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Change of Yield Stress of Minced Meat Grinded with Different Kind of Cutting Mechanism.

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ABSTRACT

The paper presents the grinding process of meat with different kind of cutting mechanism on the experimental meat grinder. Four cutting blades, including cross-shaped knife, curved blade knife, serrated blade knife and single blade knife with stationary plates with hole diameter 5,77 mm and 8,77 mm is developed. Yield stress of minced meat during the grinding process is determined. On the basis of the experiment's results the dependence graphs of yield stress against the density of grinded forcemeat using different knives and different angular speeds of rotation of knives and screws, with the hole diameter of plate 5 mm are plotted.

Keywords: meat, grinder, knife, yield stress, plate

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INTRODUCTION

Intensification of meat processing technology is one of the main directions of technological progress in the meat industry. Along with significant increase meat products outputs the meat industry is faced with the task to improve the quality and range of products with fullest and efficient use of raw materials.

The meat cutting process, that has a significant affect to the quality of raw materials and finished products, is widely used in the sausages and semi-finished products manufacturing.

One of the main technological equipment for meat grinding is meat grinder. Meat grinding process kinetics is different due to the complexity of the process changes in the spaces between the transport and cutting mechanisms elements. Improving the grinding process is based on the study of structural and mechanical characteristics and process parameters of processed raw material [1].

Analyzing the design of meat grinders it can be stated that the trend towards improvement of the meat grinders has contributed to preserve the quality of the crushed material. Household meat grinders are the main machine for cutting meat. The cutting mechanism of grinder consists of plate and cross shaped knife.

Minced meat manufactured as follows: meat is grinded without addition of ice, water, salt and spices in a meat grinder with the plate of diameter of 2 to 5 mm, then is packed into portions of 250 and 500 g and wrapped in cellophane or other transparent film [2].

The mechanical properties of meat at the plus and minus temperatures are different. Deep frozen products are referred as hard brittle materials [3].

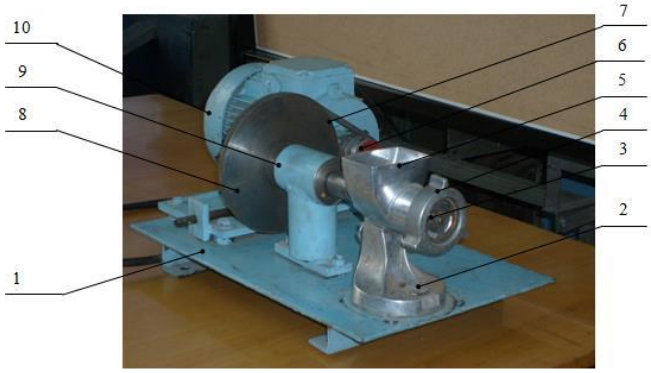
During the meat grinding it is necessary not only to achieve the required grinding size of minced meat, but also to bind a certain amount of water for obtaining a high quality product with maximum output and good consistency [4].

The minced meat is heated during the grinding process which leads to reduction of water-binding capacity. Minced meat heating causes protein denaturation, which defines reduction of water-binding capacity. Heat rate is dependent on the design and quality of the cutter sharpener.

The purpose of this study is determine the yield stress changing after grinding in a meat grinder, using different constructions of knives and rotating speed of the screw.

MATERIALS AND METHODS

Experimental meat grinder and the cutting mechanism



1 – fixed table; 2 – meat grinder body; 3 – cutting mechanism; 4 – hand nut; 5 – hopper; 6 – pulley wheel; 7 - belt; 8 – pulley wheel; 9 – shaft coupling; 10 – motor

