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JUSTIFICATION OF THE USE OF OSTRICH MEAT IN THE TECHNOLOGY OF CHOPPED MEAT PRODUCTS

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Abstract. The article gives theoretical reasons for, and describes the prospects of using ostrich meat in the technology of special purpose chopped meat products. It has been shown that ostrich meat is higher in protein and lower in cholesterol than other traditional types of meat raw materials. The results of the experimental research of the technological properties of ostrich meat are presented. The pH and water activity of the extracts of chopped meat have been investigated as well as the water-binding capacity, water molecular mobility, and the degree of penetration of chopped meat. It has been determined how much of their mass semi-processed chopped meat products lose during heat treatment. The organoleptic quality parameters of chopped meat products from beef and ostrich meat have been analysed. It has been established that the active acidity of ostrich meat is by 6.4% higher than that of beef, while the difference between the water activities of ostrich meat and beef is insignificant. The research results have allowed establishing that due to a higher protein content, the water-binding capacity of ostrich meat is higher by 5.7%, and its degree of penetration is higher by 10.8%. The results of studying the water molecular mobility in the raw materials investigated have allowed confirming that there is a greater amount of bound water in ostrich meat than in beef. It has been found that the maximum shear stress (the yield value) and the water-binding capacity of the samples of meat raw materials investigated are inversely proportional, and that there is a strong correlation between them. It has been established that mass losses of semi-processed chopped ostrich meat products are almost 20% lower during heat treatment than of those made from beef. The results of laboratory testing of the recipes of chopped beefsteaks from ostrich meat and beef taken in different proportions are given. According to the results of the organoleptic quality evaluation of the chopped beefsteaks, it has been suggested to use ostrich meat in combination with beef at the ratio 1:1 to manufacture chopped beefsteaks.

Keywords: ostrich meat, chopped meat products, water-binding capacity, loss of mass.

Introduction. Formulation of the problem

Meat dishes and products are important in human nutrition because they are a source of complete protein, fat, vitamins A, group B vitamins, a number of essential minerals such as iron, zinc, manganese, and others [1-5]. Meat chopped products are particularly popular due to their high organoleptic quality and soft consistency. However, recent studies have shown that excessive intake of saturated fatty acids and cholesterol contained in meat raw materials can cause a number of alimentary diseases, such as cardiovascular diseases, cancer, and others. So, development of technologies of special purpose meat products with a low content of saturated fats and cholesterol is an important task of the modern food industry [6].

Analysis of recent research and publications

Today, according to the Global Nutrition Report (2016), about 44% of people in different countries suffer from alimentary diseases, such as obesity, caused by excessive consumption of highly calorific and fatty food low in fibre and containing not enough essential minerals and vitamins. One of the ways to solve this problem is to develop special-purpose foods on the basis of lean red meat [7-9]. These products are aimed at improving the general condition of the body,

reducing the risk of diseases caused by irrational nutrition, and their treatment [10,11].

This makes researchers pay more and more attention to the possibility of using in the meat technologies a raw material new for European countries – ostrich meat. Its high quality results from no necessity to include stimulating and hormonal agents and antibiotics in these birds' diet. The ostrich meat properties and application of non-traditional ingredients in the technologies of special-purpose meat products are studied in the works by G. Mykyrtichev (2015), L. Malyakin (2014), B. Gekhaev (2016), D. Baranenko (2016), N. Sarbatov (2015), E. Poławska (2011, 2013), A. M. Cullere (2014), and others.

It is known that ostrich meat contains a significant amount of protein (22.5%), which is by 32.4% more than in pork, with a relatively low content of intermuscular fat (0.9%), and is characterised by low energy value (Table 1).

The composition of ostrich meat proteins is highly balanced (Table 2), as evidenced by the high utilisation rate of its amino acids (U=0.8) [15]. An analysis of the data presented in the table shows that the amino acid content of ostrich meat differs favourably from that of chicken meat and can be compared to that in beef and pork. The content of such amino acids as leucine, isoleucine, and lysine is even better in ostrich meat than in other meat types.

Table 1 – Protein, fat, cholesterol content and energy value of meat

Criteria	Type of meat			
	Beef	Pork	Poultry	Ostrich meat
Protein, g	18.9	17.0	21.1	22.5
Fat, g	12.4	27.8	1.65	1.07
Cholesterol, mg	80	70	40	32
Energy value, kcal	187	316	162	97

Source: developed by the authors and based on generalisation of [12-14].

