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Original scientific paper

Evaluation of the quality of minced meat and minced formed meat on the market of the Republic of Srpska

Biljana Pećanac[a], Bojan Golić[a] and Dragan Knežević[a]*

[a] *Veterinary Institute Republic of Srpska "Dr Vaso Butozan" Banja Luka, Branka Radičevića 18, 78 000 Banja Luka, Bosnia and Herzegovina.*

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ABSTRACT

Minced meat products are very common and popular meat semi-products today due to their simple way of preparing various meals that does not require a lot of time. If, due to commercial carelessness, cheaper meat is fully or partially incorporated into minced meat and its products, such products will not only be of lower quality and fail to meet regulatory requirements but may also be risky for human health.

The aim of the study was to assess the quality of minced meat products as well as minced formed meat available on the market in the Republic of Srpska and, based on the results of 120 samples, evaluate the degree to which these products comply with the regulations concerning their protein content, collagen content in the meat protein (collagen/meat protein ratio), and fat content.

The tests were carried out with reference-accredited methods to determine the contents of hydroxyproline (*BAS ISO*, *2007*), nitrogen (*BAS ISO, 1978*) and fat (*BAS ISO, 2007b*).

The largest number of non-compliances with the requirements of the regulation was found in the case of an increased proportion of collagen in meat proteins, which indicates the use of a larger amount of low-quality meat in production. According to the requirements of the regulation, consumers must be provided with accurate information about food from the Republic of Srpska market because otherwise, low-quality food poses a risk to people's health. More regular and comprehensive control of meat producers and processors is necessary.

1. Introduction

Minced meat products are today very common and popular meat semi-products that are produced from minced meat of lower value to produce higher-value products (*Hudson et al*., 1986; *Hassan, 2009; Witte et al*., 2022), and their acceptability is also influenced by the simple way of preparing various meals that does not require a lot of time. If, due to commercial carelessness, cheaper meat is fully or partially incorporated into minced meat and its products, such products will not only be of lower quality and fail to meet regulatory requirements but may also be risky for human health (*Cozzolino and Murray*, *2004*). The relative proportion of connective tissue proteins in meat proteins (collagen protein ratio) is one of the quality indicators for meat and minced meat products (minced meat, minced meat prepared for forming, and minced formed meat), which is a requirement established in the *Regulation (2015).* The quality of the meat used to prepare minced meat products is assessed based on the measured content of collagen or hydroxyproline and the relative content of connective tissue proteins in meat proteins (*Messia et al.*, *2008*; *Zarkadas et al.*, *1988*; *Aćimović et al.*,

***Corresponding author:** Biljana Pećanac, *biljana.pecanac@virs-vb.com*

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2017). The muscle connective tissue contains approximately 12.5% hydroxyproline (*Etherington & Sims, 1981*). Collagen provides skeletal resistance, whereas mineral content mostly impacts strength and stiffness (*Daneault et al.*, *2015*). The Rulebook on providing information to consumers about food («*Official Gazette of the Republic of Srpska*») establishes the requirements for the proportion of fat and the collagen/meat protein ratio in minced meat products, and the data should be listed on the product declaration to protect the interests of consumers. Minced-formed meat can be produced and marketed as ćevap, patty/burger, hamburger, and other types of related products**.**

The aim of the study was to assess the quality of minced meat products as well as minced formed meat available on the market in the Republic of Srpska and, based on the results of 120 samples, evaluate the degree to which these products comply with the regulations concerning their protein content, collagen content in the meat protein (collagen/meat protein ratio), and fat content.

2. Materials and methods

2.1. Materials

In the period from March 2020 to April 2023, tests were conducted on the content of total protein, hydroxyproline, collagen, the collagen/protein ratio, and fat. The paper analyzed a total of 120 samples of minced meat and formed minced meat, The samples were homogenized and stored at +4°C until analysis.

2.2. Methods

Testing of selected quality parameters was carried out using reference-accredited methods as follows: *BAS ISO (2007)* for hydroxyproline content, *BAS ISO (1978)* for nitrogen content and *BAS ISO (2007b)* for free fat content. The quality conditions in relation to the label "minced meat" are specified in the Rulebook (*Republic of Srpska*, *2015*).

2.3. Statistical analysis

Protein, hydroxyproline, collagen, collagen/meat or total protein ratio and fat content in examined samples of minced meat products were performed in duplicate and were presented as mean values with standard deviation (±SD). The results obtained were analyzed using Microsoft Excel software (Windows 10 pro).

