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COMPARATIVE ANALYSIS OF MEAT PRODUCTS MADE FROM VARIOUS CHICKEN MEAT RAW MATERIAL

[1]Tamás Kulcsár, [1]Bálint Erdei, [1]Eszter Trenyik, [1]József Mihalkó, [1]Balázs P. Szabó
[1]Department of Food Engineering, Faculty of Engineering, University of Szeged, Moszkvai Blvd. 5-7., 6725, Szeged, Hungary
e-mail: mihalko@mk.u-szeged.hu

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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 our research work was to compare the characteristics of Bologna sausages made from chicken fillet, chicken MDM and poultry MSM. After evaluating our measurements (cooking loss, colour measurement, instrumental chemical composition measuring, stock measurement, determination of water activity, pH measurement, and sensory evaluation), we concluded that in the case of production with MSM, we produced a lower quality product using the same amount of meat raw material, which can be improved by using more additives (e.g. carminic acid, tetrasodium-pyrophosphate).

Keywords: meat, mechanically deboned meat, mechanically separated meat, Bologna sausage, comparative analysis

1. INTRODUCTION

Meat is the processed and certified skeletal muscle of mammals and poultry for human consumption [1]. According to [2], 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 (sheep, 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 [3]:

- 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 ([4]; [5]; [6]). According to [2], 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 unfavourable 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 unfavourable properties – its use in meat products was maximized by 10% [3]. 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.
Ref. [3] also stipulates that:

- "if the raw material (primary ingredient) used to produce the meat product or prepared meat contains more than 200 mg/kg of calcium, it must be considered mechanically separated meat;

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- if the calcium content of the meat product or prepared meat is more than 350 mg/kg, the product certainly contains mechanically separated meat. The limit value is to be understood without the calcium content in other calcium-containing ingredients other than the meat in the product and the mechanically separated meat."

2. MATERIALS AND METHODS

2.1. Materials

Chicken breast fillet, chicken breast mechanically deboned meat (MDM) and poultry mechanically separated meat (MSM) were obtained from Hungerit Ltd. (Szentes, Hungary) (Fig. 1).

Figure 1. Raw materials (fillet meat, MDM, MSM). MDM: mechanically deboned meat, MSM: mechanically separated meat

In addition, we also used water, pork fat, sodium nitrite salting mixture, and tetrasodium-pyrophosphate (Soluprat) to produce the samples. The recipe can be found in Table 1. 1 mix was 400 g.

Table 1. Recipe of the prepared products

Raw materials	Amount [%]
Meat/MDM/MSM	60
Pork fat	20
Water	17.5
Sodium nitrite salt mixture	2.0
Soluprat	0.5

The manufacturing process can be seen in Fig. 2. The finished products were placed in cans and heat-treated in this way (in a water bath at 75 °C for 65 minutes). We used this procedure instead of the natural casings filling, because due to the small amount of the experimental products, a significant amount of technological loss should have been expected.

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Figure 2. The manufacturing process of the samples

Fig. 3. shows the finished products.

Figure 3. The finished samples (from fillet meat, MDM, MSM). MDM: mechanically deboned meat, MSM: mechanically separated meat

2.2. Methods

During of our research work, we used different measuring methods:
- Cooking loss measurement,
- Colour measurement,
- Chemical composition measurement,
- Instrumental stock measurement,
- Water activity measurement,
- pH value measurement,
- Sensory evaluation.

Cooking loss was measured by simple mass loss calculation. The mass of the meat paste was measured during filling it in a can, and then after heat treatment, the mass of the product was measured. From these, the cooking loss value was calculated as a percentage.

During our work, instrumental **colour measurement** was performed in 5 different points on the surface of the products with MINOLTA CR-300 CROMAMETER (Osaka, Japan). The obtained colour coordinates (L*, a*, b*) were used to determine the colour stimulus difference (ΔE*), which was determined by the formula of [6]:

$$\Delta E^* = \sqrt{\left(\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}\right)} \quad (1)$$

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We performed **chemical composition measurement** on examined products, we measured fat, moisture, protein content with FOSS FoodScan 2 (Hillerød, Denmark). Based on the force-displacement curves of the individual samples, the value of the spring constant was calculated between 3 mm and 6 mm, based on [8].
We performed **instrumental stock measurement** with LLOYD 1000 Texture Machine (Bognor Regis, UK) type metering device with three repeats, the force-displacement curve was made from the results.
The Novasina LAB MASTER-aw equipment (Lachen, Switzerland) was used to **measure the water activity** of the samples. The tempering unit built into the instrument ensures a constant temperature (25 °C), so the water activity of the samples was determined under the same conditions.
The **pH value** of the samples was measured with a Testo 206 (Titisee-Neustadt, Germany) device (on 3 repeats).
The **sensory evaluation** of the samples was carried out by a total of 10 people, who were students and lecturers. Sensory evaluation was done using a descriptive method and overall impression scoring. In the descriptive method, the examined properties were the colour, smell, taste, and texture of the products. For the overall impression, the reviewers could score the samples between 1 and 10 points (a higher score is considered more popular).
The **statistical analysis** was performed with the IBM (Armonk, New York, USA) Statistics 27 software. The significance level was 5% ($P < 0.05$)). ANOVA was used for statistical analysis of variance. In the case of a significant ANOVA test result ($P < 0.05$), we determined which groups differed significantly with the Tukey HSD post hoc test. The Microsoft (Redmond, Washington, USA) 365 Excel program was used for graphic representation.

