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Honey as a component of marinade for semi-finished meat products

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Abstract. The specific features of the biochemical composition and properties of raw meat determine the necessity of finding new technologies for its processing to obtain new products with high consumer properties. The actual area of technology development is the enrichment of raw meat with useful components with functional and technological properties that have high biological value: api products and products of plant origin.The purpose of the work was to develop a marinade with the addition of honey and to explore its effect on the semi-finished meat product, depending on the duration of marinating. Selection of samples for investigations and their preparation for analysis was performed according to GOST 4288-76 "Culinary and semi-finished products of minced meat. Acceptance rules and test methods", organoleptic examinations were performed according to DSTU 4426:2005**,** moisture content determination – GOST 9793-74 "Meat products. Methods for determination of moisture", the amount of fat – for GOST 23042-86 "Meat and meat products, "Methods for determination of fat", the amount of protein – GOST 25011-81 "Meat and meat products. Methods for determination of protein", determination of ash content – GOST 31727-2012 "Meat and meat products. Determination of mass fraction of total ash", determination of pH – GOST 26188-84 "Products of fruits and vegetables processing, canned meat and meat. Determination of pH", and determination of fibre-forming and fibre-retaining properties were performed through sample preparation and determination of fibre content. According to the scheme of the experiment, the research technology was determined. The research results of the initial raw meat, honey and marinated semi-finished product are presented in the study. It was established that the decrease in the pH of the marinated semi-finished product during the 24-hour exposure period ensures the stability of the meat to storage, as most bacteria develop at high pH values, while on acidic nutrient media below 6.2, their development is slowed down. Long marinating allows obtaining meat with increased moisture binding and moisture retention capacity and improved consistency and juiciness. The task of establishing new products requires new approaches and techniques of technology. Using apiproducts that have antioxidant properties will

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allow refraining from using preservatives and stabilisers of chemical origin. Thus, honey can be used in the composition of marinated meat products. The introduction of active components of honey into the marinade will extend the shelf life and adjust the organoleptic properties. In addition, during heat treatment, the meat marinated with honey marinade acquires new taste qualities, and the appearance becomes brighter due to the caramelisation of honey

Keywords: safety, components, method and duration of pickling, organoleptic and physicochemical parameters, natural antioxidants

Introduction

Providing the country's population with quality and safe products is of particular relevance in modern environmental realities and for strengthening immunity. In performing this task, an important role is played by the successful development of agriculture and high-quality production of meat raw materials and its further industrial processing. The actual area of technology development is the enrichment of raw meat with useful components with functional and technological properties that have high biological value: api products and products of plant origin (Zharinov *et al.*, 2016).

The current consumption of meat products requires a variety of new assortment of semi-finished products, which is explained by the fact that the priority is determined by the speed of cooking, availability and shelf life of food, and the usefulness and availability of antioxidant properties of food products (Gotsik & Bandurenko, 2012; Wie'k A. *et al.*, 2020).

The deterioration of the environmental situation, deformation of the diet and excessive consumption of products with carcinogenic substances pose a significant threat to the health of the population of Ukraine. Therefore, improving the range of food products, in particular, portioned semi-finished products with high nutritional and biological value is quite relevant.

To diversify the range of meat products, and to provide them with new nutritional and taste qualities, various processing processes are used, which result in new types of meat products (Kim *et al.*, 2010; Semenchenko, Nefedova & Savinova, 2013).

Currently, scientists have established a large number of technologies for the preparation of semi-finished meat products, using different types of marinades, since marinated semi-finished products have a longer shelf life and high yield after heat treatment (Balyabina *et al.,* 2016; Merenkova & Lukin, 2016). In addition, marinated meat becomes more tender and juicy, which facilitates the digestion and absorption of the maximum amount of nutrients contained in it by the body (Jinap *et al.*, 2015; Shamsudin *et al.*, 2020). Thus, in studies (Tänavots *et al.*, 2018) it was established that after the stage of marinating pork in the honey-mustard marinade with its subsequent cooking, the product became softer and more tender compared to the product cooked in vinegar-containing (white wine) marinade. In addition, the semi-finished product marinated in the honey-mustard marinade was characterised by a high yield of the finished product.

The main types of additives in marinades are: vinegar, wine materials, citrus juices, soy sauce, mayonnaise. Each of these components has its drawbacks. For example, vinegar helps to soften the structure of muscle fibres of the meat, but there is a decrease in the brightness of the taste of the finished product, with the appearance of a slightly sour taste (Seong *et al.*, 2012; Serdaroğlu *et al.*, 2007; Żochowska-Kujawska *et al.*, 2012). Marinade based on soy sauce has a spicy but quite salty and very spicy taste; allergic reactions are possible.

