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VARIABILITY OF SELECTED PARAMETERS OF HYGIENIC QUALITY OF FRESH, MARINATED AND GRILLED POULTRY MEAT IN RELATION TO ITS STORAGE CONDITIONS

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ABSTRACT

The aim of research was to verify scientifically variability of selected parameters of hygienic quality of fresh (A), marinated (B-E) and grilled (G) poultry meat in relation to its storage conditions. Marinated meat was kept under various conditions (12 hours and 48 hours at a temperature of 0 to 4 °C and 5 to 8 °C) until it was heat-treated. Using microbiological and physico-chemical methods, poultry meat was analysed in fresh, marinated, as well as grilled state. During the experiment period, water activity, pH, salt, and fat content, but also TVC - total viable count of microorganisms, coliforms, MFF - microscopic filamentous fungi and yeast were analysed. The value of a_w ranged from 0.92 (EG) to 0.99 (AG and D). The range of mean pH values ranged from 5.82 to 6.15. The salt content was lowest in fresh meat (0.16 g/100g), in samples of marinated meat it ranged from 0.38 to 0.47 g/100g. Thus, in neither case was the maximum permitted salt content (1.3 g/100g) exceeded. The difference between the lowest and the highest fat content was very observable. The lowest value of fat content 3.40 g/100g was obtained in the sample AG. On the contrary, the highest fat content (10.24 g/100g) was detected in the sample D. The average TVC value in fresh poultry meat was 4.01 log CFU/g. In marinating process, the value increased to 4.21 log CFU/g (12 hours, 0 to 4 °C) and to 4.65 log CFU/g (48 hours, 5 to 8 °C). Microorganisms were present in number of less than 1.10^1 CFU/g in grilled meat. The number of microscopic filamentous fungi and yeasts was low in fresh meat and marinated meat ($<4.10^1$ CFU/g). After grilling they were not detected. Coliforms indicating the cross contamination were not present in the samples. All the obtained results were statistically evaluated. The data were processed to the analysis of variance (ANOVA) in the general linear models (GLM), Scheffe's test and Pearson correlation coefficients (r_{xy}).