Table 2 – Essential amino acid composition in meat, g/100 g of protein

Criteria	Type of meat				Breast milk (standard)
	Beef	Pork	Poultry	Ostrich meat	
Isoleucine	4.5	4.7	1.12	4.85	4.6
Leucine	7.9	7.5	1.65	8.0	9.8
Lysine	8.0	8.78	1.76	11.0	7.5
Methionine + cystine	3.9	3.8	0.59	3.2	4.0
Phenylalanine + tyrosine	7.5	7.7	0.89	7.5	8.6
Threonine	5.2	4.7	0.92	4.45	4.6
Tryptophan	1.2	1.4	0.25	1.25	1.5
Valine	5.1	6.1	1.1	4.5	5.2

Source: developed by the authors and based on generalisation of [13,15,16].

The works of many researchers are devoted to studying the fatty acid composition of ostrich meat [13,16,17]. The results of these investigations have allowed establishing that the ratio of polyunsaturated and saturated fatty acids in ostrich meat ranges from 0.64 [16] to 1.16 [17], while the ratio recommended by the WHO is 0.5 [18]. This means that ostrich meat can be used in the technologies of special-purpose meat products.

Ostrich meat is considered to be a high-end dietary product, as, according to the data obtained by G. Mykyrtichev (2012) [19], the cholesterol level in ostrich meat is 32 mg/100 g, which is less than in other types of meat: by 20% less than in chicken, by 60% less than in beef, by 54.3% than in pork (Table 1).

Ostrich meat is high in such deficient micronutrients as iron, copper, manganese, zinc, chromium [20,21]. 100 grams of ostrich meat can satisfy almost 60% of the daily need in iron [22-24]. Taking into account N. Soleimani's data (2011) that about 30% of people suffer from iron deficiency [25], the use of ostrich meat in special-purpose meat products might help patients with anaemia as well as pregnant women. Ostrich meat contains less sodium than beef and pork, so it could be recommended to people suffering from hypertension.

Many researchers have proposed technologies for special-purpose meat products using ostrich meat. As ostrich meat products are low in calories and of high biological and nutritional value, N. Gerasimova (2013) suggested using it to make meat and vegetable products for school meals [26]. N. Sarbatova (2015) proposed a technology of ostrich meat cutlets with potatoes and cabbage added, which allowed obtaining products of high organoleptic quality [27].

The technological properties of ostrich meat have been far less studied than its chemical composition. Thus, Yu. Boyko (2016), on studying the histologic microstructure of muscular tissues, determined that chilled ostrich meat and beef had the same absorption spectra [28]. Besides, it was shown that adding ostrich meat to the formulations of chopped meat products would improve the stability of meat systems and their functional and technological properties [29]. However, despite the benefits of using ostrich meat in the technologies of special-purpose meat products, we have not found any systematic data on the

technological properties of this raw material in the scientific literature. So, further research in this direction is quite reasonable.

The purpose of the research presented in this article is to investigate the functional and technological properties of ostrich meat for further development of the technology of special-purpose meat products. To achieve this goal, the following **objectives** were formulated:

– to investigate the moisture condition in the ostrich meat compared to that in beef, and to determine the weight losses during its heat treatment;
– to determine the structural and mechanical properties of ostrich meat;
– to analyse the quality of chopped meat products made with the use of ostrich meat compared to beef products.

Research materials and methods

Meat of an ostrich leg quarter (*Agro-soyuz*, Dnipro) and first-grade trimmed beef were used in the research. The main research was carried out in the laboratories of the Kharkiv Institute of Trade and Economics of the Kyiv National University of Trade and Economics (the Department of Innovative Food and Restaurant Technologies) and on the base of the Central Research Laboratory of the Kharkiv Medical Academy of Postgraduate Education.

The functional and technological properties of meat were determined by the values of the pH and water activity of the meat extracts, as well as by the water-binding power and by the degree of penetration of chopped meat. Based on the degree of penetration determined for chopped meat, the maximum shear stress was calculated by P. Rehbinder's formula:

$$\tau = K \cdot P/h^2, \quad (1)$$

where τ is the maximum shear stress, Pa;

K is the cone constant, depending on the angle α at its apex, at $\alpha = 60°$, K = 2.14;

P is the penetration force, P = 0.163 N;

h is the depth of immersion of the cone, m.

The pH of the meat was determined potentiometrically with a pH meter 150-M [30]. The water activity was determined with a *HygroLab* portable high-speed device according to ISO 21807:2007. The water-binding capacity of the meat was determined by pressing [30]. The condition and the molecular mobility of water in the meat was studied by the spin echo (Hahn's echo) method on a nuclear magnetic resonance pulsed spectrometer by the spin-spin relaxation time [31].