3. Results and discussion

Results of quality parameters for the groups of products: minced meat and minced formed meat are in Table 1. Out of a total of 37 minced meat samples, six samples had a protein content of less than 18% and belong to the II category. Of the 28 samples tested, six had a higher collagen/meat protein ratio than allowed. The ratio of collagen and protein in other types of minced meat is satisfactory. The lowest fat was found in mixed minced meat pork and beef (4,73%). The obtained results for fat in

Table 1. Results of quality parameters for minced meat and minced formed meat

Minced formed meat	Number of analyses	Interval Min-max (%)	(%)	SD (%)
Total protein %	83	13.83–21.90	17.59	1.851
Hydroxyproline %	83	0.06–0.47	0.29	0.094
Collagen %	83	0.48 –3.76	2.32	0.752
Relative connective tissue protein in total proteins % (collagen/meat protein ratio)	83	2.35–21.34	13.41	4.420
Fat %	37	2.78–25.88	12.47	6.254
Minced meat				
Total protein %	37	16.37–22.41	19.75	1.510
Hydroxyproline %	37	0.08–0.64	0.24	0.139
Collagen %	37	0.64–5.12	1.90	1.109
Relative proportion of connective tissue proteins in total proteins	37	3.11–23.99	9.723	5.62
Fat	30	1.68–12.24	7.02	3.231

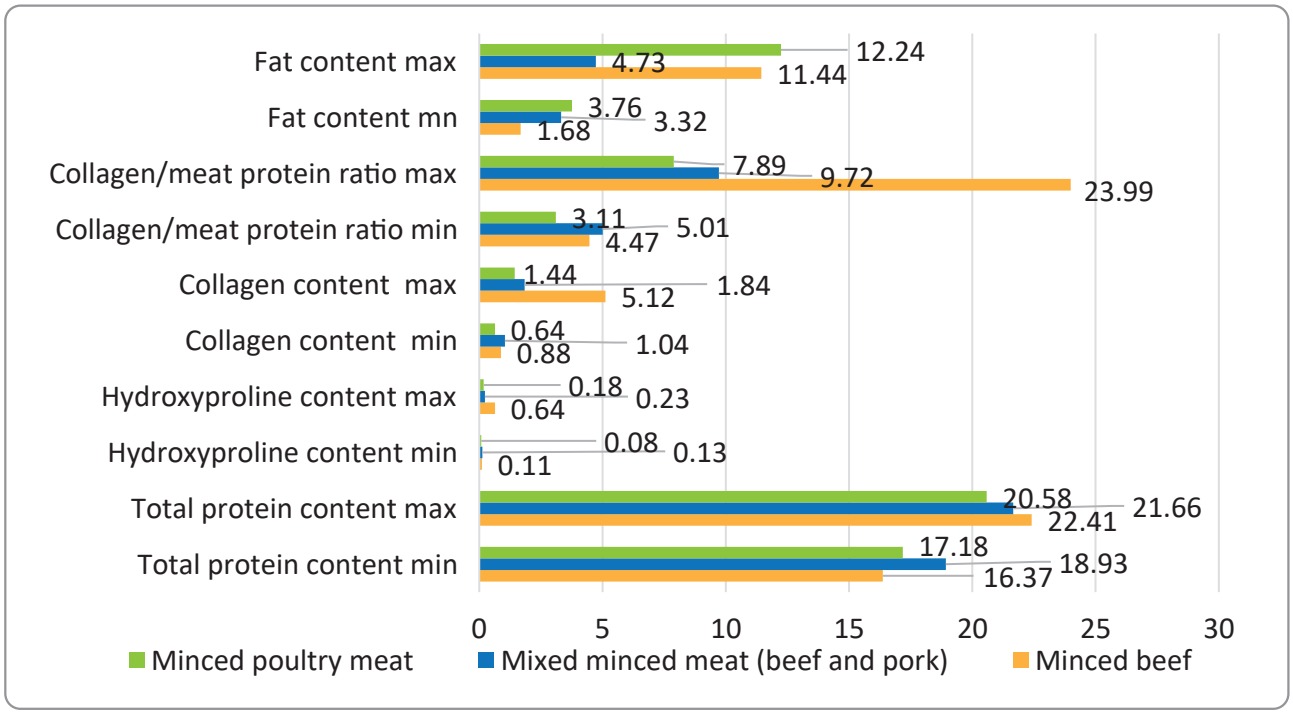

Figure 1. Min and max content of protein %, hydroxyproline, collagen %, collagen/meat or total protein ratio % and fat % in different types of minced meat