Keywords: poultry meat, marinating, grilling, food safety, analysis

INTRODUCTION

Meat represents very important source of protein in the human diet to serve as a primary ingredient in other main dish. Meat composition is almost the same in red and white meat, except for its fat content **(Jayasena *et al.*, 2013)**. Meat is composed of water, protein and amino acids, minerals, fats and fatty acids, vitamins, and other bioactive components, in addition to small amounts of carbohydrates **(Biswas and Mandal, 2019)**. Poultry is accessible in fresh and frozen form, whole body, non-portioned or portioned. Poultry meat might be boneless, variously spiced, raw or variously processed. Muscles, called breasts when on chest, wings and thighs form a part of the poultry carcase. Poultry meat is overall characterized by low energy value and high nutrient content. Many factors such as type of poultry, genetic factors, feed, agricultural systems, and method of culinary preparation influence some aspects of meat composition **(Bordoni and Danesi, 2017)**. Meat can be prepared by various methods that can be classified under two main categories: 1. dry heat cooking *i.e.*, roasting, broiling, pan- frying, stir-frying and outdoor grilling. 2. moist heat cooking such as braising and cooking in a liquid **(Istrati *et al.*, 2015; Ruiz-Carrasant *et al.*, 2019; Bassam *et al.*, 2022)**. Fat is an important quality parameter, which contributes to the taste and juiciness of meat. Fats in meat exist in two forms (intermuscular and intramuscular fat). By their storage in the muscles, marbling is created. Poultry breast muscle has a low content of overall fat and saturated fat. Majority of poultry fat is stored under the skin. Breast muscle contains more protein, thigh muscle has a higher content of fat and cholesterol **(Gul *et al.*, 2016)**. Food industry increasingly strives to manufacture products with added value reaching a wider spectrum of customers and it aims for the production to be accompanied by relatively low financial inputs. Marinating of raw meat is one of the ways to achieve it **(Mozuriene *et al.*, 2016)**. Marinating is a widespread processing method used for improving the sensory and textural properties such as softness, juiciness, taste, colour, and aroma of food. The acidic or alkaline nature of marinade and antimicrobial or antioxidant activity of some marinade components may have a positive effect on shelf life of prepared meals **(Lytou *et al.*, 2018)**. Marinating is a commonly used method, which includes injection or dipping to disperse a solution of water, salt and other ingredients in marinated meat **(Bianchi *et al.*, 2016)**. Salt is the most important marinade ingredient, which improves the meat structure by increasing meat pH, ionic strength, moisture, softness of meat and actomyosin dissociation. In general, salt is used to improve the taste and softness of meat. Sodium chloride improves the binding properties of poultry meat by increasing the solubility of myofibrillar proteins **(Susanti *et al.*, 2018)**. Other ingredients such as vinegar, lemon juice, wine, salt brine, essential oils, herbs, spices, and organic acids may be present in the marinating solution. Many of them have strong antioxidant and antimicrobial properties due to the content of bioactive ingredients. It is known that organic acids, flavonoids, and polyphenols are commonly used as natural marinade ingredients that are safe for consumer health. Mostly vitamin C and flavonoids have antioxidant functions, while polyphenols have antibacterial functions **(Israti *et al.*, 2015; Susanti *et al.*, 2018)**. Some bioactive substances may even contribute to reducing the production of harmful chemicals. Studies have shown that marinating meat with spices (onion and garlic), beer, wine, and lemon, which are rich in phenolic components, can effectively reduce the levels of polyaromatic hydrocarbons in processed meat **(Wang *et al.*, 2018)**. The composition of the marinade can also significantly contribute to reducing the growth of microorganisms. The nature of microbial communities present on meat is very diverse, depending on the species of the animal from which the meat was obtained and on the subsequent meat processing. Fresh meat is a substrate that provides all nutrients (sugars, amino acids, vitamins) and has pH values and water activity compatible with microbial development. After the initial contamination of raw meat, the number of microbial cells can increase rapidly **(Zagorec and Champomier-Verge, 2017)**. Microbial growth is influenced by storage conditions. Meat storage temperature is considered the most important factor affecting spoilage. In addition to the temperature of stored poultry meat, which should be between 2 and 4 °C, its colour, smell, weigh or consistency must be checked **(Wahyono and Utami, 2018)**. In addition to the temperature of the meat, the microbial growth is also affected by the availability of oxygen. Therefore, depending on their affinity to oxygen, bacteria differ in their competitive growth potential in aerobic and anaerobic conditions **(Casaburi *et al.*, 2015)**. Among the most common causative agents are microorganisms such as *Campylobacter*, *Salmonella spp*., *Escherichia coli* and *Yersinia*. These are basically pathogens that can contaminate raw and processed meat and poultry products, which can lead to

foodborne infections if the products are not properly processed or heat-treated before consumption. The risk is particularly higher if the meat is contaminated with the bacteria *Listeria monocytogenes*, which grown even at refrigerated temperatures **(Graziani *et al.*, 2017; Huang *et al.*, 2019)**. Grilling meat and its effect on the reduction of microorganisms has been reported in several studies **(Baylan *et al.*, 2011; Graziani *et al.*, 2017; Wang *et al.*, 2019; Naser and Ali, 2022)**.

In accordance with the afore mentioned, the aim of the work was to examine the variability of selected parameters of hygienic quality of poultry meat in fresh and marinated state, up to its culinary treatment by grilling.

MATERIAL AND METHODS

Material

In the context of the above objective, the work focused on analysing selected microbiological and physico-chemical parameters of the quality of fresh, marinated, and grilled poultry meat. All processes were continuous, while marinated meat (B-E) was kept under various conditions (12 hours and 48 hours at a temperature of 0 to 4 °C and 5 to 8 °C) until it was heat-treated (Table 1). Chicken breasts weighing 100 g were pounded to approximately the same thickness. The following ingredients were used to prepare the marinade for 100 g of poultry meat: 10 ml of oil, 1 g of garlic, 1 g of red pepper and 0.5 g of salt. A non-contact grill was used for grilling and the heat treatment at 200 °C lasted 4 minutes.