Fig.1: Experimental meat grinder

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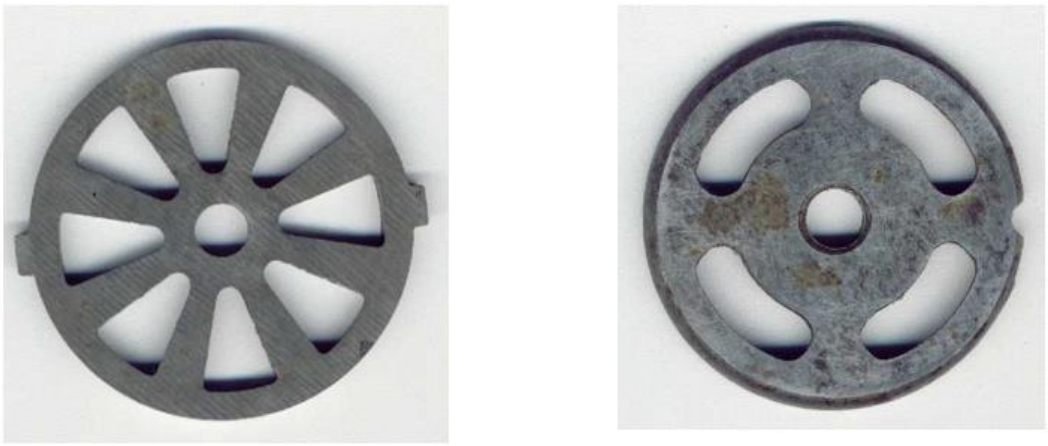
The meat grinder is installed on a plate and contains the case consisting of the bunker and working cylinder. The internal surface of the cylinder has edges. In the cylinder the screw, knife and plate are installed (fig. 1).

The cutting tool of the meat grinder consists of the stationary plate and rotary knife. the Stationary plate is disk-shaped with round holes and is the pair cutting detail with the rotating knives.

The meat grinder is completed with two plates with diameters of holes of 5 and 8 mm (fig. 2) and sector (cutting) plates (fig. 3). Central hole axis of plate is perpendicular to the plate plane.

a *b*

Fig. 2: Plates: diameter of holes 5 mm (*a*) and 8 mm (*b*)



a *b*

Fig. 3: Plates: sector (*a*) and end facing (*b*)

During the experiments, three kinds of beef of 100 grams are crushed in the meat grinder with four cutting tool designs:

1) cross-shaped knife (fig. 4);
2) curved blade knife (fig. 5);
3) serrated blade knife (fig. 6);
4) single blade knife (fig. 7).

A total of 63 experiments is performed.

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Fig. 4: Cross-shaped knife

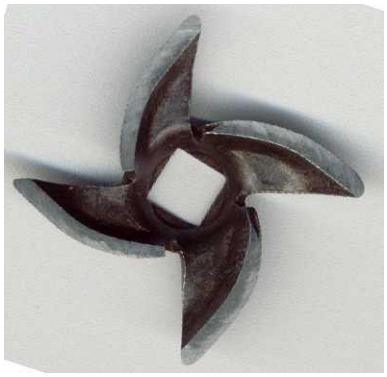
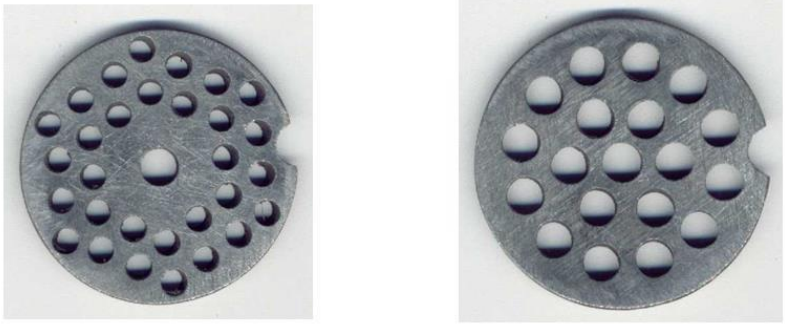


Fig. 5: Curved blade knife

Fig. 6: Serrated blade knife

Fig. 7: Single blade knife

In the following step the stationary plates are developed (fig. 8) with the hole diameter 8,77 mm and the holes are drilled in a concentric circles.



a *b*

Fig. 8: Plates with hole diameter 5,77 mm (*a*) and 8,77 mm (*b*)

According to fig. 8 a, the plate has the holes with diameter 5.77 mm which are drilled on the tops of the correct hexagon by six sectors.