ground beef were acceptable, which is not in agreement with the results of *Hudson et al. (1986)*. Also, they determined that the collagen content in retail minced beef is in the range of 1.4% to 4.4%. Nearly similar results were reported by *Hassan, M. Gad Elrab, et al. (2009)*. We found that the content of fat with a large deviation in minced poultry meat, declared as low-fat minced meat, in three samples out of five examined was higher than the allowed 7% (9.88%, 12.24%, and 8.40%), which agrees with *Fayet-Moore et al. (2014)*.

Results of quality parameters for the groups of products: minced meat and minced formed meat are in Table 1.

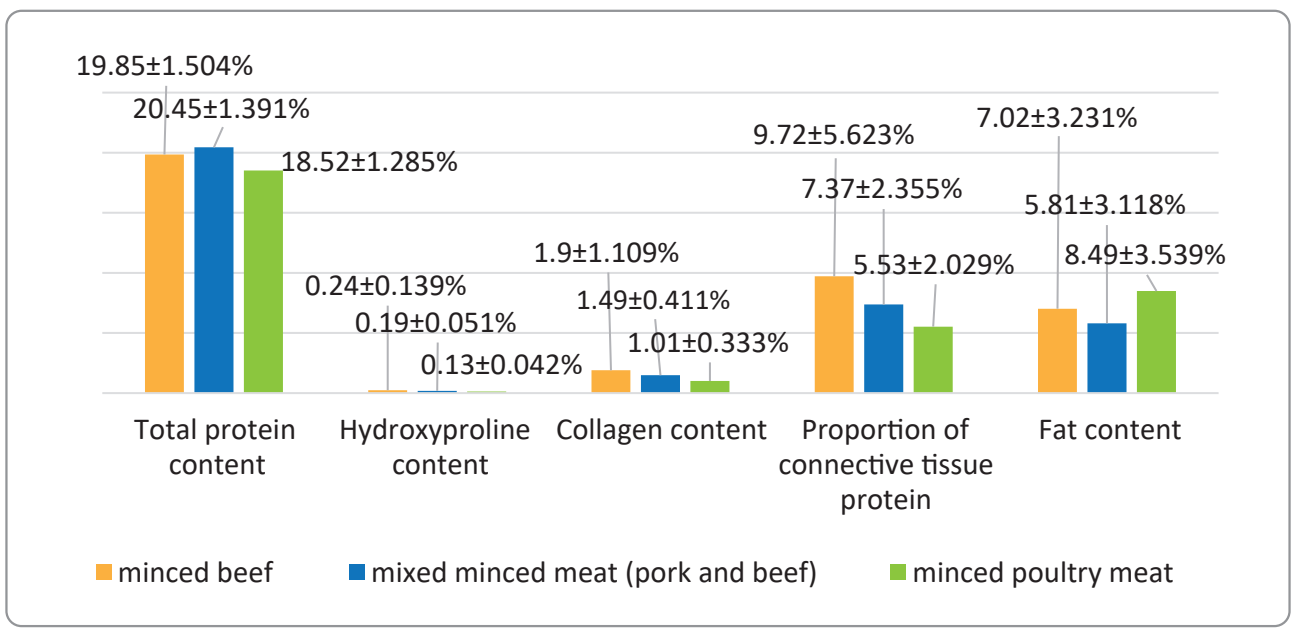

Figure 2. Protein, hydroxyproline, collagen, fet content and collagen/meat protein ratio in in different types of minced meat

In minced beef and ground poultry by-products, *Monago-Maraña, O. et al. (2021)* determined the collagen (measured by hydroxyproline) in the range of 0.1–3.3%, respectively 0.4–1.5%, and our results are in agreement with the results for minced poultry meat but higher than the results for minced beef. The fat in ground beef sold in Australia is <10 g/100 g *(Fayet-Moore et al., 2014)*, which is consistent with our results. Our results are not in accordance with the results of *Kalinova et al. (2017)* who found 23.30 ± 0.67% fat, 16.26 ± 0.73% protein, 0.12 ± 0.01% hydroxyproline, 0.96 ± 0.10 collagen, and a collagen-to-protein ratio of 6 in the mixed minced meat of pork, beef, and veal.