Table 1 Labelling of meat samples

Sample name	
A	Fresh meat
AG	Fresh grilled meat
B	Marinated meat after 12 hours of storage at a temperature of 0 to 4 °C
BG	Marinated meat after 12 hours of storage at a temperature of 0 to 4 °C - grilled
C	Marinated meat after 12 hours of storage at a temperature of 5 to 8 °C
CG	Marinated meat after 12 hours of storage at a temperature of 5 to 8 °C - grilled
D	Marinated meat after 48 hours of storage at a temperature of 0 to 4 °C
DG	Marinated meat after 48 hours of storage at a temperature of 0 to 4 °C - grilled
E	Marinated meat after 48 hours of storage at a temperature of 5 to 8 °C
EG	Marinated meat after 48 hours of storage at a temperature of 5 to 8 °C - grilled

Under the Ministry of Health of the Slovak Republic Decree No. 125/2017, marinated meats belong to semi-finished products and can be stored for a maximum of 48 hours at a temperature of 0 to 4 °C (in Table 1 marked by letter D). In terms of health safety, it is not possible under the mentioned decree to store loaded meats at higher temperatures or freeze them before heat treatment (- 18 °C). These requirements have also been applied in our analyses and have been supplemented by additional storage conditions resulting from the experience of Slovak households.

Methods

During the research, microbiological and physico-chemical analyses were carried out in poultry meat before and after grilling. The experiments were repeated five times independently at different time intervals.

Microbiological indicators of hygienic quality

Total viable cells (TVC), microscopic filamentous fungi (MFF) and coliform bacteria (CB). Plate dilution method was used to determine mentioned microorganisms and the samples were prepared by embedding or smear. A brief description of microbiological determinations is given in the Table 2.

- Determination of coliforms – VRBL agar (Violet Red Bile Lactose). This agar is intended for the reproduction and isolation of growth-demanding bacteria, especially intestinal pathogenic microorganisms. Components of VRBL agar: agar, crystal violet, lactose, sodium chloride, neutral red, yeast extract, bile salts, meat peptone.
- Determination of total viable count of microorganisms – PCA agar (Plate Count Agar). This agar is a non-selective growth medium and is commonly used to monitor total bacterial growth in the sample. Components of PCA agar: agar, glucose, enzymatic casein hydrolysate, yeast extract.
- Determination of microscopic filamentous fungi – DRBC agar (Dichloran Rose-Bengal Chloramfenikol agar). This agar is used as a selective medium to isolate and determine the count of yeasts and filamentous fungi (MFF) found in foods with water activity (a_w) greater than 0.95. Components of DRBC agar: agar, dextrose, dihydrophosphate potassium, magnesium sulphate, dichlorane, bengal red, meat peptone.

Individual culture mediums were prepared by weighing the corresponding amount of dehydrated nutrient soil and subsequently mixing in distilled water. Culture medium (except the VRBL agar) was subsequently sterilized in an autoclave at the temperature of 121 °C, pressure of 120 kPa, for 15 minutes.

Table 2 Methodology for microbiological analysis

Microorganism	Dilution	Volume	Culture medium	Cultivation	Slovak technical norm/ISO
Coliforms	10^{-1}, 10^{-2}, 10^{-3}	1 ml embedding	VRBL agar	30±1 °C, 24 hours	STN EN ISO 4832
TVC	10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}	1 ml embedding	PCA agar	30±1 °C, 72±3 hours	ISO STN 4833
Yeast and MFF	10^{-1}, 10^{-2}	0.1 ml smear	DRBC agar	25±1 °C, 5 days	ISO 7954

Physico-chemical indicators of hygienic quality

Water activity (a_w), pH, salt, and fat content. Measurements of individual parameters were repeated three times in each sample.

- Determination of water activity – FA-st lab device (GBX Scientific ltd).
- Determination of pH – pH meter (Testo). Before each measurement, the probe was cleaned with a disposable cloth and rinsed with distilled water.
- Determination of salt content – Chloride analyser 926 M devise. The devise measures chloride ions in a water solution. A sample volume of 0.5 ml is required for the measurement and the result is shown in mg/l Cl^- or mg % (mg/100ml) NaCl.
- Determination of fat content – Soxhlet devise (JP Selecta). The analysis itself was preceded by drying the meat sample for 12 hours at the temperature of 105 °C.

While determinations of water activity and pH were made directly by measuring on the devices, the salt and fat content were recalculated according to the below formulas.

