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COMPARATIVE ANALYSIS OF CATTLE, BUFFALO AND BISON MEAT

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ABSTRACT

Nowadays, the consumption of bison meat is becoming more widespread worldwide, while it's experiencing a renaissance in the United States. For the industry, this could lead to the emergence of a new market sector in the future. It is important to examine the extent to which the quality of its meat differs from that of the usual cattle or buffalo returning to the public consciousness. Our measurements were performed on the loin of bison, buffalo and cattle, including Angus cattle based on the consumer price per 100 grams of product, instrumental colour measurement, instrumental stock measurement, cooking, roasting and pressing loss, instrumental analytical examination and sensory evaluation. During our research, we concluded that bison meat may become a very popular product in Hungary in the future. There is a clear place for the consumption of both buffalo meat and bison meat in a health-conscious diet based on the measured results.

Keywords: meat, cattle, buffalo, bison, comparative analysis

1. INTRODUCTION

In the history of mankind, food of animal origin is undoubtedly important, especially meat [1]. There is a wealth of scientific evidence that meat and meat products contain essential nutrients, high biological value proteins, essential amino acids and vitamins. Vitamin B12 plays a key role in haematopoiesis and nervous system function, a lack of which can lead to anaemia, vascular and nervous system problems [2].
Cattle have been an integral part of our history. It was one of man's most important farm animals. Its domestication is dated to 8000 BC in India and the Middle East. According to today's research, it is of monophyletic origin, i.e. it comes from a single ancestor. This ancestor is *bos taurus primigenius tipicus*, i.e. the progenitors. Cattle play a very important role in steppe animal-keeping peoples, as they consume its milk and meat, while its skin was used to cover their yurts, and its strength was used for pulling yaks [3].
The breed we are looking at is Aberdeen Angus. This British breed of cattle is one of the most popular to this day. Its name comes from the county of Aberdeen and Angus in Scotland. The breed's ancestors date back to the XII. it is mentioned from the century. Hugh Watson, William McCombie and George MacPherson-Grant are considered the founders of the breed. [4] In Hungary, the black version first began to spread in the 1960s, and then the red version appeared in the 70s. The most significant stock in Central Europe is now found in Hungary. Its meat can be used to produce high-quality marbled steaks bred on a pure bloodline.
The buffalo is a mixed-use animal, i.e. it was kept for its meat, milk, and draft power. In Hungary, it is primarily considered for its very good meat-producing ability, as it is a pasture-raised calf whose body weight can exceed 300 kilos at only 8-10 months of age. Its high-quality meat is an internationally sought-after product, as its meat contains more protein, phosphorus compounds and iron than cattle.
Its milk is a real curiosity, because although it does not yield much (only 5-10 litres/day), it can be used to make special quality milk products due to its high fat content (6-15%). During lactation, the fat content increases at the same time as the amount of milk decreases [5].
In the case of buffalo, unlike cattle, aging the meat for grilling is almost inevitable, as its meat is much tougher. Its cutting parts and breakdown are almost identical to those of cattle. In buffalo, fat surrounds the muscles, unlike cattle, where the proportion of fat between muscles is higher. In this way, we can easily remove excess fat from the meat.