The minimum and maximum values of the content of fat, collagen/meat or total protein ratio, collagen, hydoxyprolin, and protein (%) in minced meat are shown in Figure 1.

The mean values of proten, hydoxyproline, collagen, and collagen/meat or total protein ratio and fat content in minced beef (29 samples), mixed minced (3), and minced poultry (5 samples) are shown in Figure 2.

The minimum and maximum values of the content of fat, hydoxyproline, collagen, and the collagen/meat ratio or total protein (%) in different types of minced formed meat are shown in Figure 3.

The mean values of fat. hydoxyproline. collagen content. and collagen/meat protein ratio (%) in beef ćevap (43 samples). mixed beef and pork ćevap (12 samples). patty (23 samples). and related products (5 samples) are shown in Figure 4.

From the group of formed minced meat. the highest collagen and collagen protein ratio was found in the ćevap. Out of a total of 55 ćevap samples tested. 16 samples (29%) did not comply with the requirements of the regulation regarding the collagen/meat protein ratio. of which non-compliance was found in 28% of beef ćevap samples. Incomplying collagen content test results were also found in six patties samples. so that 23% of the samples had a collagen/meat protein ratio higher than the prescribed limit. The highest fat content was found in the patty/burger (25.88%). while the lowest was recorded in the beef minced meat. One beef ćevap has a lower protein content (13.82%) than the prescribed 14%. and in the patty/burger more fat than the prescribed values (24.88%). Our results agree with those obtained by *Ljutić et al. (2019), Saad et al. (2018)* and *Muftić et al. (2020). Salim and Abou El-Roos (2013)* determined the average value of