The degree of penetration of the chopped meat was determined with a *Labor* penetrometer. Its operation is based on free immersion of the cone indenter in the tested sample for a certain time [32].

The properties of ostrich meat were studied in comparison with those of beef. Beef was chosen as a reference sample because this raw material is widely used for chopped meat products and is the closest to ostrich meat in its properties. 5 samples of model systems of chopped meat were analysed:

1 – beef (reference sample);
2 – beef and ostrich meat in the ratio 3:1;
3 – beef and ostrich meat in the ratio 1:1;
4 – beef and ostrich meat in the ratio 1:3;
5 – ostrich meat.

To determine the yield of chopped meat products, we studied the weight loss in semi-processed products during frying. Meat chopped products were prepared according to the recipe and technology described in the collection of recipes by L. Golunova (2005). The quality of the products was evaluated by organoleptic indicators using the method of expert evaluation on a 5-point scale.

The data was statistically processed with the *Statistica 10* software.

Results of the research and their discussion

The active acidity of meat and the water activity of raw meat are important parameters that determine the technological properties of the semi-processed meat products and their storage life. So, these were the parameters of the meat extracts determined at the first stage of studying the model systems of chopped meat (Table 3).

Table 3 – Water activity and pH of chopped meat

Criteria	Samples of chopped meat				
	1 (reference sample)	2	3	4	5
pH	5.4800 ± 0.0020	5.5600 ± 0.0023	5.7800 ± 0.0005	5.6900 ± 0.0030	5.8000 ± 0.0004
Water activity	0.9870 ± 0.0004	0.9870 ± 0.0004	0.9880 ± 0.0007	0.9890 ± 0.0004	0.9900 ± 0.0005

The analysis of the data presented in Table 3 has allowed establishing that the pH of ostrich meat is higher by 6.4%, while the water activity in all the test samples does not differ significantly. The data obtained confirm that ostrich meat can be used in meat product technologies and agree with the data obtained by V. Kuzmichev (2008) and R. S. Nascimento (2015) [33,34].

When developing the technologies of chopped meat products, it is of utmost importance to study the moisture content of the raw material and its ability to be retained by the system. These characteristics effect on the structural and mechanical properties of chopped

meat, the yield of chopped meat products, their quality and cost. That is why, we found it necessary to investigate the water-binding power of the chopped meat, their degree of penetration, and the weight loss of semi-processed products during heat treatment. The results of the studies are presented in Fig. 1–4 and in Table 4.

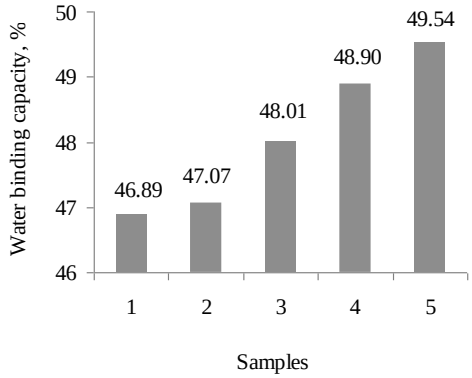

Fig. 1. Water-binding capacity of chopped meat made from: 1 – beef; 2 –beef and ostrich meat in the ratio 3:1; 3 – beef and ostrich meat in the ratio 1:1; 4 – beef and ostrich meat in the ratio 1:3; 5 – ostrich meat

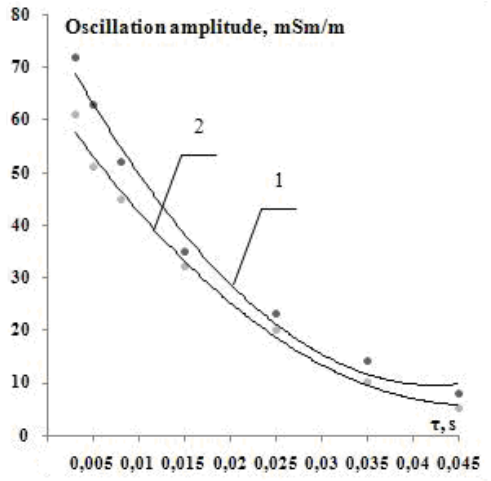

Fig. 2. Dependence of the oscillation amplitude of water protons during their spin-spin relaxation in the chopped meat model systems:
1 – beef; 2 – ostrich meat

Ostrich meat has been found to have 5.7% more moisture-absorbing capacity than beef, and in the blended chopped meat models, this figure increases with the increase in the ostrich meat added. The result is predictable and is explained by the differences in the content of protein substances in the studied types of raw materials (Table 1). Studying the mobility of water molecules in beef and ostrich meat has shown that the moisture in ostrich meat is mainly in the osmotically retained form, i. e., more strongly bound than it is in beef, where weakly bound form of water dominates (Fig. 2).

