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STUDY OF WATER STATE CHANGES IN MEAT DURING AUTOLYSIS

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Introduction

The main tasks of meat processing are the rational use of raw material resources increase in the production output and improvement of the production quality. Meat quality control has assumed a constantly rising significance. On the one hand the consumer made the enhanced demands to the quality of meats, and, on the other hand, the industry has need for the raw material possessing the definite properties.

Solving the problems of the manufacture of wholesome and sound food, in particular, meat products, is intimately associated with the use of modern and advanced express-methods of water state analysis, obtaining the systems of impartial and reliable estimation of the quality of meat raw material and ready production.

Studies of water state in food systems attract the attention of researchers on the score of the important functions of it in biological systems

Aims

The estimation of water state in meat samples, prepared of internal part of muscle, was carried out on the various stages of storage after slaughter at +4^{0}C and 0^{0}C during 4 and 10 days accordingly. In this period the distinctions of meat main properties are the most pronounced. These properties include the relaxation time, in particular, spin-spin, water activity (a_w) and water holding capacity (WHC).

The recording of the parameters studied was carried out after every 2 hours, when they reach the extremums; after that the interval between measurings was increased for 4-25 hours.

Choosing the methods of studies

It is well known, that the any direction of use or processing of meat is consistent with the definite and the most beneficial extent of the progression of autolytic tissue changes.

With the aim of the rational use of meat raw material it is neccessary to establish the optimal parameters, characterizing the water state in it. Then, in consequence, we can judge about the direction and character of meat processing with the aim of the lesser expenditures and obtaining the products of the required quality.

Such parameters can be as follows: the relaxation time of water protons T_1 (spin-lattice) and T_2 (spin-spin), characterizing their lability, water holding capacity (WHC) and water activity (a_w). These parameters reflect the strength of water bond with material. By means of these parameters one can characterized the complex biochemical processes in meat during autolysis.

Methods

Nuclear - magnetic resonance analysis of water in the meat samples was carried out by standard procedure at the frequency 20 mHz, on «Minispec PC-20» relaxometer, (Bruker, Germany).

In the table.1 there are shown the results of factorization of experimental dependence of T_2 on the NMR signal amplitude, into the components T_{2a} and T_{2b} and mass proportion of water protons corresponding to its for the weak holded water T_{2a}, P_{2a} and T_{2b}, P_{2b} for the fraction of holded water. Whith the availability in the studied samples of two water fraction with the different liability T_{2a} and T_{2b}, the mean values of spin-spin relaxation T_{2cp} were determined by means of equation $< 1/T_2> = (P_{2a}/T_{2a} + P_{2b}/T_{2b}) : 100$.

The measurements of water holding capacity (WHC) and water activity (a_w) were carried out on the installations developed in MSUAB. The determination of the contents of water, protein, fat, and pH were carried out by means of well-known traditional methods .

Results of studies and conclusions

During the study of meat tissue at autolysis at +4^{0}C and 0^{0}C the water contents were 77,28$\pm$0,16% and 76,74$\pm$0,42% accordingly; the protein contents were 16,7$\pm$0,2% and 18,0$\pm$0,1%, fat contents 1,5% and 1,2% - that is not significantly changed.

The main results of experimental studies of WHC, T_{2a}, T_{2b}, P_{2a}, P_{2b}, T_{cp}, and pH at +4^{0}C and 0^{0}C are presented in table 1, and results of measurements of a_w and E were presented in table 2.

It was established that the changes of values, presented in the table 1 have the non - linear character during the period after slaughter.

WHC and pH are gradually decreased and reach its minimum to 10-16 hours (at t=+4^{0}C) and to 24-26 hours (at t=0^{0}C) after slaughter. Then gradually increasing they had gone on the stable level.

In response to NMR studies in all cases the two - component spin-spin relaxation with T_{2a}, T_{2b}, times and corresponding to its mass proportions of protons P_a and P_b was revealed. That attests about the presence of two water fraction in meat raw material. The higher T_2 values correspond to the more liable fraction.

The analysis of NMR data also show the non-linear character of the change of spin-spin relaxation, but it is antiphase in reference to WHC and pH; firstly T_{2a} and T_{2b} were gradually increased, reaching the maximum to 10-16 hours (at t=4^{0}C) and to 24-26 hours (at t=0^{0}C), and then were decreased, reaching the stable portion of the curve.

It should be noted that the extremums of these parameters of the experiments indicated occur within the common time interval, that is: 10-16 hours for the autolysis at t= +4^{0}C and 24-26 hours for the autolysis at t = 0^{0}C. Moreover, the higher WHC values correspond to the meat raw material with the higher pH values.