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The American bison is the largest land mammal in North America. Bison herds ranged from the warm southern prairies to the cold northern forests.
The bison is the largest land mammal in the temperate zone, reaching 3.5 meters in length and 1.86 meters in height, and can weigh more than 1 ton. Its body structure is like that of cattle, but there are some differences. For example, the withers are much higher and stand out with a hump, the forehead is wider, and the horns start from the front of the head, not from the back corner of the frontal bone like the horns of cattle and buffalo. They are relatively small, cylindrical, smooth, outward and upward. Tail ending in a tassel, short. Its fur is thick and soft, dense, short and smooth in the back half of its body; it turns into a long-tangled mane on the forehead, head, neck and withers. Its colour is brown, the ends of its legs and its mane are darker, its tail tuft is brownish black. [6]
The consumption of meat in Hungary shows a continuously increasing trend [7]. It is a proven fact that the improvement of economic conditions and the general increase in the income of the population manifests itself primarily in the increase in meat consumption [8]. It is an interesting fact that Hungarians consume the largest quantities of poultry and pork. Cattle consumption is very low, only 3.6 kg/year. In the United States, cattle consumption per capita is almost ten times that of Hungary [7], [9]. There is also a difference in the consumption of poultry meat, where in the USA it is more than 40 kg/person/year, while in Hungary this number is around 35 kg/person/year. In terms of pork consumption, we consume almost 10 kg/person/year more in Hungary.
Cattle meat is perhaps one of the richest foods. It contains all the important nutrients and is in a much more concentrated form than other meat and protein sources. Cattle meat is one of the body's most important sources of protein, vitamin B12 and zinc. Consumption of bison and buffalo meat is also recommended for weight loss diets. This is because they are high in protein and contain all the essential amino acids. It is rich in vitamins B12, B6, as well as selenium, zinc, phosphorus, niacin and iron. They also contain omega-3 and omega-6 essential fatty acids, which further reduce the development of circulatory system disorders [10], [11].

2. MATERIALS AND METHODS

2.1. Materials

The products we used in our tests were bought ready. During the studies we used cattle, buffalo and bison loins (Fig. 1).

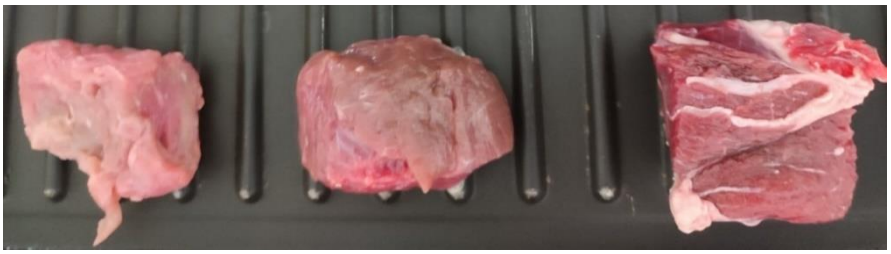

Figure 1. Raw materials (cattle, buffalo, bison meat) used in our project

2.2. Methods

During our work we first performed instrumental colour measurement in 5 different points on the surface of the meats with MINOLTA CR-300 CROMAMETER. The obtained colour coordinates (L*: degree of

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lightness, a*: red colour intensity, b*: yellow colour intensity) were used to determine the colour stimulus difference (ΔE*). Equation (1) shows the determination of colour stimulus difference [12]:

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

We performed analytical measurements on examined products, we measured fat, saturated fatty acid (SFA), moisture, salt, protein, collagen, ash and energy content with FOSS FoodScan 2 (Fig. 2).

Figure 2. FOSS FoodScan 2

We performed stock measurement with LLOYD 1000 Texture Machine type metering device with three repeats (Fig. 3), the force-displacement curve was made from the results.

Figure 3. LLOYD 1000 Texture Machine

We also calculated the value of the spring constant. From the data obtained on the force-displacement curve, we observed that between which 2 penetration depth values the hardness values of the sample increase sharply. Based on the force-displacement curves of the individual samples, we calculated the value of the spring constant between 2 mm and 4 mm. After that, we looked at the hardness values for the 2 penetration depths, using them to calculate the value of the spring constant based on the Equation (2):

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$$D = \frac{F_2 - F_1}{x_2 - x_1} \quad (2)$$

where:
- D: spring constant value [N/mm],
- F_2: the value of the applied force corresponding to the penetration depth x_2 [N],
- F_1: the value of the applied force corresponding to the penetration depth x_1 [N],
- x_2: value of the second penetration depth used for the measurement [mm],
- x_1: value of the first penetration depth used for the measurement [mm],

Pressing loss was determined by the following method. 0.5 to 1 gram of 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 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 samples were heat-treated in a contact grill heated to 170 °C for 5 minutes. Measurements were performed on three repeats.

