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Comparative analysis of meat raw materials

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Abstract

Animal food, especially meat, has played an important role in the history of mankind. Different meats can be used in the production of meat products. In addition to lean meats, mechanically deboned meat (MDM) and mechanically separated meat (MSM) can also be used in meat products. However, the latter does not qualify as meat due to damage to the muscular structure due to the high pressure applied during the separation, therefore cannot be included in the meat content of products.

The aim of the experiment was to compare whole, minced meat, MDM and MSM from turkey (raw and in the form of meat paste). Technofunctional tests (water-holding and -binding capacity), color measurement, chemical composition (moisture, protein and fat content), electron microscopic recording, rheological properties show that the quality of MSM is inferior to other meat raw materials. These properties can also result in the production of lower quality products.

Introduction

Meat is the processed and certified skeletal muscle of mammals and poultry for human consumption. According to Regulation (EC) No 853/2004, meat is the edible parts of the following animals, including blood: pigs, cattle, calves, poultry (e.g., chickens, hens, ducks, geese, turkeys), other warm-blooded animals (sheeps, rabbits, goats, horses, etc.), wild animals (wild boar, deer, cervids, wild rabbits, etc.) and ratites (ostriches)

In addition to lean meat, meat removed from bones can also be used in meat products, according to the provisions of the Requirement No 1-3 / 13-1 of the Codex Alimentarius Hungaricus:

- Mechanically deboned meat (MDM), the production operation is limited to the mechanical removal of the bone from the boned meat and is not intended for the further extraction of meat from the bone remaining after boning.

- Mechanically separated meat (MSM) is a product obtained after boning from fresh, fleshy bones or poultry which have been removed by mechanical means in such a way as to damage or modify the muscular structure. This does not qualify as meat.

The basis of the method was developed in Japan in the early 1940s for remove and separating fish meat (Trindade et al., 2004; Oliveira et al., 2015). According to Regulation (EC) No 853/2004, MSM cannot be made from poultry skins, neck skin and heads. Bone-in meat packaged for up to 3 days at 2°C can be used as raw material. The regulation stipulates a shelf life of 3 months when stored at -18°C. It is important that MSM can only be used in heat-treated products. MSM does not qualify as meat due to its unfavorable chemical (high fat and calcium content) and functional (poor water binding) properties. The composition and name of the product must also include 'mechanically separated meat (MSM)'. Previously, this was also classified as meat, but - due to its unfavorable properties - its use in meat products was maximized by 10% (Req. No 1-3 / 13-1 of the Codex Alimentarius Hungaricus). Of course, it can also be used in larger quantities to produce a product, but in this case the product cannot be called e.g., bologna sausage, vienna sausage.

Fig. 1. Raw materials (minced meat, MDM, MSM).

Fig. 2. Mechanically separated meat (MSM) pastes (amount of added water: 0 mL, 10 mL, 20 mL, 30 mL, 40 mL, 60 mL, 80 mL, 100 mL).

Materials and methods

Whole turkey drumsticks, minced turkey drumsticks (particle size: 3 mm), mechanically deboned meat made from turkey drumsticks and MSM made from turkey backs were obtained from Gallfood Ltd. (Kecskemét, Hungary) (*Fig. 1)*.

Preparing of meat paste: 100 g of sample (minced, MDM and MSM) and 0 mL, 10 mL, 20 mL, 30 mL, 40 mL, 60 mL, 80 mL, and 100 mL of water were used to prepare the meat paste. Paste production was performed for 20 seconds (*Fig. 2*).

Pressing loss was determined by the following method. 0.5 to 1 gram of raw samples was placed on dried filter paper. The samples were placed between glass plates and were weighed at 1000 g for 5 minutes. To determine the cooking loss, the 2x2x2 cm raw samples were heat-treated in an airtight plastic bag until a core temperature of 72 °C was reached. In determining the roasting loss, two sides of the 2x2x2 cm raw samples were heat-treated in a contact grill heated to 170 °C for 5 minutes. Measurements were performed on three repeats.

The color stability of the raw samples was measured (in CIELab color space) with a Minolta CR-300. The measurement lasted for 120 min, measured every 10 min (five points). During the measurement, commercial meat display coolers were simulated. The samples were continuously cooled from below. The samples were also under lighting. The illumination level was 700 lx. Half of the samples were uncovered, and the other half were covered with foil (to avoid changes caused by oxygen).

I performed analytical measurements on examined products, I measured fat, moisture, protein content with FOSS FoodScan 2 (*Fig. 3*).

