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Original Scientific Paper

MICROBIOLOGICAL QUALITY OF MINCED MEAT AND MEAT PREPARATIONS

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Summary

Microbiological examination of food is one of the most important control processes in food production and trade. In that way, we provide safe food on market, but also the consumption of foods and the prevention of diseases that can be transmitted by food contaminated with microorganisms.

The aim of this study was to examine the microbiological status of minced meat and meat preparations in the period from years 2014 to 2020.

Microbiological examinations included *Salmonella spp*., *Escherichia coli* and the total number of aerobic mesophilic bacteria. ISO standard were used to isolate microorganisms (BAS EN ISO 6579-1, BAS ISO 16649-2, BAS EN ISO 4833- 1).

A total of 9,942 samples of minced meat and meat preparations (kebabs, burgers, grilled sausages) were tested.

It was determined that 10.66% of the samples did not meet the microbial criteria. The most commonly isolated pathogens were *Escherichia coli* in 11.60% and *Salmonella spp.* in 1.93% samples. The higher number of aerobic mesophilic bacteria (86.65% of samples) indicates bad hygiene and a potential rapid spoilage of the product.

Keywords: minced meat, meat preparations, microbiological quality.

INTRODUCTION

Quality is generally considered to be one of the most important factors of the product`s market success, especially its long-term well-being. The concept of quality is difficult to define due to its complexity. Many philosophers debated about the quality term. At the beginning of the development of food science, quality was defined as “lack of deficiency” (Bilska and Kowalski, 2014). Good product quality is not an accidental matter but the result of planned and coordinated action. The most important goal is to eliminate all factors that can negatively affect product quality).

Minced meat and meat preparations are products of slaughtered animals and game, i.e., fresh meat products and according to the way they are placed on the market, they are divided into minced meat, minced shaped meat. Minced shaped meat is semi-finished product from one or more different types of meat and additional ingredients, with shaping that is brought to the market under the names: kebabs, burgers, grilled sausages or under

other names (Regulation, 2015). Food safety is one of the main issues of modern society. Usually, meet may be a source of foodborne illness. The main issues related to meat safety are the number of pathogenic microorganisms and spoilage microorganisms. The most common causes of foodborne infections are *Salmonella, Campylobacter, Yersinia enterocolitica, Staphylococcus aureus, Clostridium perfringens, Clostridium botulinum, Listeria monocytogenes, Escherichia coli*, *Shigella.*

Cause of spoilage of raw meat is mainly related to the unwanted growth of microorganisms in the meat during storage. The type and number of microorganisms depend of the initial contamination of meat and specific storage conditions that can affect the development of different populations associated with spoilage and thus affect the type and speed of spoilage process (EFSA 2014; EFSA, 2013).

The microbiological status of meat is important from the aspect of the occurence of microbiological damage, as well as the presence of pathogenic species that can lead to food poisoning in humans. The prevalence of pathogenic bacterial species varies and depends on the health status of animals for slaughter, hygiene process during slaughter, carcasses processing, as well as the conditions of distribution and storage of products (Doulgeraki et al., 2012). The presence and change in the number of certain groups of microorganisms is used as parameter of the shelf-life of minced meat and meat preparations (Cerveny et al., 2009). The total number of aerobic mesophilic bacteria and *Escherichia coli* is most often tested as parameters of hygiene criteria on the process of minced meat and meat preparations, and the presence of *Salmonella spp*. (Regulation, 2019) is tested as a food safety criterion.

Minced meat and meat preparations originating from healthy animals can be subsequently contaminated with pathogenic bacteria, most often because of unhygienic procedures, use of hygienically unsafe water, through insects, as well as inadequate procedure during transport, storage and distribution. The degree of contamination depends on the application of good manufacturing practice and hygiene standards during production, with special reference to the slaughter process (Newell et al., 2010). Sustainability of minced meat is conditioned by a numerous factors, such as the initial number of microorganisms, method and type of packaging, storage temperature, etc.

Minced meat is more susceptible to spoilage compared to whole pieces of meat due to the destruction of the muscle structure by machining, the release of water and the increase of the available surface area by microorganisms. Different bacterial species associated with the breakdown of minced meat and meat preparations colonize the surface of meat and are absorbed into the interior during different phases (Jay et al., 2005). Proteolytic bacteria break down sarcolemma and lead to the aforementioned breakdown of the muscle cell, which make it more susceptible to colonization and multiplication by other microorganisms. The development and duration of this process depends on many internal and external factors, such as type of minced meat or meat preparations, pH value, amount of oxygen, temperature as well as the presence of other bacterial species (Limbo et al., 2010).