The sensory evaluation was performed by 18 participants. The properties studied were colour, smell, taste, hardness and overall impression of the samples. The participants were able to rate the samples on a scale of 0 to 100 (using the method of profile analysis). The higher value was darker for colour, more pleasant for smell and taste, and harder for stock. In the case of the overall impression, the higher value is also more favourable.

The statistical analysis was performed with the IBM 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 365 Excel program was used for graphic representation.

3. RESULTS AND DISCUSSION

The results of the colour coordinates of the samples are shown in Fig. 4. It can be seen from this that there was a significant difference between the samples ($P < 0.05$). The degree of lightness of the tested samples was between 32 and 43. The lightest sample was cattle, followed by buffalo, and the darkest sample was bison meat. The red colour intensity of the samples was between 11 and 17. The sample with the highest red colour intensity was bison, followed by buffalo, and the lowest was cattle meat. It can be observed that the yellow colour intensity values fall between 2 and 7. The sample with the highest yellow colour intensity was cattle and the least was bison meat.

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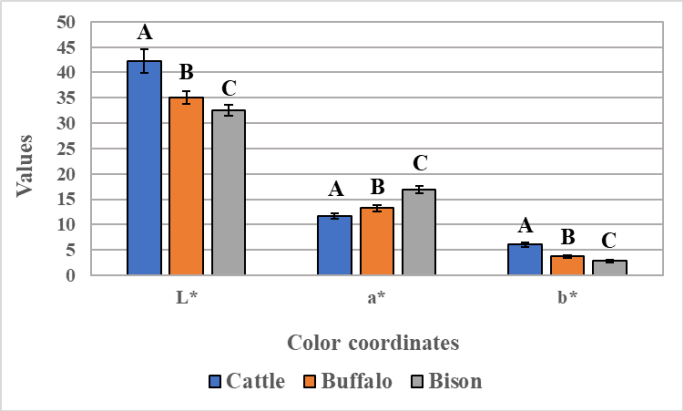

Figure 4. Colour coordinates of the samples. L*: degree of lightness, a*: red colour intensity, b*: yellow colour intensity. Capital letters above the bars show significant difference (P < 0.05).

From the data in Tab. 1, there was no sample where there was no noticeable colour difference between the 2 samples. The most significant colour stimulus difference value was when comparing cattle and bison meat. The smallest was in the case of bison and buffalo meat, but even here the difference was well noticeable.

Table 1. Values and evaluation of colour stimulus differences (ΔE*) between different species. WND: Well Noticeable Difference, LD: Large Difference. ΔL*: difference of degree of lightness, Δa*: difference of red colour intensity, Δb*: difference of yellow colour intensity between different species.

Species	ΔL*	Δa*	Δb*	ΔE*	Evaluation
Cattle – Buffalo	-9.31	1.59	-2.30	9.72	LD
Cattle – Bison	-9.63	5.23	-3.20	11.41	LD
Buffalo – Bison	-2.50	3.64	-0.90	4.50	WND

During the instrumental analytical analysis (Tab. 2), we observed that the highest energy and fat content was obtained from cattle meat, in addition to which the protein content was the most favourable (P < 0.05). Bison meat had the lowest values (fat, saturated fatty acid, protein and energy content), so this type of meat is recommended in the diet for understandable reasons.

Table 2. Chemical composition and energy content of the samples. Capital letters next to the values show significant difference (P < 0.05).