Scanning electron microscopy (SEM): Preparation: 1 gram of raw samples – whole meat, minced meat, MDM and MSM – were fixed in glutaraldehyde (2.5 g 100 g^{-1}) for 24 hours in 0.1 M phosphate buffer (pH 7.0). After fixing the ethanol dehydration, the samples were freeze-dried and spray-coated according to the method of Cao et al. (2012). The prepared samples were tested on a FEI Quanta 3D Two-Beam Scanning Electron Microscope at 5°C, 700 Pa and 100% relative humidity.

The surface color of the meat pastes (minced meat, MDM and MSM) containing different amounts of added water (in CIELab color space) was measured with a Minolta CR-400 (five parallel measurements).

Viscosity characteristics were tested with an Anton Paar Physica MCR 92 viscometer (*Fig. 4*). The temperature of the meat paste was 10°C, the frequency was 10 Hz, the amplitude was increased to 0.05-100%, the gap was 1 mm, and the diameter of the measuring head was 25 mm. Using the amplitude sweeping method, 3 parallel measurements were performed with a sheet-to-sheet arrangement, with a sheet diameter of 23 mm. Measured characteristics: modulus of storage (G') and loss (G") and shear stress (τ).

Fig. 3.
FOSS FoodScan 2.

Fig. 4.
Anton Paar Physica MCR 92 viscometer

Results and discussion

Pressing loss: there is a significant difference between the samples (P <0.001), the lowest value is given to the whole turkey drumstick meat (0.54 ± 0.380), so this sample has the highest water-holding capacity value. This was followed by minced turkey drumsticks (1.69 ± 0.050) and turkey drumstick MDM (5.27 ± 0.540). Most of the water was lost by MSM due to compression (10.76 ± 0.330).

Cooking loss: it can be stated that there is a significant difference between the samples due to cooking (P <0.001). The smallest loss was for minced meat (21.12 ± 0.760), followed by whole turkey drumstick meat (24.09 ± 0.460), MDM (27.00 ± 0.120). MSM had the highest cooking loss and thus the smallest water-binding capacity (37.14 ± 0.290) of the samples.

Roasting loss: there is a significant difference between the samples (P <0.001). The trend was similar in cooking test. Minced meat had the best water-binding property - the lowest roasting loss (36.40 ± 0.795), followed by whole meat (38.81 ± 0.535), MDM (41.19 ± 0.295) and MSM (42.41 ± 0.295).

Color stability: The uncovered samples became darker and darker than the covered ones (P <0.05), their lightness decreased more. It was found that the lightest sample at the beginning was MSM, followed by minced meat and MDM. The uncovered samples became more and more reddish compared to the covered ones (P <0.05), their color intensity value increased more. It was found that the reddest sample at the beginning was MSM, followed by MDM and minced meat. The uncovered samples became more and more yellowish compared to the covered ones (P <0.05), their color intensity value increased more. The most yellow sample at the beginning was MSM, followed by minced meat and MDM. Overall, the uncovered samples darkened, reddened, and turned yellow due to contact with air. In addition, MSM was lighter, redder, and yellower in color compared to MDM and minced meat.

Chemical composition: There's a significant difference (P <0.001) between the fat contents of the samples. Minced meat had the lowest fat content (4.12 ± 0.017), this value was not much higher for MDM (5.24 ± 0.114). The sample with the highest fat content was MSM (20.90 ± 0.029). There's also a significant difference between the moisture content values of the samples (P <0.001), the highest value was that of minced meat (74.87 ± 0.012). This was followed by MDM (74.30 ± 0.036) and MSM (61.33 ± 0.037). The trend shows that there is an inverse relationship between moisture content and fat content. There's also a significant difference between the protein content results of the samples (P <0.001). The highest protein content was in minced meat (20.82 ± 0.032), followed by MDM (20.54 ± 0.033) and MSM (14.27 ± 0.038). Thus, the trend in protein content follows the trend observed for moisture content (inverse proportion to fat content be detected).

SEM: In *Fig. 5 (a),* the fibers of the whole turkey drumstick meat can be seen. The other figures (*Fig. 5 (b), (c)* and *(d))* show the results of the various processing operations (mincing, mechanical deboning and separation). Electron micrographs of MSM show a complete change in muscle structure compared to minced meat and MDM. This may be due to the high pressure applied during the separation.