As the experimental model systems with the addition of ostrich meat can retain more moisture, they have a more tender consistency, as evidenced by the penetration indicator of the ostrich meat sample, which is by 10.8% higher than that of the beef sample (Fig. 3).

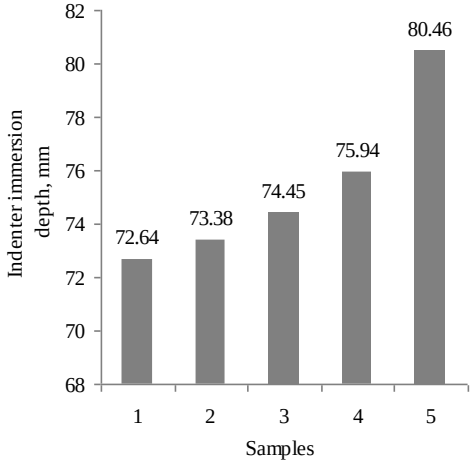

Fig. 3. Penetration values of chopped meat samples made from: 1 – beef; 2 – beef and ostrich meat in the ratio 3:1; 3 – beef and ostrich meat in the ratio 1:1; 4 – beef and ostrich meat in the ratio 1:3; 5 – ostrich meat

The experimentally determined values of penetration of the chopped meat samples have been analysed, which has made it possible to calculate their maximum shear stress. The data obtained have been statistically processed, and a strong correlation (the Pearson correlation coefficient was 0.878, $p < 0.05$) between the maximum shear stress and the water-binding capacity of chopped meat (Table 4, Fig. 4) has been established. It has been found that these parameters are inversely proportional, which is of great practical importance and can be used to predict the properties of raw meat.

The study of how much weight semi-processed chopped meat products lose during heat treatment has shown that ostrich meat products lose almost 20% less of their weight than beef products (Fig. 5).

The results obtained are explained by a higher protein content in ostrich meat compared to beef (Table 1), and correlate with the results of the determination of its water-binding capacity (Fig. 1).

Though ostrich meat has better technological properties than beef, which resulted in the better consistency (tenderness and juiciness) of chopped beefsteaks (Fig. 6), the organoleptic quality analysis of the products made following a recipe from L. Golunova's collection (2005) has shown that the ostrich meat samples have a specific taste and flavour that are unusual for Ukrainian consumers. However, one of the samples has shown the best sensory characteristic. It is the sample made from beef and ostrich meat in the ratio 1:1 (No.3). This agrees with P. C. Carlos's data (2013) that the best organoleptic characteristics are of meat products with the total ostrich meat content in the recipe 19.08 to 57.6% [29].

Table 4 – Water-binding capacity and maximum shear stress (yield value) of the test samples of chopped meat

Criteria	Samples of chopped meat				
	1	2	3	4	5
Maximum shear stress, Pa	648	635	617	593	528
Water-binding capacity, %	46.89±0.05	47.07±0.07	48.01±0.82	48.90±0.20	49.54±0.93

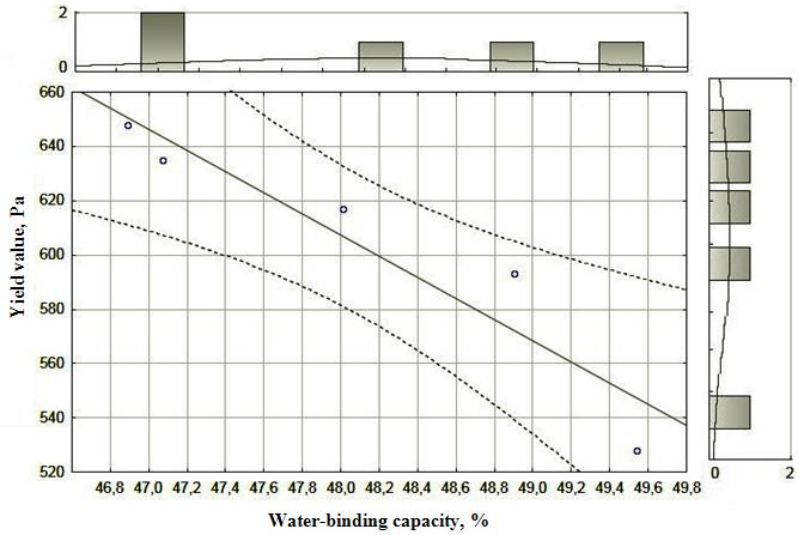

Fig. 4. Screenshot of a *Statistika 10* window: Scatter diagram of the yield values and the water-binding capacity values of chopped meat