	Cattle	Buffalo	Bison
Fat content [%]	5.49 ± 0.005 ^{A}	4.60 ± 0.015 ^{B}	2.23 ± 0.011 ^{C}
Saturated fatty acid content [%]	2.08 ± 0.010 ^{A}	1.90 ± 0.028 ^{B}	0.72 ± 0.041 ^{C}
Moisture content [%]	72.80 ± 0.039 ^{A}	73.72 ± 0.049 ^{B}	77.96 ± 0.036 ^{C}
Salt content [%]	0.62 ± 0.015 ^{A}	0.74 ± 0.011 ^{B}	1.26 ± 0.016 ^{C}

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Protein content [%]	22.19 ± 0.018 ^{A}	21.21 ± 0.055 ^{B}	19.67 ± 0.061 ^{C}
Collagen content [%]	1.24 ± 0.026 ^{A}	1.36 ± 0.034 ^{B}	1.27 ± 0.070 ^{AB}
Ash content [%]	2.77 ± 0.070 ^{A}	3.13 ± 0.066 ^{B}	3.43 ± 0.008 ^{C}
Energy content [kcal]	138.00 ± 0.000 ^{A}	126.20 ± 0.447 ^{B}	99.00 ± 0.000 ^{C}

In instrumental stock measurements (Fig. 5), bison meat proved to be the hardest, approximately four times harder than cattle meat, which proved to be the softest, and twice as hard as buffalo meat ($P < 0.05$). From the results, the values of the spring constants were calculated for a displacement interval between 2 and 4 mm. The bison meat had the highest spring constant (0.56 N/mm), followed by buffalo meat (0.50 N/mm) and the lowest value was for cattle meat (0.16 N/mm).

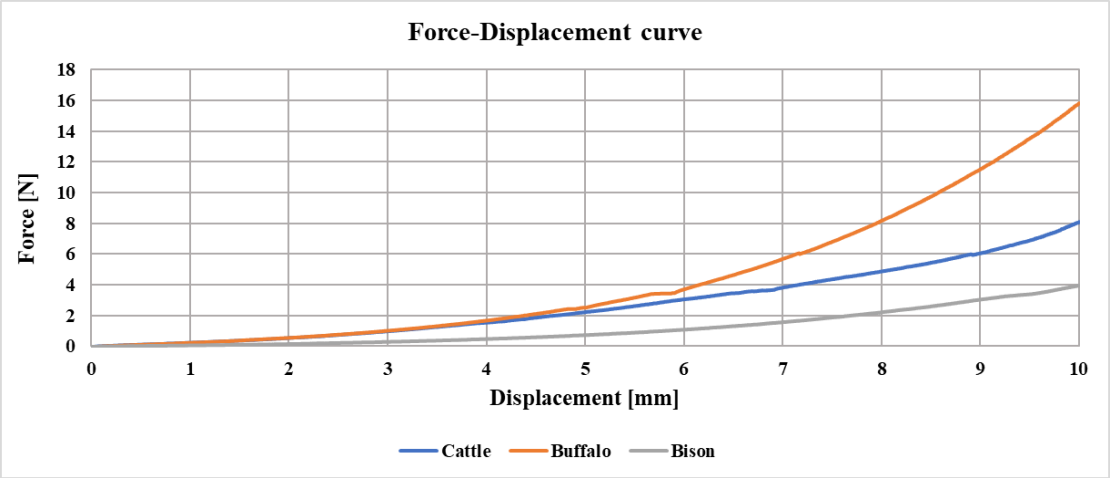

Figure 5. Force-Displacement curve of the samples (P < 0.05).

Fig. 6 shows the values of pressing, cooking and roasting loss of the samples. In the case of pressing loss results there isn't significant difference between the samples ($P > 0.05$), the pressing loss values fall between 6.52 and 7.05. Comparing the results of cooking loss of the samples, it can be stated that there is a significant difference between cattle and buffalo meat ($P < 0.05$), there isn't significant difference between the bison meat and the other meats ($P > 0.05$). From the roasting loss values of the samples, we concluded that the bison shows a significant difference from the other meats ($P < 0.05$), between which there isn't significant difference ($P > 0.05$).