Calculation of salt content in %:

$$x = A \times 0.0084$$

x = NaCl in %
A = value from the device in mg/l

Calculation of fat content in %:

$$x = \frac{100 \times a}{b}$$

x – fat content in %
a – weight of extracted fat in g
b – weighing of the original sample before drying in g

Laboratory analyses were carried out in the microbiological and physico-chemical laboratory of the Institute of Food Sciences, Faculty of Biotechnology and Food Sciences of the Slovak University of Agriculture in Nitra.

Statistical evaluation

The obtained data were statistically evaluated according to the indicators of descriptive characteristics, i.e., $\bar{x}$ – arithmetic mean and SD – standard deviation, the result of which is information on the accuracy of the measurement. Analysis of variance (ANOVA) was used to compare groups, *i.e.*, the assumption of agreement of variance was verified by the F test (F). Statistical comparison of differences between storage conditions was made using Scheffe´s test. For the results, the p value of the respective achieved statistical significance was evaluated at the selected level of significance $\alpha = 0.05$. The linear relationship between the two variables was tested according to the Pearson correlation coefficient (r). The values of (r) are set between +1 and -1, and a value of 0 means that there is no linear relation between the data in the file. According to **Cohen (1988)** the value (r) between the two variables means: less than 0.1 is trivial dependence, 0.1 to 0.3 is weak dependence, 0.3 to 0.5 is medium dependence and more than 0.5 is strong dependence. The result of the correlation relationship (r) between the two variables was statistically tested at a significance level of $\alpha = 0.05$, $\alpha = 0.01$, and $\alpha = 0.001$. For statistical evaluation of the results was used the SAS program package, version 8.2.

RESULTS AND DISCUSSION

Presence of microorganisms in poultry meat before and after grilling

Under the **Ordinance No. 06267/2006-SL** of the Ministry of Agriculture of the Slovak Republic and the Ministry of Health of the Slovak Republic the TVC assessment in terms of microbiological criteria for pre-prepared and prepared meals is not stated. However, Chapter 4, second part of the Foodstuffs Code stipulates that the complete absence of the total number of microorganisms is the condition for commercial sterility. This information may be considered inaccurate and misleading in relation to other types of microorganisms referred to in the legislation. In practice, operators therefore set their own limits for TVC. It must be noted that although the determination of total count of microorganisms is not strictly intended for both pre-prepared and prepared meals, we wondered how many of these microorganisms would be present in the analysed meat samples.
Average value of TVC in fresh poultry meat was 4.01 log CFU/g, which is in accordance with maximum permitted value of TVC 5.10^5, i.e. 5.70 log CFU/g under the **Commission Regulation (EC) No. 1441/2007** of 5 December 2007 amending Regulation (EC) No 2073/2005 on microbiological criteria for foodstuff. **Kačániová *et al.* (2021)** tested microbiological quality of chicken breast Sous vide meat and in first day of analysis was TVC 5.24 log CFU/g.

