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INSTRUMENTAL STUDIES STRUCTURAL AND MECHANICAL CHARACTERISTICS OF MEAT RAW MATERIALS AND MEATS

Rogov I.A., Sizykh E.V., Mitaseva L.F., Kulagin V.N.

Moscow State University of Applied Biotechnology, Russia.

Introduction.

The processing of meat raw material is accompanied by complex physico-chemical, biological and mechanical processes which exert an effect on the quality of the ready product. One can fully judge about the quality of meats on the theological properties which are determined by their internal structure. For the analysis and scientific classification of this properties it is necessary the obtaining plausible experimental information about the complex of structural and mechanical properties (SMP) of meats.

In our opinion the instrumental estimation of structural and mechanical properties, characterizing the consistency of any meat product, meet to the requirement of the plausible information about qualitative characteristics of meats. Structural and mechanical properties are well correlated with the peculiarities of the sensory perception of consistency.

AIM.

The aim of this work is a generalization of studies of structural and mechanical properties of meat and meat products, connected with possibility of control and stabilization of their consistency.

The structural and mechanical properties characterize the behaviour of the subject studied under the condition of stress state and allow to connect the stress and the values of deformation rate during applying the forse.

Methods.

The studies were carried out on "Instron –1140, 1122" machines. The shearing stress and cutting performance characterizing the strength, were determined for viscous elastic meats in "Kramer shear Press" cell. The Stress of standard penetration and period of stress relaxation, characterizing the shearing properties of meats were determined for viscous plastic meats by means of plunge of conic indentor.

Results and discussion.

The results of the experimental determination of structural and mechanical characteristics (SMC) of the native meat raw material and subproducts are presented in table 1.

Table 1

Raw material/characteristics	Shearing stress, $x10^{-4}$Pa	Cutting performance, $x10^{-2}J/m^2$
	Meat raw material	
Beef of a high-quality		
Beef of 1st gradeBeef of 2nd grade	26.5	18.0
Pork nonfat	27.7	19.4
Raw beef trimmings	34.5	23.6
Raw fermented beef trimmings	17.5	12.6
Heat treated beef trimmings	43.5	28.0
Heat treated fermented beef trimmings	39.5	25.9
	31.7	20.1
	27.8	18.8
	Subproducts	
Beef heart	13.1	7.25
Fermented beef heart	10.9	6.3
Pork heart	12.4	7.4
Fermented pork heart	10.6	7.0
Beef kidney	13.5	7.3
Fermented beef kidney	11.1	6.8

The data from the table show that the beef of 2nd grade is the most tough due to the increased content of the connective tissnes. The pork tissnes on the CMC values are significantly lower than beef tissnes, that connected with the lower content of collagen and elastin fibers in the pork connective tissues. The shearing stress and cutting performance of subproducts depending on their kind, are smaller than that of meat by a factor of 2-3.

The ferment treatment of the beef trimmings and subproducts with 0.1% pepsin produces a tenderizing effect on the meat raw material both in raw and in a heat treatment state. The shearing stress and cutting performance decrease for the beef trimmings by a factor of 1.1, for the subproducts of 1.2, as compared with non – fermented raw material.

It is explained by the proteolotic action of pepsin on the muscular and connective tissues, accompaining by the destructive changes of muscular fibers, loosening the connective tissue layers, formation of the microcapillar network, releasing the reaction groups bondind the water dipoles.

The finely divided farces, containing only meat raw material were prepared of the same kind and grade of raw material (indicated in table 1). The receiptive farces of cooked sausages were also prepared.

The results of the determination of their structural and mechanical properties in raw and heat treated forms are presented in table 2.

