Changes in Temperature, the Heat Released and the Power Required for Chopping Meat

Daniela Ianiţchi, Vasile Băcilă, Gratziela Victoria Bahaciu, Lucica Nistor, Laura Urdeş, Camelia Hodoşan

Faculty of Animal Sciences, 011464, Bucharest, Mărăşti 59, Romania

Abstract
Chopping meat is an important operation in the technological process to obtaining meat products, which can have negative implications on quality of emulsions and on the properties of finished products when temperature rises recorded during the process is not kept in check by adding water-cooled or ice flakes. Experiments showed that the largest increase in temperature and the highest heat generated in chopping have been reported for the compositions obtained from beef meats, without added water cooled, the lowest final temperature recorded in the case of compositions of pork that was added cooling water. Power required registered at chopping, fell towards the end of the process of chopping, as a result of reducing the size of fragments of meat.

Keywords: chopping, heat generated, temperature

1. Introduction

Fine chopping meat to obtain meat products ensure increased water retention capacity by releasing a greatest number of ionic groups (polar and non-polar) of proteins capable of additional water.
Chopping is affected by a number of factors such as: material related factors (the ratio of muscle tissue, fatty tissue and connective tissue), related factors processing technology (previous processing of raw materials, rough chopping) and equipment related factors (speed of rotation of the tank and knives, the geometric shape of the teeth and their number, the degree of sharpening of knives and their number, as the tank, filling it level, degree of deaeration composition) [1,2]. Dolata (2000) shows that the geometric shape of knives chopping has an important influence on the quality of filling and finished products. Knives form affects viscosity compositions, temperature increase, the energy consumed in chopping, mechanical properties of finished products, such as compressive strength, adhesion, sensory properties of finished products such as composition, adhesion, juicy and losses to heat treatment [3]. Studies on the influence on quality chop meat compositions, the energy consumed in chopping were performed and Dolata (1999), Milanowski and Diakun (1980), Honikel and Egginger (1984). In chopping, the rise of temperature occurs in composition because of friction table knives when cutting meat, meat and fat particles between them and rubbing their vat launches and release heat due to hydration of meat.

* Corresponding author: Daniela Ianitchi, Tel: +40(21) 3182266, Fax: +40(3182888), dianitchi@yahoo.com

2. Materials and methods

The evolution of temperature and heat released from chopping was done on composition of beef and pork with and without added water cooled. Chilled meats, along with hydration water cooled, were chopped with robotic Blixer 3, 3000 rot. / min. for 15 seconds, 30 sec, 45sec and 60 sec. For mincing no added water cooled, the sample weight was 0.200 kilograms (65% mixture is composed

of muscle tissue and 35% fat) and when added to water cooled, the sample weight was 0.256 kilograms (the mixture of 50% muscle tissue, 27% fat and 23% water cooled).

To see the effect of chop on the growth temperature after each period of chopping, the temperature of the paste was determined in the center tank, using for this purpose an electronic thermometer.

Given the mass heat capacity of the composition, its mass and temperature difference, the heat generated was calculated (Joules) in the mass of mince, using the equation:

$$Q=c\cdot M\cdot \Delta t, (J)$$

where: c - heat mass capacity of mince, KJ / KgK;

m – mass of load, Kg;

Δt - temperature difference made every step of chopping, K.

At Q calculation were considered, mass heat capacity of beef and pork lean meat 3.81 KJ / KGK, the heat capacity of fat mass - 4.689 KJ / KGK, water - 4.23 KJ / KGK, temperature of 0^0C and the proportion of them.

Power required (Watts) to achieve mince versus time can be calculated by the relation:

$$N = \frac{Q}{Tchooping}, (W)$$

where: $T_{chopping}$ – is time of chopping, (s).