Yield stress measurement

Yield stress is measured using cone penetrometer “Structurometer” (“Radius” Company, Russia). It is used for measuring the rheological parameters of food in various field of food industry. Method of sample preparation and measurement as follows: the sample of forcemeat is filled into the container and slightly pressed leveling the surface of the sample. Then the container is placed to the air or water bath under the

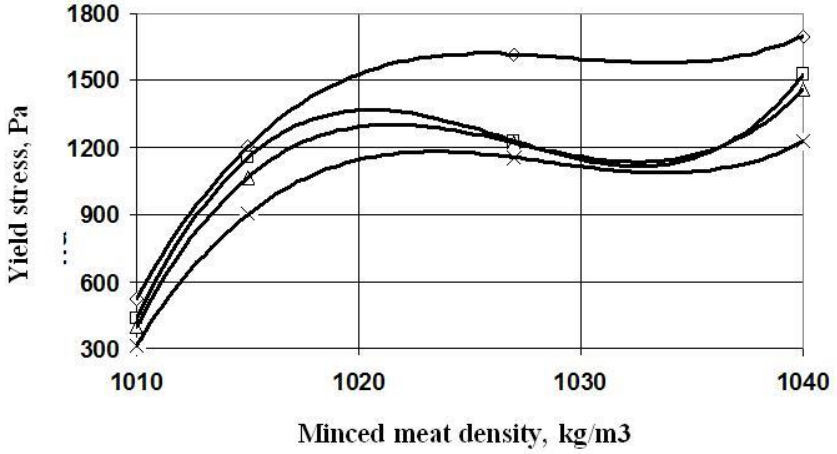
temperature of (10-30) ^{0}C for the sufficient time of heating the sample until (10-30±0,5) ^{0}C. After that, the measurement is performed in accordance with the operational instructions of the device "Structurometer". The operation principle is based on penetration of stationary indentor to the sample, moved up by constant speed for determination of rheological properties of food materials [5].

Using "Structurometer" device the kinetic curve deformations of various minced meat depending on loading time are plotted. More than 10 experiments are made.

RESULTS AND DISCUSSION

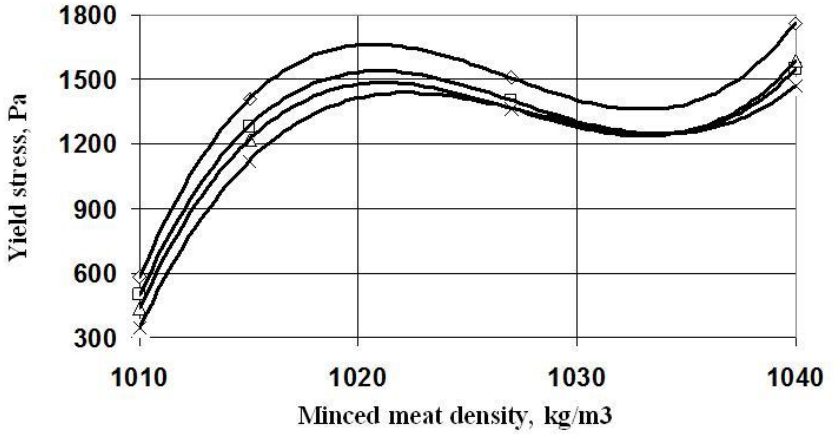
The most important factor influencing to rheological parameters of minced meat is yield stress. Yield stress of minced meat has an effect on the technological modes of processing and the quality of ready products [6].

On the basis of the experiment's results the dependence graphs of yield stress against the density of grinded forcemeat using different knives and different angular speeds of rotation of knives and screws, with the hole diameter of plate 5 mm are plotted. It is established that with downgrading of beef quality the value of yield stress is lowered.



◊ - Single blade knife; □ – Serrated blade knife;
Δ – Curved blade knife; x – Cross-shaped knife

Fig. 9: Yield stress changing against the density of minced meat at $\omega_ш$=15,7 rad/s.