Table 2

Raw material	Finely divided farces			
	Fresh		Heat treated	
	Stress of standard penetration, $x10^{-3}$Pa	Period of stress relaxation, S	Shearing stress, $x10^{-4}$ Pa	Cutting performance, $x10^{-2}J/m^2$
Beef of a high quality	1.60	-	5.90	3.88
Beef of 1st grade	1.55	-	5.10	3.36
Beef of 2nd grade	1.52	-	4.85	3.20
Pork nonfat	1.21	-	3.85	2.55
Pork semi-fat	1.23	-	1.40	1.07
Beef heart	0.38	44.1	-	-
Fermented beef heart	0.19	49.5	-	-
Pork heart	0.28	45.6	-	-
Fermented pork heart	0.19	52.9	-	-
Beef kidneys	0.063	56.2	-	-
Fermented beef kidneys	0.051	65.7	-	-
	Farces of cooked sausades, containing			
Non fermented beef trimmings	1.39	-	5.30	3.55
Fermented beef trimmings	1.44	-	5.05	3.31
Non fermented pork trimmings	0.48	-	-	-
Fermented pork trimmings	0.5	-	-	-

The data from the table 2 show that the fresh and heat treated farces of the beef of a high quality possess the highest values of structural and mechanical characteristics. The decrease in the grade of beef leads to the decrease of strength properties of heat treated systems.

The pork forms the weaker structural frameworks, characterizing by the least values of SMC, the lower level of which corresponds to the heat treated farce on the base of the pork with the middle quantity of fat tissue.

The values of stresses of standard penetration of fresh farces of subproducts are significantly lower than that of farces of meat. The farce of beef kidneys has the lowest value.

The increase of the period of stress relaxation of fermented subproducts farces and decrease in the shearing stress and cutting penetration of cooked sausages farces, containing beef trimmings, are explained by the tenderizating action of pepsin, which decrease the mechanical strength and elasticity of the separate roughly dispersed particles of farce.

A large body of research of structural and mechanical characteristics of viscosity elastic meats carried out on "Instron" machine allows for determining the ranges of the numerical values of SMC at the change – over to smoked sausages from cooked sausages: Shearing stress: $(1,9 - 4,2)\ x10^{-4} – (12,7 – 16,5)\ x10^{-4}$Pa ;

Cutting performance: $(1,4 – 3,3)\ x10^{-2} – (9,7 – 11,6)\ x10^{-2}J/m^2$;

Period of stress relaxation: (92 – 108) – (79 – 86,5), S.

The change of the main characteristics of consistency in the range of the same assortment groups is determined by the formula set of raw material: the biggest values of SMC belong to the sausages containing the high percentage of the beef muscular tissue, and, as a consequence, characterizing by the increased protein and decreased fat contents.

We also studied the effect of some kinds of protein components, modified secondary animal raw material on the consistency of meats.

It was established, that the addition of 20% protein product of paunch to the beef farce decrease the shearing stress of heat treated farce by 25,4% that connected with the folmation of gel – like structures during heat treatment. It is allso connected with the cleavage and hydrolytic decomposition of collagen, accompaining by the decrease in strength characteristics.

The introduction of the wheat paste into the chop farce leads to the decrease of stress of standard penetration from $0,95x10^{-3}$ to $0,76x10^{-3}$ Pa and the period of stress relaxation from 45 to 41 S. It also decrease the shearing stress from $5,7x10^{-3}$ to $3,8x10^{-3}$ Pa and cutting performance from $4,2x10^{-2}$ to $2,8x10^{-2}$ J/m^2 for heat treated chops. It is connected with the increase in carbohydrate contend and decrease in mass proportion of muscular proteins, which take a main part in the formation of strength and elastic three – dimensional framework of ready products.

The studies of shearing characteristics of meat – vegetable pastes depending on temperature show that the stress of standard penetration is sharply decreased at the range of 6 – 30°C, and at 30 – 50° C this tendency is dropped. It is connected with the weakening of the links between the aggregated particles and particular disruption of structural framework of the product due to the energy scaterring during the phase transition of fat fraction. That makes the paste consistency more plastic and tendered.

Conclusions.

The generalization of the own studies carried out allows for making the following conclusions:

1. The structural and mechanical characteristics of the subjects studied are varied in the wide range, during which to the every their type the specified quantitative interval is corresponded. This interval is inherent to the individual peculiarities of their consistency.
2. The effect of the fermentation of low grade meat raw material was established. The structural and mechanical characteristics of some meats containing modified low – grade raw material and vegetable protein components were determined.
3. The developed and used instrumental methods of the determination of meat and meat products SMC allow to estimate reliably their consistency. It is necessary at the rational choice and optimization of technological processes and production of meats; at the design of modern and redesign of available technological equipment.