A food safety criterion is the one used to assess the acceptability/safety of product or production batch placed on the market. This criterion applies to products during the shelf

life, and if the result of product testing is unsatisfactory related to the criterion, the food business operator can not place such a product on the market or, if the product is already on the market, it must be withdrawen.

Modern consumers are looking for high-quality food that has retained the sensory characteristics and nutritional value of the raw material from which it is produced, while also being safe for human health (Bøknæs et al., 2002; Nattress and Jeremiah, 2000).

The aim of this study is to assess the safety of minced meat and meat preparations to assess the risk for public health, especially assessing food criteria in the production process (total number of aerobic mesophilic bacteria, *Escherichia coli*) and safety criteria (*Salmonella spp.*).

MATERIALS AND METHODS

Samples of minced meat and meat preparations submitted to the Public Institution Veterinary Institute of the Republic of Srpska "Dr Vaso Butozan" Banja Luka in the period from 2014-2020 were used as material in this study. A total of 9,942 samples were examined (2,696 minced meat, 4,920 kebabs, 652 burgers and 1,367 sausage grills). The control of microbiological safety was done according to the Rulebook on microbiological criteria in food of animal origin (Regulation, 2019).

After homogenization of samples, decimal dilutions were made and inoculated on appropriate selective media in accordance with standard BAS ISO methods. Following standard methods were used: BAS EN ISO 4833-1 (ISBIH, 2014), BAS ISO 16649-2 (ISBIH, 2008) and BAS EN ISO 6579-1 (ISBIH, 2018).

RESULTS AND DISCUSSION

In the period 2014-2020, 9,942 samples of minced meat and meat preparations were tested. The results of the analysis are shown in the Table 1.

Table 1 Results of microbiological tests of minced meat and meat preparations in the period 2014-2020.

Year	Number of samples	Assessment of microbiological safety in %	
		Satisfactory	Non satisfactory
2014.	906	89.95	10.0
2015.	1,013	8924	10.76
2016.	1,134	93.91	6.08
2017.	1,436	93.73	6.27
2018.	2,536	85.33	14.66
2019.	1,789	86.75	13.24
2020.	1,128	89.62	10.37
Total	9,942	83.24	10.91

In the period period from 2014 to 2020, 9,942 samples were microbiologically tested, of which 10.91% of samples did not meet the microbiological criteria prescribed by the Regulation (2019). The highest number of non satisfactory samples in relation to the examined number of samples was 13.24% in 2019, and the lowest 6.08% in 2016.
Results of microbiological tests of minced meat and meat preparations for the period 2014-2020, shown in Tables 2, 3, 4 and 5.

Table 2 Results of microbiological tests of minced meat

Year	Aerobic mesophilic bacteria		*Escherichia coli*		*Salmonella spp.*	
	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %
2014.	186	27.41	186	3.76	186	1.07
2015.	231	35.06	231	1.29	231	0
2016.	237	22.78	237	2.95	237	0
2017.	390	19.48	390	0.76	390	0
2018.	1,008	25.29	908	3.19	908	0
2019.	504	31.74	89	13.44	129	0
2020.	140	34.28	109	19.26	109	0
Total	2,696	26.89	2150	3.81	2190	0.09

When it comes to the criteria of hygiene in the production process, in 26.89 % of samples minced meat did not meet the provisions of the regulations due to the findings of the total number of bacteria, and in 3.81 % of samples due to the findings of *Escherichia coli*. The food safety criterion did not meet the prescribed norms in 0.09% samples.

Table 3 Results of microbiological tests of kebabs

Year	aerobic mesophilic bacteria		*Escherichia coli*		*Salmonella spp.*	
	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %
2014.	536	2.42	536	074	536	1,11
2015.	603	1.16	603	0.33	603	0.49
2016.	647	0	613	0.32	220	0.45
2017.	747	0,26	647	0.15	520	0.19
2018.	1,026	4.19	1026	0.29	912	0.10
2019.	895	3.91	805	0.12	106	0
2020.	466	37.5	402	2.73	173	0
Total	4,920	2.52	4632	0.51	3009	0.39

Samples of kebabs in 2.52% of cases did not meet prescribed criteria in the production process due to the finding of the total number of microorganisms and 0.51% of samples due to the findings of *Escherichia coli*, while *Salmonella spp.* was found in 0.39% samples.