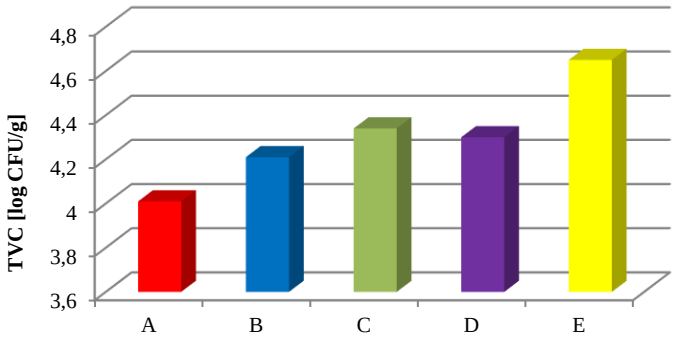

Figure 1 Evaluation of TVC in poultry meat samples before grilling

In the process of marinating the value increased to 4.21 log CFU/g (B: 12 hours, 0 to 4 °C) and to 4.65 log CFU/g (E: 48 hours, 5 to 8 °C). In the sample representing the legislative requirements in terms of storage conditions (sample D) the total viable count of microorganisms was at the level of 4.3 log CFU/g (Figure 1). A microbiological analysis of grilled marinated meat (BG, CG, DG and EG) found that fewer than 10 specific colonies ($<1.10^1$ CFU/g) grew on Petri dishes. The results have also shown that despite a slight increase of TVC in marinated meats, microorganisms were inactivated during the grilling process. Statistical analysis using the Sheffe's test has shown that comparable conditions of storage of marinated meat up to the time of heat treatment had no effect on TVC of marinated grilled meat (P>0.05).
The average value of TVC in the study of **Szosland-Faltyn *et al.* (2014)** was in the range of 5.87-7.47 log CFU/g. This level of microbial contamination is consistent with **Wang *et al.* (2019)**, who found the presence of TVC in poultry meat at a level of 6.8 log CFU/g. Higher amounts of TVC were detected in all samples of marinated meat. The reason for this may be the use of spices, which can be a source of microbial contamination. Marinades prevent the growth of unacceptable microorganisms due to their low pH, high level of salts, sorbates, benzoates, and varied spices. The antibacterial activity of marinades depends on several factors, such as pH and temperature **(Karam *et al.*, 2019)**. As for marinades with a relatively high pH (pH>4.5), these may have a positive effect on the overall sensory quality of the final product, but no effective slowdown in the growth of microorganisms is guaranteed. In contrast, marinades with a lower pH can slow down microbial growth, but often lead to undesirable changes in sensory and nutritional terms. The research should focus on the inclusion of new ingredients that could lead to the improvement of the microbial, nutritional, and sensory quality of meat products **(Lytou *et al.*, 2018)**. Food contamination with microscopic filamentous fungi and yeast is a very useful indicator for evaluating the food quality. Microscopic filamentous fungi commonly contaminate meat and meat products and cause spoilage by producing mycotoxins that can cause liver damage and food poisoning in humans **(Zakki *et al.*, 2017).**
As shown in Table 3, the presence of these types of microorganisms in fresh poultry meat samples was recorded in the amount of $<1.10^1$ CFU/g, or $<4.10^1$ CFU/g. The count of CFU $<4.10^1$ per gram was detected mainly in marinated meat stored at the temperature of 5 to 8 °C (E). After grilling, neither microscopic filamentous fungi, nor yeasts were found in any of the meats. It can be assumed that the absence of microscopic filamentous fungi in meat samples indicates the strict observance of hygienic conditions in every step of processing. Also, the processed meat was not contaminated with any component of the marinade. The absence of yeast in heat-treated meat (AG, BG, CG, DG, EG) may have been influenced by the effect of garlic, which was part of the marinade.

Table 3 Evaluation of MFF and yeast in poultry meat samples before and after grilling

Amount of microscopic filamentous fungi in meat samples [CFU/g]										
Analysis order	**A**	**AG**	**B**	**BG**	**C**	**CG**	**D**	**DG**	**E**	**EG**
1.	<4/d	<4/d	<1/d	<1/d	<4/d	<1/d	<1/d	<1/d	<4/d	<1/d
2.	<4/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<4/d	<1/d
3.	<4/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d
4.	<4/d	<1/d	<4/d	<1/d	<4/d	<1/d	<1/d	<1/d	<1/d	<1/d
5.	<4/d	<1/d	</d	<1/d	<1/d	<1/d	<1/d	<1/d	<4/d	<1/d
Amount of yeast in meat samples [CFU/g]										
Analysis order	**A**	**AG**	**B**	**BG**	**C**	**CG**	**D**	**DG**	**E**	**EG**
1.	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<4/d	<1/d
2.	<4/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<4/d	<1/d
3.	<1/d	<1/d	<1/d	<1/d	<4/d	<1/d	<1/d	<1/d	<4/d	<1/d
4.	<1/d	<1/d	<4/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d	<1/d
5.	<1/d	<1/d	<1/d	<1/d	<4/d	<1/d	<1/d	<1/d	<4/d	<1/d

Legend: $<1/d = <1.10^1$ CFU/g, $<4/d = <4.10^1$ CFU/g

Shuford *et al.* (2005) confirm the inhibitory effects of garlic on yeasts that are attributed to allicin. This sulphur-containing compound is formed in fresh cloves of garlic in the amount of 3 to 5 mg/g. Filamentous micromycetes and yeasts do not form the predominant part of the meat microflora. Spices added to the marinade can significantly contribute to the contamination. Research of **Szosland-Faltyn *et al.* (2013)** suggests that used marinades have very little effect on the detected counts of filamentous micromycetes and yeasts. The same results were recorded by **Ismail *et al.* (2000)**. Contamination with filamentous micromycetes and yeasts usually occurs because of meat handling, processing, and packaging. Another reason may be washing the meat with contaminated water, air and temperature fluctuations during transport and storage **(Sharaf and Sabra, 2012)**. Similarly, **Zakki *et al.* (2017)** confirm that the contamination of meat occurs due to poor hygiene conditions at the slaughterhouses and poor personal hygiene of workers handling the meat. It was also found that the thigh muscle has a higher microbial load compared to the breast muscle of poultry meat.
The last microorganisms observed in fresh, marinated, and grilled meat were coliform bacteria. It is commonly known that they are the main indicator of faecal pollution, or their presence indicates cross contamination. Their occurrence was not recorded in any of the analysed samples.