Mayonnaise significantly increases the nutritional and energy value of the semi-finished product (Toleubekova *et al.*, 2020). Marinades made with non-conventional products can be spicy, savoury, sour, sour-sweet, sweet, exotic, fruity and flavoured with spices. Marinades with the addition of honey are particularly bright.

In previous studies (Alzahrani *et al.*, 2012; Yücel *et al.*, 2005) of the physicochemical and organoleptic properties of meat products and semi-finished products, it was proved that the combination of meat and honey has an interesting and promising nature of research. After all, using bee products in the marinade provides the meat with new technological and taste properties.

Honey is most widely used in the production of lactic acid products: yoghurts, and curd desserts. In addition, using of beekeeping products found itself in the production of salted fish and caviar products, as an alternative to synthetic preservatives, the foundation for the production of environmentally friendly, organic products.

According to the literature on physicochemical and quality indicators, honey has therapeutic value due to the nature of carbohydrates and the content of pollen grains. It promotes the normalisation of metabolism and the strengthening of immunity. Useful substances contained in it contribute to normalising the acidity of gastric juice and improving digestion. Honey has a positive effect on the nervous system and improves the quality of sleep. For diabetics and those with high blood cholesterol, honey successfully replaces sugar. Regular consumption of honey significantly improves performance, thus, it should be consumed by patients, athletes and anyone who works physically (Iliaab *et al.*, 2021).

Literature data suggest that honey, used alone or as an auxiliary ingredient, may be a potential natural antioxidant (Ahmed *et al.*, 2019). Thus, the development of new recipes for marinades with the addition of honey and their use in the production technology of semi-finished meat products will allow both to diversify the taste of conventional products and to increase their nutritional value.

It is proven that numerous natural products, in particular honey, reduce the oxidation process of meat. Such antioxidant activity can reduce potential carcinogenic substances. Antimicrobial activity can inhibit the establishment of biogenic amines produced during microbial growth (Lee *et al.*, 2020).

The development of heterocyclic amines, in particular, in chicken meat, was explored by Jinap *et al.* During their research, it was determined that using tamarind in marinades with honey reduces the content of heterocyclic amines.

Regarding the requirements of national and international standards for honey quality and safety, in addition to compliance with organoleptic and physicochemical parameters, the content of antibiotic residues should be monitored (Kumar *et al.*, 2020; Khamid, Pushkar & Hurko, 2020).

The study (Benzik *et al.*, 2020) was designed to explore the impact of the pickling process on the quality of the newly designed food product. The influence of marinating and the duration of heat treatment on the quality of product samples was explored. According to the results of the experiments, the optimal composition of the marinade is proposed.

Quality meat products with high biological value will be quite competitive, which is an integral part of the development and prosperity of any enterprise in the food industry and catering.

The purpose of the study was to develop a marinade with the addition of honey and to explore its effect on the semi-finished meat product depending on the duration of marinating (2 and 24 hours).

Material and Methods

The research was conducted in the laboratory of the Department of Meat, Fish and Seafood Technology of the National University of Life and Environmental Sciences of Ukraine.

Beef hips and marinades based on different types of honey were chosen for the study: goldenrod – crystallised and dense, and citrus – transparent with a liquid consistency. According to organoleptic indicators, the varieties of honey corresponded to the requirements of DSTU 4497:2005 "Natural honey. Specifications", according to the type of plants from which they were collected, had the aroma and taste inherent in this variety and did not contain mechanical impurities and signs of fermentation. According to the scheme of the experiment, the following technology was performed: the meat semi-finished product was pre-incubated in a marinade of oil, honey, salt, pepper and a mixture of herbs for 2 and 24 hours, followed by baking at a temperature of 180°C. There were 5 experimental samples and 1 control in which honey was used in the following proportions (Table 1):

Table 1. *The ratio of honey in the marinade*

Sample number	Honey type	%
c	-	-
1s	Citrus	10
2s	Citrus	20
3s	From goldenrod	10
4s	From goldenrod	20
5s	Citrus + from goldenrod	20 (10 each)

Sampling for organoleptic and physicochemical studies and their preparation for analysis was performed according to GOST 4288-76 "Culinary products and semi-finished products from minced meat. Acceptance rules and test methods".

- organoleptic studies were performed according to DSTU 4426:2005;

- determination of moisture content – GOST 9793-74 "Meat products. Methods of moisture determination";

- fat content – according to GOST 23042-86 "Meat and meat products Methods of determination of fat";

- protein content – GOST 25011-81 "Meat and meat products. Methods of protein determination";

- determination of ash content – GOST 31727-2012 "Meat and meat products. Method the mass fraction of total ash";

- pH – GOST 26188-84 "Fruit and vegetable products, tinned meat and canned meat. Determination of pH";

- determination of moisture-binding and moisture-holding capacity was performed by pressing the samples and the release of free moisture, further calculated using the appropriate formulas.

$$MBC = \frac{(A-B\times 8{,}4)}{A} \times 100$$

where, MBC- moisture binding capacity, %; A – total moisture content in bulk, %; 8.4 – constant, which means the amount of moisture retained by 1 cm^3 filter paper; B – wet spot area, cm^2.