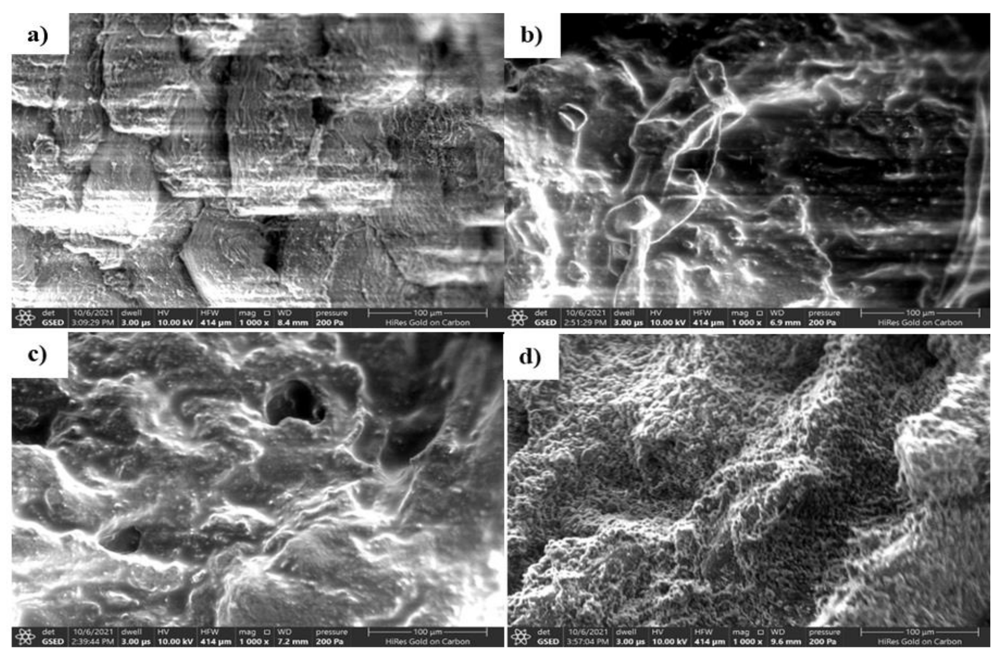

Fig. 5. Electron micrographs of the samples. a) whole, b) minced, c) MDM: Mechanically deboned meat, d) MSM: Mechanically separated meat.

Colour of meat pastes: Based on the trend, it can be said that the different meat pastes became lighter with increasing amount of water (P <0.05). It was found that the lightest sample alongside was MSM, followed by minced meat and MDM. Increasing the amount of water shows a decrease in the red color intensity of the pastes (P <0.05). It was found that the reddest sample alongside was MSM, followed by MDM and minced meat. It can be observed that the yellow color intensity of the pastes decreased with increasing water volume (P <0.05). The most yellow sample alongside was MSM, followed by minced meat and MDM. Overall, the pastes became lighter and less red and yellow as the amount of water added increased. The MSM paste was lighter, redder and yellower in color compared to MDM and minced meat pastes. Furthermore, it can be seen that in the case of MSM meat paste, there is no apparent large color difference between the two samples, in contrast to the sample made from MDM and minced meat.

Viscosity characteristics of meat pastes: In Fig.6 shown that the storage modulus (G') of meat pastes decreases with increasing amount of added water, i.e., it becomes less and less elastic. In Fig. 6 shown that the value of the initial storage modulus of the meat paste made of MDM is the highest, followed by the meat paste made of minced meat and MSM (P <0.05). MSM meat paste is the least flexible, to which more additives must be added to produce the right quality paste. In Fig. 7 shown that the loss modulus value (G") of meat pastes decreases with increasing amount of water, i.e., the paste becomes less and less viscous. In Fig. 7 shown that the value of the initial loss modulus of the meat paste made from MDM is the highest, followed by the meat paste made from minced meat and MSM. Thus, MSM meat paste is the least viscous (P <0.05). For the three types of meat paste, the loss modulus is initially less than the storage modulus, so their quotient is less than 1, which means that is a solid material despite of added water. The value of the shear stress (τ) of the meat pastes decreases with increasing amount of water added, i.e., the paste becomes less and less resistant to the shear strain. The final shear stress value of the meat paste made of MDM is the highest, followed by the meat paste made of minced meat and MSM (P <0.05). So, the least shear strain is required for MSM paste.