Determination of a_w, pH, salt, and fat content in poultry meat before and after grilling

Meat is a biological material, in which biochemical processes take place very complexly and many of them are not yet sufficiently explored. These processes create substances that can interact synergistically or antagonistically, in other cases they can function as precursors. During meat storage, it undergoes maturation, gradual autolysis and later even proteolysis, which also results in a change of the reaction environment (change in pH, water activity) **(Tkáčová and Angelovičová, 2013)**. Water activity serves not only as a useful indicator of microbiological stability of food, but also as an indicator of sensory properties of food. Water activity is also an important indicator of chemical stability. This parameter helps to control the course of non-enzymatic reactions in food **(Maneffa *et al.*, 2017).**
Our results have shown that in poultry meat samples – fresh, marinated, and grilled, the average water activity values ranged from 0.96 to 0.98 (Figure 2). The lowest value of a_w (0.92) was measured in a sample of marinated meat after 48 hours of storage at the temperature of 5 to 8 °C – grilled (EG). On the contrary, the highest value of a_w (0.99) was found in fresh grilled meat (AG) and marinated meat after 48 hours of storage at the temperature of 0 to 4 °C (D). Meat samples after heat treatment (AG, BG, CG, DG, EG) did not show a significant difference in a_w value compared to the samples of fresh meat (A) and marinated meat stored under different conditions until heat treatment (B, C, D, E). The variation coefficient ranged from 0.26 to 1.71 %. Statistically significant differences (P<0.05) were found only in two cases – between marinated grilled meat (EG: 48 hours, 5 to 8 °C) and fresh meat (A) or marinated grilled meat (BG: 12 hours, 0 to 4 °C). There was a statistically insignificant difference between the other samples (P>0.05). **Durack and Alonso-Gomez (2012)** classified meat as a rapidly perishable food based on water activity value. **Mani-López *et al.* (2012)** report that average values

of fresh meat water activity range in the interval of 0.98±0.01. Similar values of water activity have also been measured in our samples. **Casaburi *et al.* (2015)** state that the course of pH changes in poultry meat is dependent on the storage temperature, whereas when stored at the temperature of 4 °C, the pH of meat was satisfactory until the fifth storage day. Meat stored at the temperature of 22 °C had a faster increase in pH values, from which it can be assessed that the temperature is a limiting factor during meat spoilage. **Maní-Lopez *et al.* (2012)** report that the average pH value of fresh meat ranges from 5.5 to 6.5. In another study **Sharaf and Sabra (2012)**, have reported that the pH value of fresh poultry meat ranged from 6.0 to 6.2. Marinating and decreasing pH value of the marinade had no significant effect on the reduction of pH values of the meat core. High pH values of meat create conditions for faster bacterial degradation of meat even though the meat is stored at refrigerated temperatures **(Milicevic *et al.*, 2015)**.

The results of our analyses have shown that the average pH values ranged from 5.82 to 6.15 (Figure 2). The highest value (6.30) was recorded in the sample of marinated grilled meat after 48 hours of storage at the temperature of 5 to 8 °C (EG). The lowest value of pH (5.53) was recorded in the sample of fresh meat (A). The variation coefficient ranged from 0.65 to 3.85%. Statistical analysis according to the Scheffe's test has shown that the individual methods of storage and processing of meat did not affect the increase or decrease of the pH of meat (P>0.05).