Moisture-holding capacity (%):

$$MHC = \frac{(A-B\times 8{,}4)}{M} \times 100$$

where, MHC – moisture holding capacity of meat, %; A – total moisture in the meat sample, mg; 8.4 – constant, which means the amount of moisture retained by 1 cm^3 filter paper; B – wet spot area, cm^2;

Results

In the course of the research, it was established that the physical and chemical parameters of the initial meat raw materials corresponded to the requirements of the state standard (Table 2). The results of the physicochemical parameters of honey research are presented in Table 3. Analysing the data obtained, it was established that the physicochemical parameters of honey corresponded to the requirements of the highest grade of DSTU.

Table 2. *Physicochemical parameters of beef meat*

Indicator	Experimental sample	According to DSTU 4426:2005
Active acidity, pH	6.00±0.03	5.6-6.5
Mass fraction of moisture, %	69.8±0.2	67.7-70.5
Mass fraction of ash, %	0.91±0.10	1.0
Mass fraction of protein,%	17.5±0.1	18.9
Mass fraction of fat,%	11.2±0.3	12.4
Moisture-holding capacity, %	65.31±0.05	65-67

Table 3. *Main physical and chemical parameters of honey quality*

Indicator	DSTU (Top quality)	Goldenrod honey	Citrus honey
Pollen analysis result	presence of pollen grains	Present	Present
Species composition of pollen grains, % not less	10.0	35.6	41.2
Mass fraction of water, %, no more than	18.5	16.3	17.1
Mass fraction of reducing sugars, %, not less than	80.0	88.4	81.7
Mass fraction of sucrose, %, not more than	3.5	3.5	3.0
Diastasis number, Gote units (Schade units for EU countries), not less than	15.0	16.3	4.1
Hydroxymethylfurfural content, mg/kg, not more than	10.0	7.2	7.4
Acidity, milliequivalents of sodium hydroxide per 1 kg, not more than	40.0	39.1	34.5
Electrical conductivity, mS/cm	0.2-0.1	0.1	0.09
Proline content, mg/kg	300	299	298

In addition, the diastase number of citrus honey, according to the state standard, this figure should not be less than 15 units of Gothe, while according to Directive 2001/110/EC (Council Directive 2001/110/EC, 2001) for citrus honey should be at least 3.0 units Gothe. Whereas the sample of citrus honey in terms of diastase number was 4.1 units of Gothe.

Thus, having examined the organoleptic and physicochemical characteristics of beef and honey varieties used for marinating, it can be concluded that all the requirements of the raw materials corresponded to the quality indicators.

Analysing the methods of marinating meat, for 2 and 24 hours, the observed decrease in the pH of the marinated semi-finished product during the ageing period up to 24 hours indicates the stability of the meat to storage, as most bacteria develop at high pH values, while on acidic nutrient media below 6.2, their development slows down (Fig. 1). The obtained results are confirmed by scientific research of foreign scientists (Yusop *et al.*, 2010)

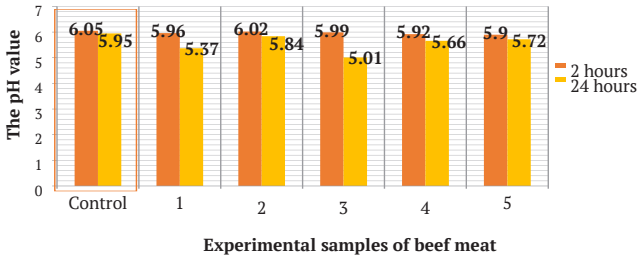

Figure 1. Effect of ageing time on pH change in samples of beef meat

According to the results of determining the physicochemical parameters (Tables 4, 5), it was established that the addition of honey to the marinade increases the protein content in the samples being studied, best of all in samples No. 2 by 0.16 and No. 5 by 0.23 for storage for 2 hours and, respectively, by 0.66% and 0.69% after storage for 24 hours, compared to the control sample. Indicators such as the mass fraction of ash did not vary significantly in all the experimental samples, but the fat content, on the contrary, did not significantly, but increased in all samples, due to sunflower oil, which was part of the marinade.