Table 4 Results of microbiological tests of burgers

Year	aerobic mesophilic bacteria		*Escherichia coli*		*Salmonella spp.*	
	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %
2014.	70	7.14	70	1.42	70	2.85
2015.	51	0	51	0	51	1.96
2016.	77	2.59	77	1.29	77	1.29
2017.	86	2.32	78	1.28	86	2.32
2018.	168	12.26	57	1.75	12	0
2019.	143	9.09	143	0.69	114	0.87
2020.	57	5.26	5	0	0	0
Total	652	6.90	481	1.03	302	2.31

The finding of the total number of microorganisms in 6.90% of samples and *Escherichia coli* in 1.03% from burgers samples indicates poor hygienic conditions in the production process, while the findings of 2.31% of *Salmonella spp*. indicate on non satisfactory food safety criteria.

Table 5 Results of microbiological tests of grilled sausages

Year	aerobic mesophilic bacteria		*Escherichia coli*		*Salmonella spp.*	
	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %	Number of samples	Unsatisfactory samples %
2014.	114	0.87	114	0.87	1	0
2015.	83	10.84	21	14.28	3	0
2016.	173	0	173	0.57	1	0
2017.	213	0.46	212	0.47	8	0
2018.	354	5.64	134	0	10	0
2019.	247	5.26	238	0.42	220	0
2020.	183	1.63	15	13.33	4	0
Total	1,367	3.43	907	0.99	247	0

Grilled sausage in 3.43% of samples did not meet criteria of hygiene in the production process due to findings of the total number of microorganisms and the finding of *Escherichia coli* in 0,99% of samples. No *Salmonella spp.* was isolated from grilled sausage samples.

In the period from 2014 to 2020, 2,696 samples of minced meat and 6,939 meat preparations (4,920 kebabs, 652 burgers and 1,367 grilled sausages samples) were examined. Related to the number of isolated pathogen in relation to the tested samples, minced meat was dominant compared to meat preparations, and the reason may be the fact that all semi-finished products had a certain amount of spices and other additives to improve the taste of the products (salt, onion, pepper, etc). Many spices are known to

have antibacterial activity and to have a strong bactericidal or bacteriostatic effect on certain pathogenic bacteria (Zhang et al., 2009). The inhibitory activity of spices was determined against various pathogenic bacteria from food in vitro (Filipović et al., 2016; Filipović et al., 2014; Becerril et al., 2013).

The results indicate a significant risk in terms of spoilage and increase in the number and type of bacteria depending on the origin of the type of meat, as well as the method of storage and packing during market turnover. Poor hygiene practices in meat processing can result in contamination of minced meat and meat preparations with pathogens that could be a serious risk to human health.

Many researchers have examined the bacteriological status and viability of minced meat and meat preparations and the obteined results are different (Belhaj et al., 2018; Erdem et al., 2014).

Microbiological quality of 38 samples of minced meat, 27 samples of kebabs and 35 samples of fresh grilled sausages for the presence of *Escherichia coli* and *Escherichia coli* was determined in a number of less than 10 CFU / g. (Varga et al., 2012).

The results of our study are in agreement with the results of researchers who examined the microbiological safety of fresh meat, burgers and sausages (Belhaj et al 2018; Salem et al., 2018; Bouzid et al., 2015; Yang et al., 2012; Direkel et al., 2010).

The initial number of bacteria in minced meat and meat preparations is very important for the further course of microbiological processes that occur during storage, manipulation or futher processing and the preraration of the same. The temperature at which minced meat and meat preparations are stored is one of the key factors for the safety of the final product (Remenant et al., 2015; Andritsos et al., 2012; Limbo et al., 2010).

CONCLUSION

The reason for the inadequate microbiological quality of minced meat and meat preparations is the findings of aerobic mesophilic bacteria (86.72%), *Escherichia coli* (11.06%) and *Salmonella spp.* (1.93%), were is dominantly unsatisfactory samples of minced meat compared by meat preparations. Microbiological control of minced meat and meat preparations directly participates in the prevention and development of human diseases. In order to produce a safe end product, it is necessary to have hygienically correct primary raw materials. Good production and hygiene practices will enable food to be safe during transport and storage, and not to be a danger to human health. It is necessary to emphasize that even in the condition of proper cooling, processing, transport and storage, the safety of minced meat and meat preparations depends primarily on the initial contamination with pathogenic bacteria.

Conflict of interest statement: The authors declare that there is no conflict of interest.

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