3. Results and discussion

Following research it was found that the greatest increase in temperature, for compositions without added water cooled, was recorded in the first 15 sec of chopping, the temperature rose to 11.7^0 C for pork and 14.1^0 C for beef. Subsequent growth period resulted in increases chopping temperatures less pronounced. Adding cooling water temperature strongly influenced the evolution of chopping; the temperature has not made a strong jump in first 15 seconds of shredding, it increased slightly to 6^0C for the pork composition and 7.4^0 C for beef compositions at 30 sec chopping, followed by a higher rate when the duration of chopping increase at 45 sec. For both compositions, increasing the duration of chopping to 60 sec, the temperature increased by approximately 1^0C. At the end of the chopping, the compositions that have been added cooling water, the temperatures were lower than compositions without cooling water added. Changes in temperature, the heat released and the power required for chopping are presented in tables 1 and 2.

The heat generated in chopping has risen sharply in the first 15 sec of chopping, then having a less pronounced growth when increases chopping time towards 60 sec, for compositions without water cooled added, while at the addition of chilled water temperature rise was reduced within 30 sec and then increased with increasing duration of chopping to 60 sec. At the end chop, heat generated in the case of samples with added water was cooled below the heat generated in the case of samples without adding water cooled.

At the beginning of the chopping is required more electrical power since the cuts of meat and fat are large, and as the chopping progresses necessary power is diminishing, in mixtures with water cooled added, the power required records a growth increase of chopping time from 30 sec to 45 sec.

The increase of temperature at meat chopping determine the distortions of protein structures, resulting in ultimate loss of their technological properties, which again emphasizes the importance of adding water cooled or flakes ice from chipping.

Experimental results obtained are different from the results recorded in the literature (C. Banu and others - in 2003 recording the temperature increases of the mince mixture 3 - 4^0 C, and in case of using colloidal mills of 5 - 8^0C) given the conditions of chopping.

Table 1. Changes in temperature, the heat released and the power required for chopping meat mixtures of pork

Tracked parameters	Type mixture	Chopping time, s			
		15	30	45	60
Rise of temperatura, ^{0}C	Without water	11.7	16.1	16.9	17.9
	With water	3.4	6	13.5	14.7
Generated heat, KJ	Without water	10.04	13.66	14.32	15.14
	With water	3.93	6.68	14.63	15.9
Power generated, KW	Without water	0.669	0.455	0.318	0.252
	With water	0.26	0.22	0.33	0.27

*Initial temperature of the compositions without cooled water added was -0.5^0 C, and the compositions with added cooled water was -0.3^0 C.

Table 2. Changes in temperature, the heat released and the power required for chopping meat mixtures beef

Tracked parameters	Type mixture	Chopping time, s			
		15	30	45	60
Rise of temperatura, ^{0}C	Without water	14.1	18.3	20.2	21.4
	With water	6.1	7.4	14.6	15.7
Generated heat, KJ	Without water	12.02	15.47	17.04	18.02
	With water	6.78	8.16	15.79	16.96
Power generated, KW	Without water	0.8	0.52	0.38	0.3
	With water	0.45	0.27	0.35	0.28

*Initial temperature of the compositions without cooled water added was -0.5^0 C, and the compositions with added cooled water was -0.3^0 C.

4. Conclusions

The biggest increase in temperature and the highest heat generated in chopping were recorded at mincing beef compositions without added water cooled, they also recorded the highest temperatures at the final.

Adding water-cooled lead to a reduction in growth temperature during the chop, the final temperature with these compositions is smaller.

Electrical power required is greater at the beginning of chopping, and it is decreasing as the material is crushed.

References

1. Banu, C., Alexe, P., Vizireanu, C., Procesarea industrială a cărnii. Editura Tehnică, Bucureşti, 1997, pp. 372-375.

2. Banu, C. (coord.), Tratat de industrie alimentară. Tehnologii alimentare. Editura ASAB, Bucureşti, 2009, pp. 129-130.

3. Dolata, W., Uchman, W., The estimaion of technological effectiveness of the work of chopperknives with the shear edge in the shape of circle segment. Food Science and Technology, 3 (2), 2000.

4. Dolata, W., Bewertung der technologischen Arbeitseffektivitat von Kutternmessern. Fleischwirtsch, 79 (5), 1999, pp. 94-97.

5. Honikel, K., Egginger, R., Einsatz verschiedener Kuttermesser bei der Bruhwurstherstellung. Fleischwirtsch, 64 (5), 1984, pp. 518-520.