Conclusion

Summarizing the results, it can be stated that MSM differs from whole meat, minced meat and MDM both in the raw state and as a raw material for meat paste. Water activity and pH results are not significantly different from MDM. However, differences in key properties can be detected. In terms of technofunctional properties – water-holding and water-binding capacity -, MSM has worse properties due to high levels of muscle cell destruction. It had higher pressing, cooking and roasting loss compared to the other samples. Electron micrographs of MSM show a complete change in muscle structure compared to minced meat and MDM (cause: high pressure applied). In the case of surface color characteristics, it can be observed that MSM is a lighter, redder and yellower color both in the raw form and in the form of meat paste. These properties cannot be kept stable over time. The rheological properties (e.g., elasticity) of MSM meat paste are less favorable than those of other raw materials. These defects can also occur during the production of meat products which must be compensated for e.g., with natural additives or physical impact (high pressure).

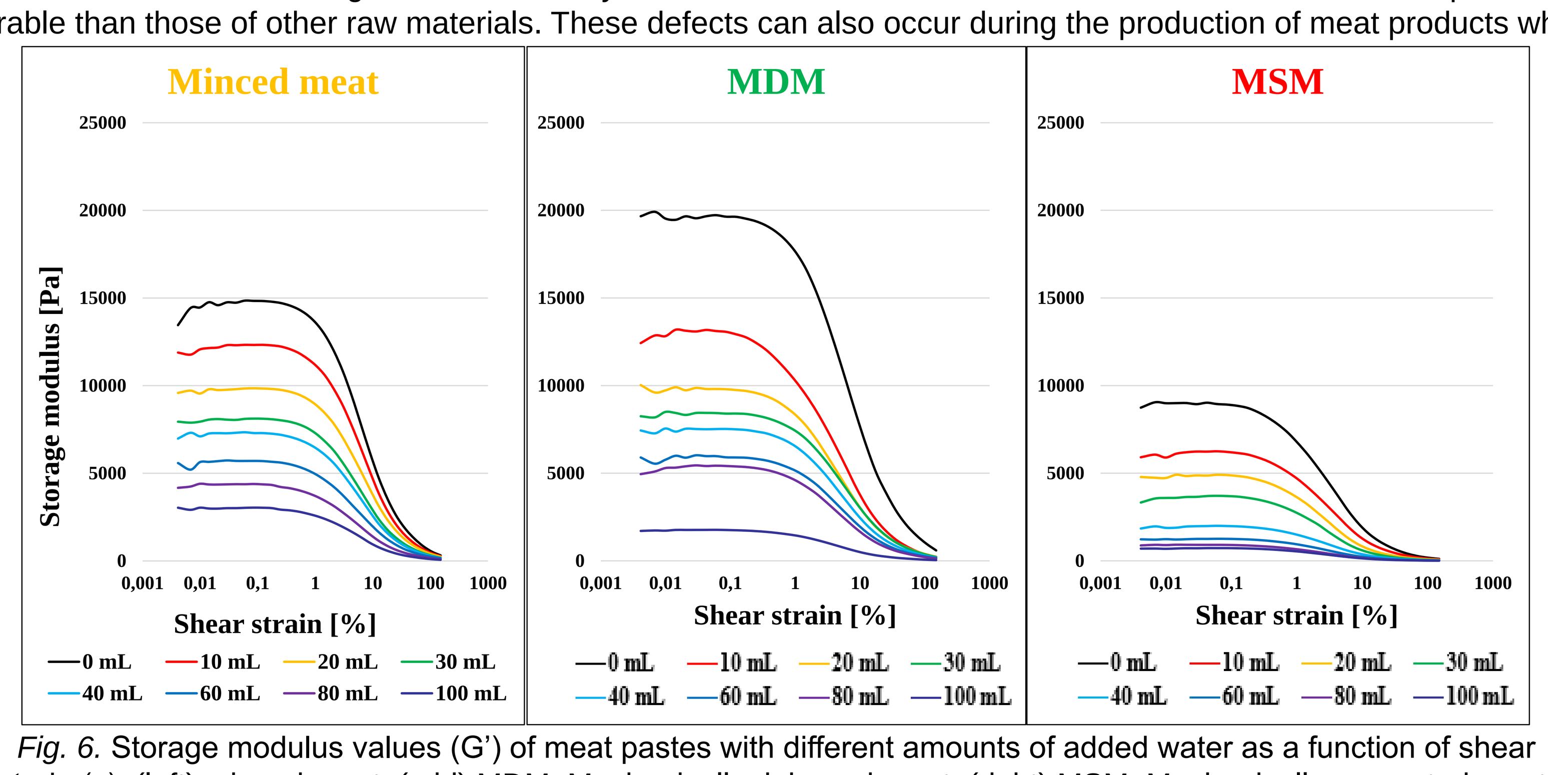

Fig. 6. Storage modulus values (G') of meat pastes with different amounts of added water as a function of shear strain (γ). (left) minced meat, (mid) MDM: Mechanically deboned meat, (right) MSM: Mechanically separated meat.