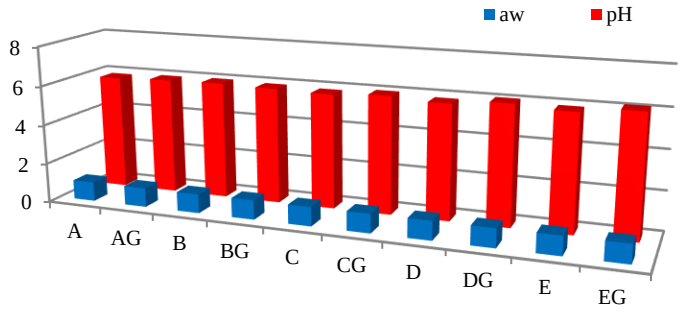

Figure 2 Average value of a_w and pH in poultry samples depending on storage conditions

Salt is one of the essential ingredients of the marinade. It is one of the oldest and most used preservatives. Adding salt to the marinade will improve the taste of the product, inhibit the growth of *Clostridium botulinum*, and increase moisture retention. The antimicrobial effects of salt are based on its ability to lower water activity. The salt effect on microorganisms depends on the salt portion in the water phase of food **(Alvarado and McKee, 2007)**. The amount of salt to be added to the marinades is determined by the taste of the final product, because at a high concentration it already has an adverse effect on the finished product. In meat preparations, the salt concentration ranges approximately from 1.5 to 2% to allow the extraction and solubilisation of myofibrillar proteins and in marinades it usually ranges from 4 to 10% **(Susanti *et al.*, 2018)**. In their study, **Petracci and Baéza (2011)** found a direct influence of salt content in poultry meat on increasing its pH. A significant effect of adding salt on the pH of the meat was found even with addition of 0.2% salt to meat.

The salt content was the lowest in fresh meat (0.16 g/100g), in individual samples of marinated meat it ranged from 0.38 to 0.47 g/100g. In no case was the maximum alowed salt content (1.3 g/100g) exceeded. Statistical analysis according to the Scheffe's test revealed that, depending on the conditions of meat storage and processing, there was a statistically significant difference (P<0.05) only between fresh meat (A) and other samples. Statistical significance was not confirmed between marinated and grilled samples (P>0.05).

Poultry fat is characterized by a higher content of polyunsaturated fatty acids than the fat of other slaughter animals. It is these fatty acids that are subject to the most oxidative changes that worsen the organoleptic properties and the shelf life of food **(Tkáčová and Angelovičová, 2013)**. The lowest value (3.40 g/100g) was recorded in the fresh grilled meat (AG). The highest value (10.24 g/100g) was recorded in the marinated meat sample after 48 hours of storage at the temperature of 0 to 4 °C (D). Figure 3 shows that there are significant differences between average values of fat content. Average values ranged from 3.90±0.32 to 9.18±1.02 g/100g. Compared to fresh and marinated meat (A, B, C, D, E), grilling decreased the fat content in meat. The juice, and therefore fat from the meat, was released during grilling.

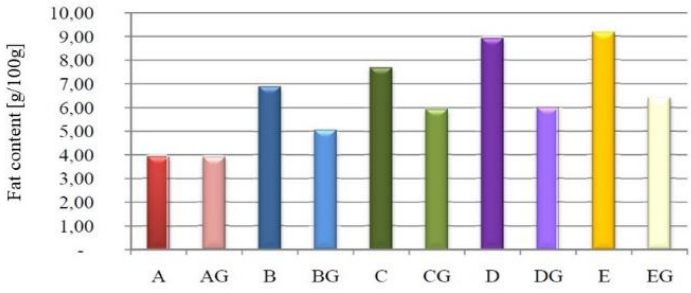

Figure 3 Average fat content in poultry meat samples

Depending on the method of meat storage and processing, a statistically significant difference (P<0.05) between fresh meat (A) and marinated meat was observed after 12 hours of storage at the temperature of 5 to 8 °C (C). A statistically significant difference was also found between A and D; between A and E; between BG and D; between BG and E. There was no statistically significant difference between the other samples (P>0.05).