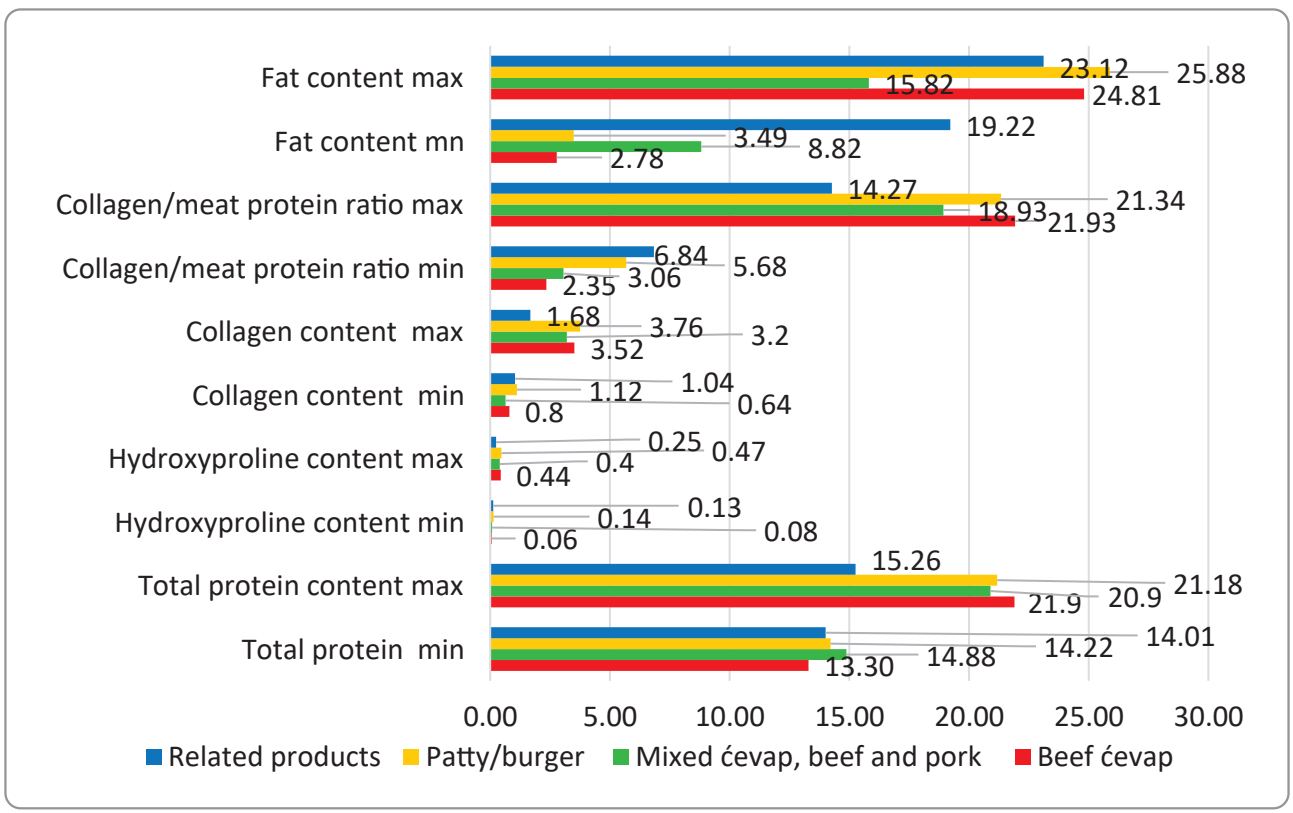

Figure 3. Min and max content of protein. hydroxyproline. collagen. fat and collagen/meat protein ratio in minced formed meat

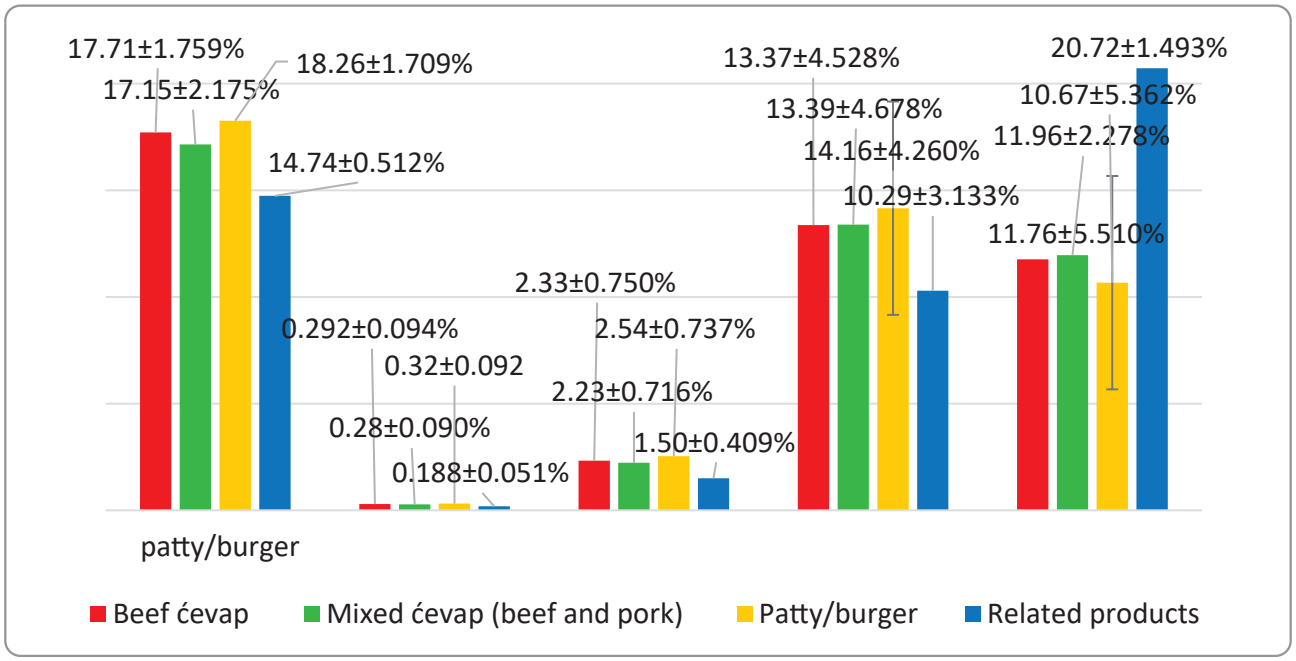

Figure 4. Fat. collagen. hydroxyproline content and collagen/meat protein ratio (%) in minced formed meat

hydroxyproline in ground beef. which is significantly lower than ours.

4. Conclusion

The largest number of non-compliances with the requirements of the regulation was the unacceptably high proportion of collagen in total meat protein, which indicates the use of a large amount of low-quality meat in production. According to the requirements of the regulation, consumers must be provided with accurate information about food on the Republic of Srpska market because otherwise, low-quality food poses a risk to people's health. More regular and comprehensive control of meat producers and processors is necessary.

Disclosure statement: No potential conflict of interest was reported by the authors.

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