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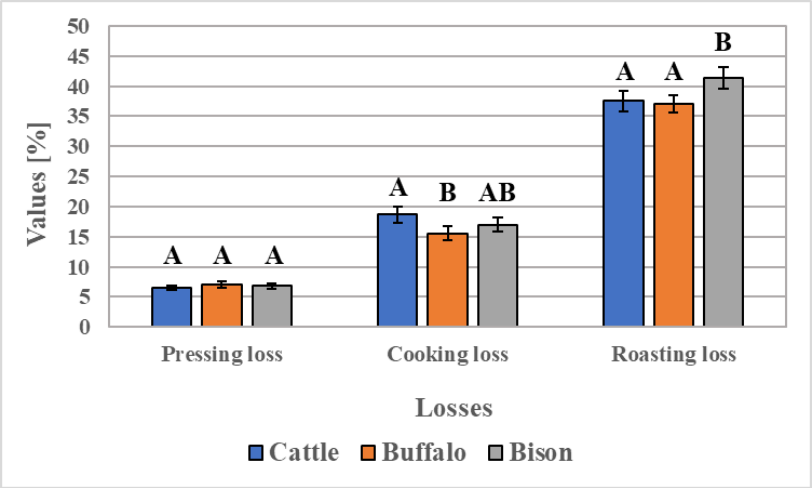

Figure 6. Pressing, cooking, and roasting loss values. Capital letters above the bars show significant difference (P < 0.05).

The most outstanding results in the sensory evaluation (Fig. 7) were the bison meat, which received the most favourable evaluation in all respects, so based on the overall impression, it performed in the best place. The buffalo meat received good reviews in colour and smell, but it was too hard, and the taste was less than that of cattle.

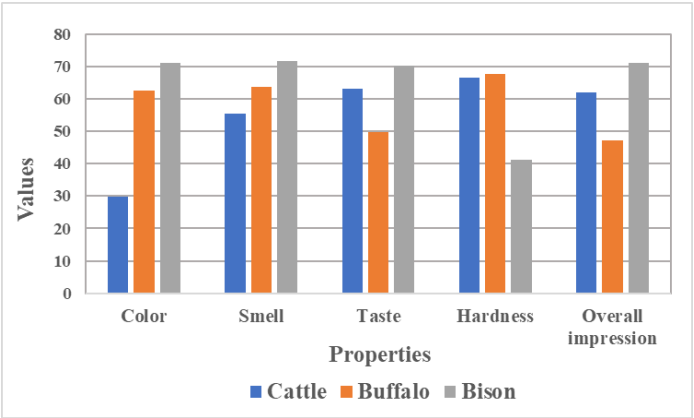

Figure 7. Results of sensory evaluation (n = 18).

4. CONCLUSIONS

Based on the obtained results, we established the following conclusions:

- ***Instrumental colour measurement:*** The bison meat was the darkest, highest red and least yellow colour intensity sample; the cattle meat was the lightest, least red and highest yellow colour intensity sample. So, the most significant colour stimulus difference value was when comparing cattle and bison meat. The smallest was in the case of bison and buffalo meat, but even here the difference was well noticeable.

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- ***Instrumental analytical analysis:*** we observed that the bison meat had the lowest values, so this type of meat is recommended in the diet for understandable reasons.
- ***Instrumental stock measurement:*** bison meat proved to be the hardest, approximately four times harder than cattle meat, which proved to be the softest, and twice as hard as buffalo meat.
- ***Measurements of technofunctional properties:***

a) *Pressing probe:* there wasn't significant difference between the samples
b) *Cooking probe:* there was a significant difference between cattle and buffalo meat, and there wasn't significant difference between the bison meat and the other meats.
c) *Roasting probe:* the bison showed a significant difference from the other meats, between which there wasn't significant difference.

- ***Sensory evaluation:*** The most outstanding results were the bison meat, which received the most favourable evaluation in all respects, so based on the overall impression. The buffalo meat received good reviews in colour and smell, but it was too hard, and the taste was less than that of cattle.

During our research, we have concluded that bison meat may become a very popular product in Hungary soon, if they are backed up by adequate resources and marketing. There is a clear place for the consumption of both buffalo meat and bison meat in a health-conscious diet based on the measured results.

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