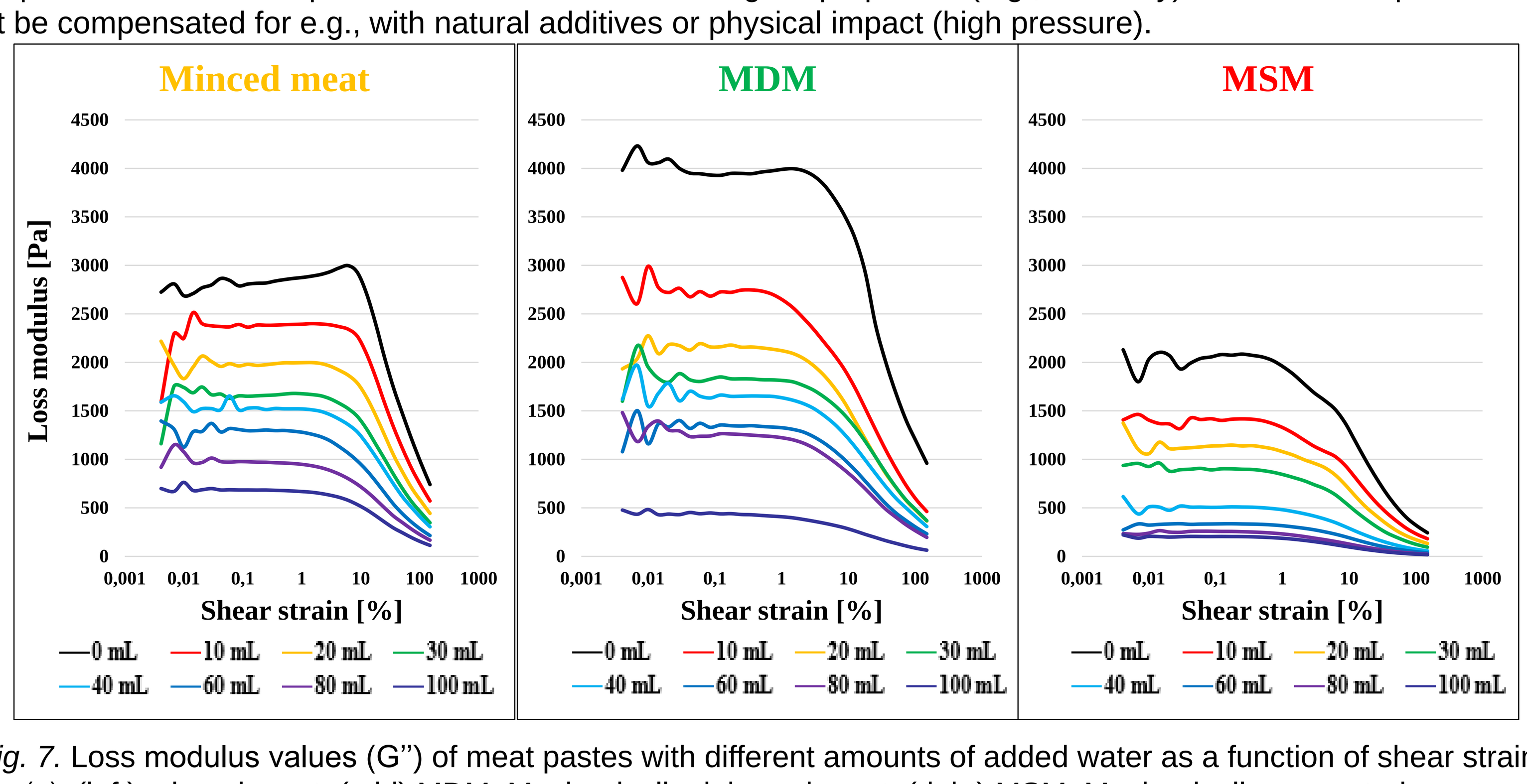

Fig. 7. Loss modulus values (G'') of meat pastes with different amounts of added water as a function of shear strain (γ). (left) minced meat, (mid) MDM: Mechanically deboned meat, (right) MSM: Mechanically separated meat.

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