3. RESULTS AND DISCUSSION

3.1. Cooking loss

It can be clearly observed that, based on the percentage of the cooking loss, there was no significant difference between the samples made from the fillet and the MDM (0.49% and 0.53%), since we experienced almost the same cooking loss for these two. In the case of the MSM-based product, the higher value is caused by the raw material, nearly twice as much loss value was observed (0.95%). However, it should be noted that the cooking loss was reduced by tetrasodium pyrophosphate, without which we would certainly have noticed a higher cooking loss.

1.2. Colour measurement

Fig. 4 shows that the lightness (L*) of the products is between 70 and 72, the red colour intensity (a*) is between 3 and 6, and the yellow colour intensity (b*) is between 9 and 13. A significant difference can be seen within some of these intervals. In terms of lightness, there is no significant difference between the samples. In the case of red and yellow colour intensity, the sample made of MSM took on a significantly higher value, i.e. it became redder and yellower compared to the other two samples. Using these values, the colour stimulus difference was calculated between 2-2 samples. The largest colour stimulus difference value (3.19) was between products made from fillet and MSM, i.e. it is a well noticeable difference. There was a visible difference between the sample made from MDM and the other two samples (values of 1.55 and 1.81).

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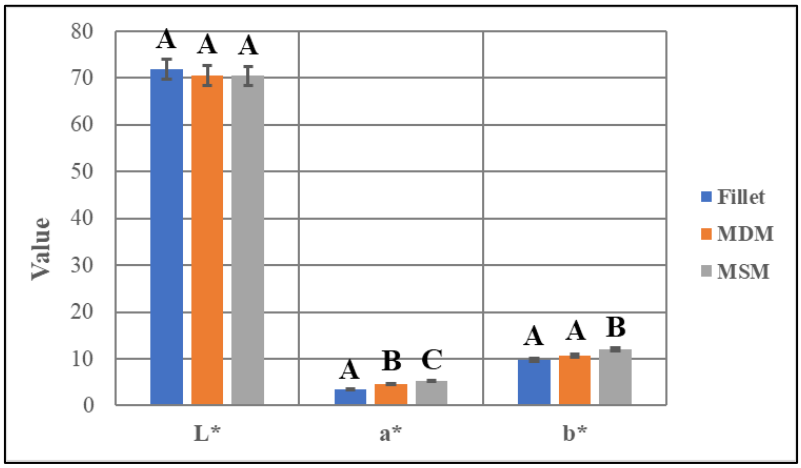

Figure 4. Colour coordinates of the samples. L*: lightness value, a*: red color intensity, b*: yellow color intensity, MDM: mechanically deboned meat, MSM: mechanically separated meat. Capital letters above the bars show significant difference (P < 0.05).

1.3. Chemical composition measurement

As we can see in Fig. 5, there is a significant difference between the fat content of the samples. The product made from fillet had the lowest fat content (20.90%), this value was not much higher for the product made from MDM (21.12%). The sample with the highest fat content was the MSM-based meat product (24.64%). There is also a significant difference between the moisture content values of the samples, however, the fillet-based product had the highest value (61.33%). This was followed by the sample made from MDM (61.20%) and MSM (58.69%). In other words, it can be seen from the trend that there is an inverse proportion between moisture content and fat content. There is also a significant difference between the results of the protein content of the samples. The Bologna sausage made from fillet contains the most protein (14.27%), followed by the MDM- (14.23%) and the MSM-based sample (13.76%). In other words, the trend of the protein content follows the trend observed for the moisture content (an inverse proportionality can be discovered with the fat content).

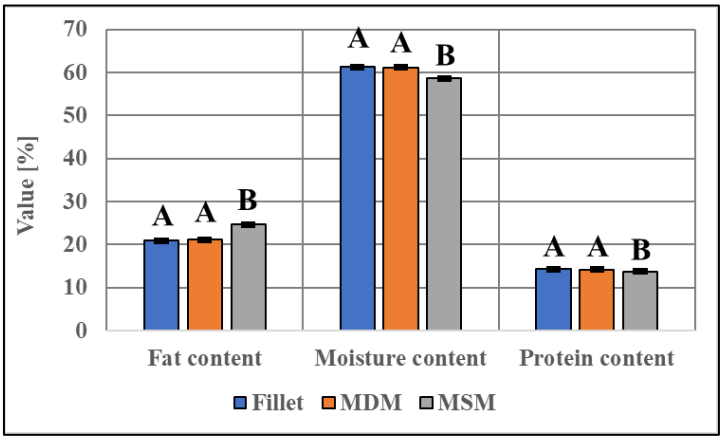

Figure 5. Chemical composition of the samples. MDM: mechanically deboned meat, MSM: mechanically separated meat. Capital letters above the bars show significant difference (P < 0.05).

