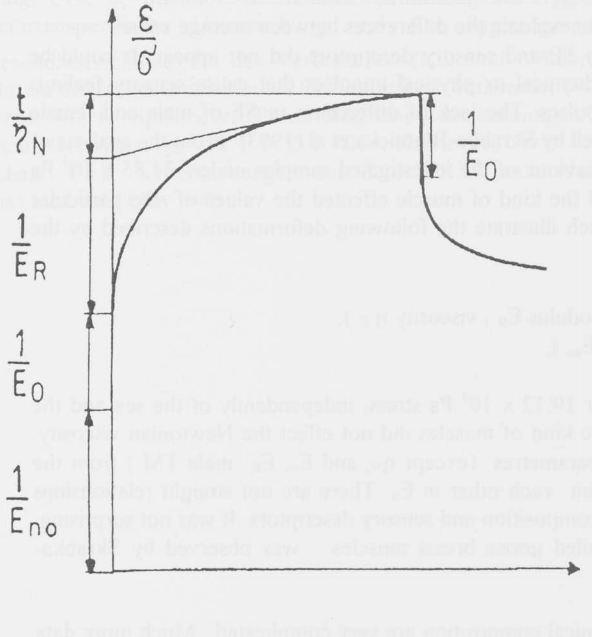

Fig. 1 The creep compliance - time curve for the roasted breast muscle from drake under 31,85 x 10^4 [Pa] stress

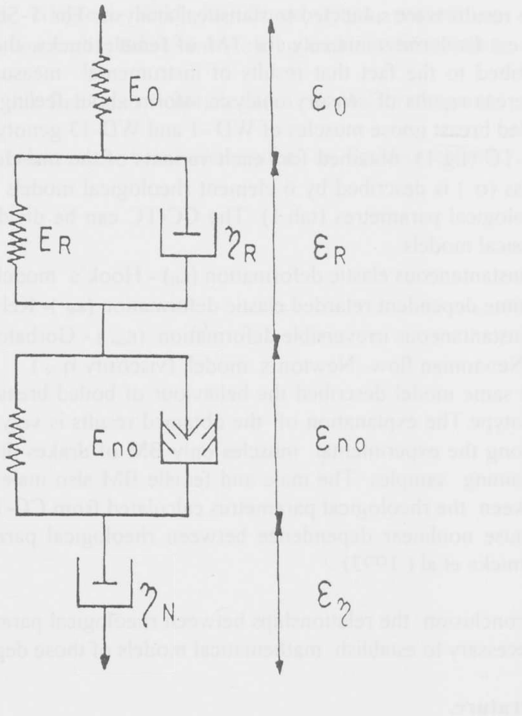

Fig. 2 The rheological model for the roasted duck muscles under 31,85 x 10^4 [Pa] stress