Table 1

i, hour	pH	BCC, %	T_{2a}, ms	P_{2a}, %	T_{2b}, ms	P_{2b}, %	T_{2cp}, ms	i, hour	pH	BCC, %	T_{2a}, ms	P_{2a}, %	T_{2b}, ms	P_{2b}, %	T_{2cp}, ms
	Results at $+4^0C$								Results at $+0^0C$						
4	6,15	72,7	73,1	91,9	13,1	8,1	53,3	4	6,00	67,4	66,3	87,7	13,5	12,3	40,0
6	5,96	71,2	77,7	88,4	17,2	11,6	55,2	6	5,94	66,2	69,9	87,9	14,6	12,1	47,9
8	5,72	69,4	82,9	82,8	19.8	17,2	53,5	8	5,88	65,9	70,5	86,0	15,5	14,0	47,1
10	5,70	67,7	88,1	81,3	22,2	18,7	56,7	10	5,82	65,0	72,1	83,9	16,1	16,2	46,1
12	5,68	64,6	99,4	62,7	36,4	37,3	60,4	16	5,66	63,2	85,0	70,0	20,4	30,0	43,6
16	5,64	54,6	142,2	20,9	60,0	79,1	68,2	18	5,64	62,1	86,2	71,2	21,4	28,8	46,0
25	5,72	62,9	106,4	50,3	38,1	49,7	56,3	22	5,60	58,6	100,7	53,8	32,1	46,2	44,9
50	5,80	66,0	94,4	57,1	38,3	42,9	58,0	26	5,54	49,4	153,4	35,9	42,2	64,1	57,0
72	5,81	66,8	94,1	57,0	37,8	43,0	57,3	36	5,73	55,2	115,9	42,0	24,3	58.0	36,4
96	5,81	67,0	94,0	57,4	37,2	42,6	57,0	48	5,75	58,8	105,4	43,2	21,6	56,8	32,9
240	-	-	-	-	-	-	-	72	5,75	59,2	98,2	66,7	21,1	33,3	44,3
								96	5,12	59,9	98,0	43,1	21,0	56,9	31,8
								240	5,87	60,1	97,9	55,9	17,2	44,1	31,9

As shown in the table 2, the increase in a_w and decrease in E are more pronounced in the postmortem period 14-16 hours (at t= $+4^0C$) and 20-24 hours (at t=0^0C). As this takes place the dynamics of the a_w and E changes is more pronounced at 0^0C. It should be noted, that A_w and E take the extremal values after the longer period of time (20-24 hours) than during the autolysis (t=$+4^0C$).

Such difference can be explained by the fact, that biochemical processes during autolysis (t=0^0C) proceed more slowly, that is suggested by NMR data and WHC.

Analysis of the changes of spin-lattice relaxation shows that this value retains non sensitive to the transformations in meat during autolysis (T_{1a}=0,11-0,12s, T_{2b}= 0,38-0,43s), because T_1 depends on the water content in tissues and ability of macromolecules to found hydratic layer. Taking in to account that the total water content does not significantly change, that does not lead to the T_1 change. Occuring during autolysis transformations of muscle proteins, influencing on the ability of meat to bond water, lead to its qualitative and quantitative re-distribution, change of water bond strength with the main components of muscle tissuer. That has an effect on the liability of protons of meat raw material water phase. Consequently, the extremal values of all measured characteristics are agreed in time and answer the postmortem state. This period is characterized by the minimal hydratation of muscle proteins (in consequence of AMK - formation) and pH values approaching to its isoelectric points. As a consequence, this period corresponds to the greatest liability of the water protons T_2, minimal WHC, and the greatest water activity (a_w).

Table2

i, hour	a_w,	E, g/mole k	a_w	E, g/mole k
	Results at $+4^0C$		Results at 0^0C	
2	0,975	61,68	0,972	69,18
4	0, 972	69,18	0,972	69,18
6	0,974	64,17	0,989	26,95
8	0,975	61,68	0,990	24,48
10	0,978	54,19	0,990	24,48
12	0,978	54,19	0,991	22,02
14	0,984	39,29	0,991	22,02
16	0,985	36,82	0,992	19,57
18	0,985	36,82	0,992	19,57
20	0,982	44,25	0,993	17,11
22	0,984	39,29	0,993	17,11
24	0,982	44,25	0,993	17,11
48	0,988	29.41	0,992	19,57
72	0,990	24,48	0,989	25,71
96	0,991	22,02	0,990	24,48

It fallows that the postmortem period (16 hours, at t=$+4^0C$ and 24 hours, at t= 0^0C) is characterized by the increase in T_2 and a_w and decrease in WHC and energy of water bond in muscle tissue. Durig the ageing the character of change of the properties under review was stable.

In our opinion, the variable dependence of given parameters can be explained by the realignment of muscle tissue structure and change of the water bond forms.