◊ - Single blade knife; □ – Serrated blade knife;
Δ – Curved blade knife; x – Cross-shaped knife

Fig. 10: Yield stress changing against the density of minced meat at $\omega_ш$=20,93 rad/s.

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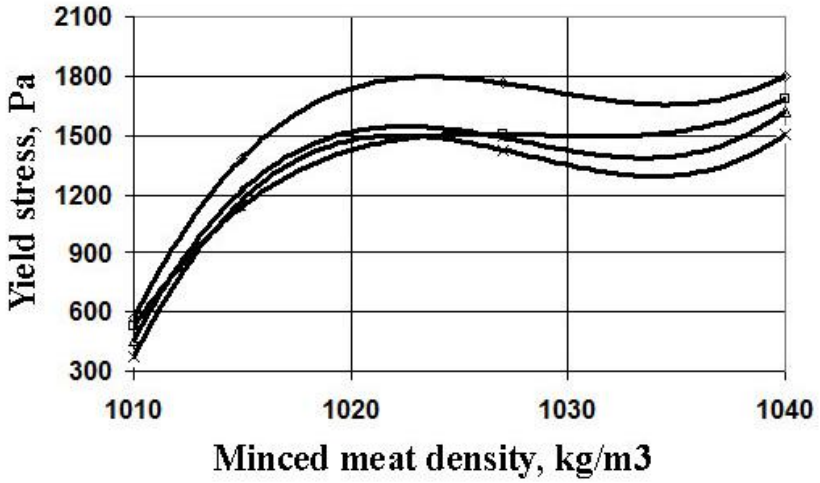
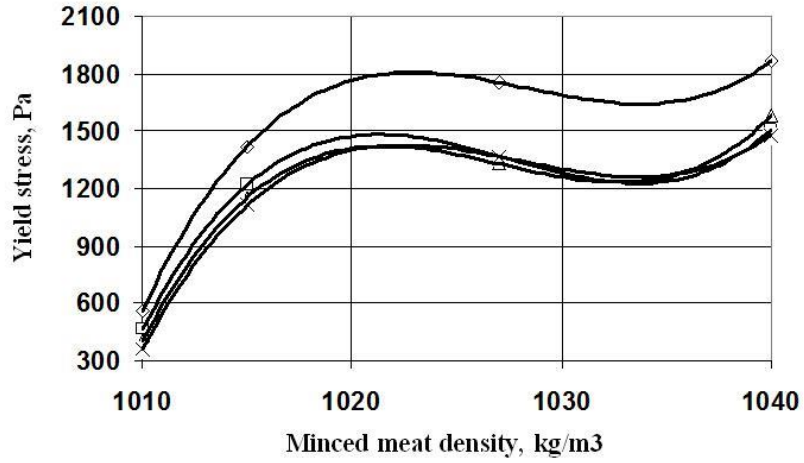


◊ - Single blade knife; □ – Serrated blade knife;
Δ – Curved blade knife; x – Cross-shaped knife

Fig. 11: Yield stress changing against the density of minced meat at $\omega_ш$=24,07 rad/s.



◊ - Single blade knife; □ – Serrated blade knife;
Δ – Curved blade knife; x – Cross-shaped knife

Fig. 12: Yield stress changing against the density of minced meat at $\omega_ш$=26,17 rad/s.

According to the fig. 9-12, the yield stress is increased during the grinding of meat with curvilinear, gear and cross-shaped knives at angular speeds of knives and screw 15,7 and 20,93 rad/s. The yield stress is reached the extreme levels at grinding with the single blade knife with angular speed of shaft 24,07 and 26,17 rad/s.

The highest value of density of minced meat at which the yield stress reached the extreme values is 24,07 rad/s. As angular speed of knives and screw is increased the yield stress of minced meat is decreased exponentially. Angular speed of screw has no significant effect on change yield stress value of minced meat. Therefore, while increasing the angular speed of knives and screw, the minced meat density decreases at which the yield stress reaches the rational values.

Based on the above, the structural and mechanical properties of minced meat are the integrated indicators reflecting the structure features and composition of initial materials and development of the

processes leading to creation of such difficult multicomponent as minced meats for sausages, pastes and meat loaf.

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