Table 4. *Physicochemical parameters of portioned semi-finished products in the marinade for 2 hours, %*

Indicator	Characteristic					
	Control	No.1	No.2	No.3	No.4	No.5
Mass fraction of moisture	69.14	70.58	69.84	68.95	68.49	68.05
Mass fraction of fat	12.65	11.31	11.83	12.72	13.25	13.74
Mass fraction of protein	17.30	17.43	17.46	17.45	17.39	17.53
Mass fraction of ash	0.91	0, 88	0.87	0.88	0.87	0.88
Mass fraction of table salt	1.63	1, 61	1.66	1.65	1.62	1.64

Table 5. *Physicochemical parameters of portioned semi-finished products in the marinade for 24 hours, %*

Indicator	Characteristic					
	Control	No.1	No.2	No.3	No.4	No.5
Mass fraction of moisture	69.02	69.61	69.04	67.70	67.32	67.81
Mass fraction of fat	12.72	11.95	12.08	13.49	13.94	14.27
Mass fraction of protein	17.35	17.56	18.01	17.93	17.86	18.04
Mass fraction of ash	0.91	0.88	0.87	0.88	0.88	0.88
Mass fraction of table salt	1.69	1.73	1.81	1.80	1.88	1.78

Thus, the process of marinating increases the hydration and solubility of muscle tissue proteins, due to the accumulation of free myosin (the most moisture-binding protein of meat).

According to the research results of the moisture retention capacity of the marinated semi-finished product during 24 hours of exposure, it was established that this indicator is 1.09 times higher than the samples marinated for 2 hours. Therewith, the moisture binding capacity was 1.6 times higher. As a result, meat with increased moisture binding and moisture holding capacity acquired improved consistency and juiciness. In addition, these results are confirmed by the research of other scientists (Aktaş *et al.*, 2003).

In addition, as a result of the research, it was established that the moisture-binding capacity of beef meat without the addition of honey (control sample) was 49.86%, which is 1.15 times less than the average value of other samples after 24 hours of exposure to the marinade. When marinated for 2 hours, the control sample (without the addition of honey) was 1.64 times less in terms of the value of the MBC compared to the samples marinated with the addition of honey. Thus, with the addition of honey, the moisture binding and moisture holding capacity increases compared to the control, which provides the finished product with taste, smell and colour.

Several physical and chemical changes occur in marinated semi-finished meat products during refrigeration storage: hydrolytic and oxidative changes of oil. The products of these reactions become integral components of meat. Due to the heating of semi-finished products, secondary lipid oxidation products can be generated, which poses

a serious health hazard (Wie˛k *et al*., 2020). It is essential to compose the marinade ingredients in such a way as to minimise these processes.

During the manufacture of semi-finished pork products, the effect of the mustard-honey marinade was determined in comparison with marinades containing apple cider vinegar, white wine vinegar and kefir. The mustard-honey marinade retained the original pH during the ageing period compared to raw meat samples. A significant decrease in pH value in samples treated with apple and white wine marinade ($P<0.05$). The lowest losses during heat treatment were in the samples of mustard-honey marinade. In addition, semi-finished pork products where mustard-honey marinade was used were softer after cooking (Tänavots *et al*., 2018).

The study (Meretukova and Abregova, 2021) determined the effect of marinating and cooking with sous-vide technology, compared to conventional methods, on the quality characteristics of the finished product and shelf life. Pickling, in particular, in vacuum packaging and the proposed method of heat treatment can significantly increase the shelf life of the semi-finished product and improve its taste while maintaining microbiological purity.

To accelerate and improve the absorption of the marinade in semi-finished meat products, in particular pork chops, high-pressure treatment is used. In addition, from a microbiological standpoint, high-pressure treatment, namely at 300, 400 or 500 MPa, extended the shelf life by 16, 22 and 29 days, respectively. The results demonstrated that high-pressure treatment ⩾400MPa increased ($P<0.05$) marinade absorption, which enhanced the organoleptic performance of marinated semi-finished products (O'Neill *et al*., 2019).

Conclusions

The expediency and efficiency of using natural honey in the technology of marinating semi-finished meat products have been theoretically substantiated and experimentally confirmed. It was confirmed that the samples of honey and meat raw materials chosen for the research comply with the requirements of the current regulatory documents.

It was established that when the meat is marinated for 2 hours, the pH value does not change, and after 24 hours it decreases by only 0.13-0.63 units, depending on the type of honey used.

It was established that for marinating for 24 hours, the value of the MHC was 1.09 times higher than the samples marinating for 2 hours on average, while the MBC was 1.6 times higher. As a result, meat with increased moisture binding and moisture holding capacity acquired improved consistency and juiciness.

Based on the results obtained, the area of further research was established, namely, to establish the basic indicators of organoleptic characteristics of the finished product, to determine the complex indicator of the quality of the finished product after baking, and to determine the nutritional and biological value of the products.

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