Table 4 Statistical evaluation of differences in fat between different conditions of meat storage and processing

F test	**7.67^{+++}**								
Indicator	**AG**	**B**	**BG**	**C**	**CG**	**D**	**DG**	**E**	**EG**
A	-	-	-	+	-	+	-	+	-
AG		-	-	-	-	-	-	-	-
B			-	-	-	-	-	-	-
BG				-	-	+	-	+	-
C					-	-	-	-	-
CG						-	-	-	-
D							-	-	-
DG								-	-
E									-

-: Statistically insignificant difference according to Scheffe's test (P>0.05) +: Statistically significant difference according to Scheffe's test (P<0.05)

Rusin *et al.* (2019) analysed PCDDs, PCDFs, PCBs in locally produced foods as health risk factors in Silesia Province, Poland. They also analysed the fat content in poultry meat from different EU countries. He found that the poultry meat from the Czech Republic had a fat content ranging from 1.57 to 2.6%, meat from Germany had a fat content ranging from 0.02 to 1.53% and meat from Poland had a fat content ranging from 0.12 to 3.33%. According to the available literature, the average fat content in poultry meat ranges from 2 to 4%.

Table 5 Correlation relationships between indicators a_w, pH and salt in fresh/marinated meat (A, B, C, D, E) and in grilled meat (AG, BG, CG, DG, EG)

Sample		**A**			**B**	
		pH	**salt**		**pH**	**salt**
	a_w	-	-	**a_w**	0.66^{-}	-0.85^{++}
	pH		-0.32^{-}	**pH**		-0.27^{-}
Sample		**AG**			**BG**	
		pH	**salt**		**pH**	**salt**
	a_w	-0.06^{-}	-0.65^{-}	**a_w**	0.80^{+}	-0.40^{-}
	pH		0.68^{-}	**pH**		-0.66^{-}
Sample		**C**			**D**	
		pH	**salt**		**pH**	**salt**
	a_w	-0.36^{-}	0.58^{-}	**a_w**	0.37^{-}	-0.79^{+}
	pH		-0.57^{-}	**pH**		-0.45^{-}
Sample		**CG**			**DG**	
		pH	**salt**		**pH**	**salt**
	a_w	-0.40^{-}	-0.56^{-}	**a_w**	-0.04^{-}	0.49^{-}
	pH		0.91^{++}	**pH**		0.43^{-}
Sample		**E**				
		pH	**salt**			
	a_w	-0.70^{-}	-0.33^{-}			
	pH		-0.20^{-}			
Sample		**EG**				
		pH	**salt**			
	a_w	-0.57^{-}	-0.55^{-}			
	pH		0.71^{-}			

r_{xy} value:
+++: Statistically very highly significant difference between variables (P<0.001)
++: Statistically highly significant difference between variables (P<0.01)
+: Statistically significant difference between variables (P<0.05)
-: Statistically insignificant difference between variables (P>0.05)

Even more interesting were the results of the correlation analyses between indicators a_w, pH and salt within individual combinations of prepared meat samples. Table 5 shows that between water activity, in which almost the same values were measured, and other indicators, there was found mostly negative linear relationship of various intensity, statistically insignificant (P>0.05). Only in the case of samples B, BG, D and DG other types of linear relationships were recorded with statistical significance.

Every producer, distributor and seller of food products should prioritize high-quality, fresh, and safe food in terms of health. Meat is a risky commodity and is associated with many food scandals. Since meat as a rich source of nutrients is a part of the daily diet of people and its consumption is constantly increasing, greater attention should be paid to its safety.

CONCLUSION

One of the current trends in gastronomy is marinating and grilling meat. The aim of the work was to examine the variability of selected parameters of hygienic quality of poultry meat in fresh and marinated state, up to its culinary treatment by grilling. Under the Decree of Ministry of Health of the Slovak Republic No. 125/2017 on requirements for catering facilities, the meat intended for grilling must be stored for a maximum of 48 hours at a temperature of 0 to 4 °C. Performed microbiological analyses of meat have shown that the temperature range from 0 to 4 °C is truly the most suitable one and it also respects the requirements for storage of fresh poultry meat, but in terms of storage we have achieved better microbiological quality results at 12 hours. However, from a culinary point of view, this period is not sufficient for the penetration of substances from the marinade into the meat. It is therefore necessary to find in practice such a combination of temperature and time conditions, so that both hygienic and culinary criteria are met, respecting the legislative regulations. The results have also shown that the combination of marinating and grilling is among the most effective methods of inactivating microorganisms. An important factor is the very composition of the marinade and the grilling conditions. In general, it is necessary to carry out official controls of meat at every stage of its processing. Especially because of the latest cases with poultry meat. In addition to official controls, self-controls by meat producers and processors, as well as operators of catering facilities, should be carried out more often. No less important is the education of the population in the handling of poultry meat.

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