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3.4. Instrumental stock measurement

The results obtained from the average of the measurement data were plotted on a force-displacement curve (Fig. 6). It can be read from the curve that the product made from the fillet proved to be the hardest (the hardness corresponding to the maximum penetration value was 19.92 N). This was closely followed by the sample made from MDM (18.92 N). The meat product made from MSM was the softest (12.02 N). The value of the spring constant also was calculated. The product made from fillet (1.92 N/mm) and MDM (1.7 N/mm) has the highest spring constant value, the sample made from MSM had the lowest value (1.1 N/mm).

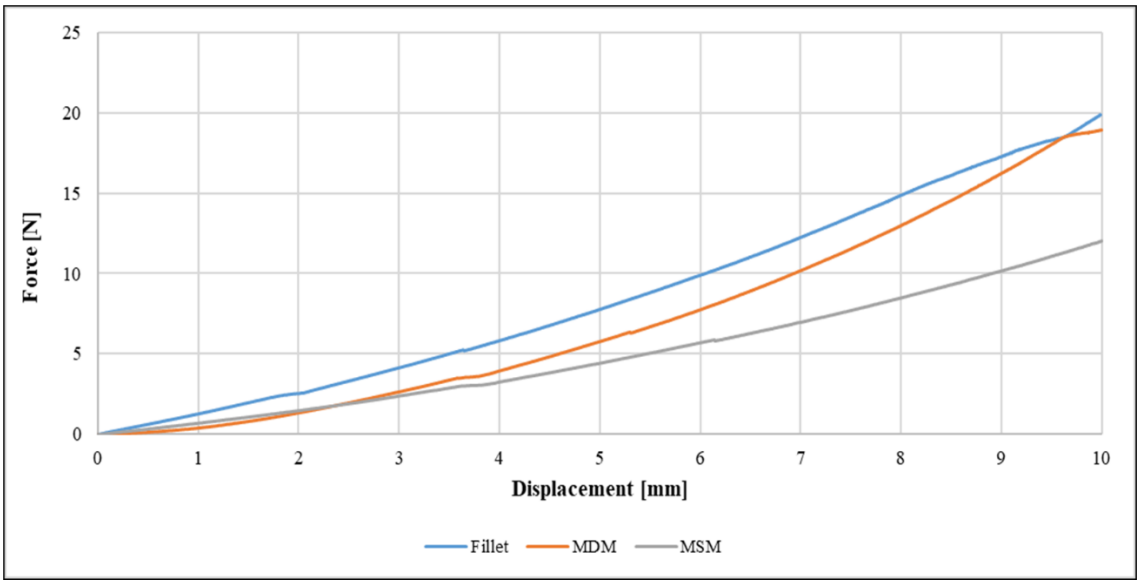

Figure 6. Force-displacement curve of the samples. MDM: mechanically deboned meat, MSM: mechanically separated meat

3.5. Water activity

From the water activity values of the samples, it can be concluded that there is a significant difference between the products made from MSM and the other samples. The fillet and MDM-based products had the lowest water activity (0.954), meaning that these samples contain less free water. The sample made from MSM had the highest value (0.963).

3.6. pH value

There was no significant difference between the pH values of the products made from meat raw materials, as the pH values of the samples were as follows: the MSM-based one was 6.42, the MDM-based one was 6.44 and the fillet-based one was 6.46.

3.7. Sensory evaluation

No excessive difference can be noticed between products made from chicken fillet and MDM. In both cases, the colour of the product was characteristic of cooked, marinated meat (pink). In addition, the smell and taste of the product made from fillet and MDM was typical of cooked meat, with so many additions that the taste of the MDM-based sample was weaker in intensity. In addition, the stock of products made

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from fillet and MDM was compact and could be sliced well. However, the meat product made from MSM fell short of the other two raw materials in all aspects. Because the colour of the product was pale, with a yellowish tint, a slight foreign character was noticeable in its smell and taste, the latter also had a slightly rancid, stale taste. In addition, the product became too hard and not cohesive. These differences also appeared in the numbers given during the overall impression, since the product made from fillet became the most popular (7.5), followed by the sample made from MDM (6.9), and the meat product made from MSM was far behind (4.3).

4. CONCLUSIONS

After evaluating our measurements (cooking loss, colour measurement, instrumental chemical composition measuring, stock measurement, determination of water activity, pH measurement, and sensory evaluation), we concluded that in the case of production with MSM, we produced a lower quality product using the same amount of meat raw material, which can be improved by using more additives (e.g. carminic acid, tetrasodium-pyrophosphate).

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