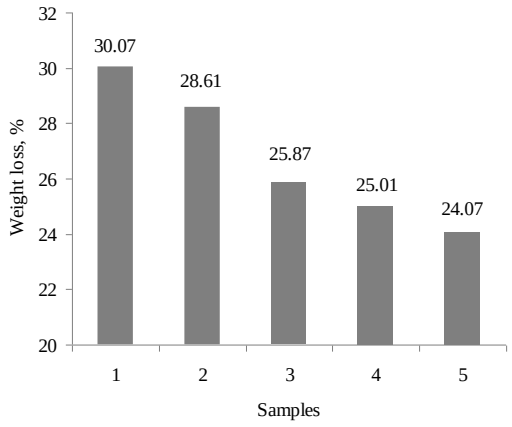

Fig. 5. Weight loss during frying of chopped beefsteaks made from: 1 – beef; 2 – beef and ostrich meat in the ratio 3:1; 3 – beef and ostrich meat in the ratio 1:1; 4 – beef and ostrich meat in the ratio 1:3; 5 – ostrich meat

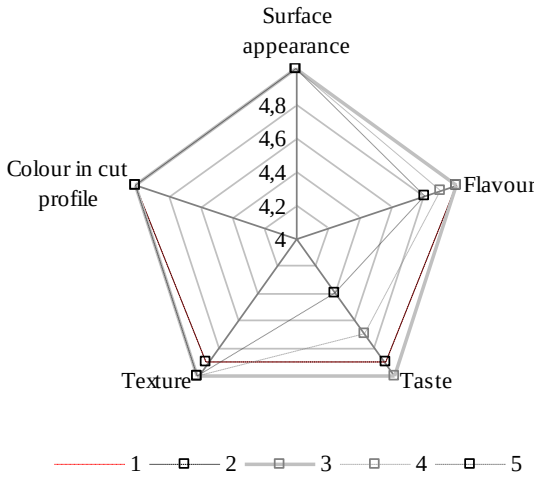

Fig. 6. Sensory quality indicators of the samples of chopped meat products made from: 1 – beef; 2 – beef and ostrich meat in the ratio 3:1; 3 – beef and ostrich meat in the ratio 1:1; 4 – beef and ostrich meat in the ratio 1:3; 5 – ostrich meat

Conclusion

As a result of the research, it has been established that the active acidity of ostrich meat is by 6.4% higher than that of beef, while the water activity of both meat types is practically the same. Ostrich meat has been found to have water-binding capacity that is higher by 5.7%. It is characterised by lower mobility of water molecules, which is explained by a higher protein content in this raw material and allows reducing weight loss of semi-processed products by 20% during their heat treatment. The statistical processing of the experimental data has allowed establishing a strong correlation between the maximum share stress and the water-binding capacity of chopped meat, and has shown that the value of penetration of chopped ostrich meat is by 10.8% higher than that of chopped beef. On the basis of laboratory tests, it is recommended to use ostrich meat in combination with beef at the ratio 1:1 to cook chopped products.

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ОБГРУНТУВАННЯ ЗАСТОСУВАННЯ М'ЯСА СТРАУСА В ТЕХНОЛОГІЇ М'ЯСНИХ СІЧЕНИХ ВИРОБІВ

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Анотація. У статті теоретично обгрунтовано перспективи використання м'яса страуса в технології м'ясних січених виробів спеціального призначення. Показано, що м'ясо страуса характеризується вищим вмістом білка та меншим вмістом холестерину, порівняно з іншими традиційними видами м'ясної сировини. Подано результати експериментальних досліджень функціонально-технологічних властивостей м'яса страуса. Досліджено показники pH та активності води екстрактів подрібненого м'яса, а також вологозв'язувальну здатність, стан рухливості молекул води та ступінь пенетрації подрібненого м'яса. Визначено втрати маси м'ясними січеними напівфабрикатами під час термічної обробки. Проведено аналіз органолептичних показників якості м'ясних січених виробів із яловичини та м'яса страуса. Встановлено, що м'ясо страуса відрізняється на 6,4% вищим показником активної кислотності, ніж яловичина, тоді як різниця між активністю води у водних екстрактах подрібненого м'яса страуса та яловичини незначна. За результатами досліджень встановлено, що завдяки більшому вмісту білків м'ясо страуса має на 5,7% вищий показник вологозв'язувальної здатності та на 10,8% вищий ступінь пенетрації. На основі аналізу результатів дослідження стану рухливості молекул води в досліджуваних видах сировини підтверджено наявність більшої кількості зв'язаної води у м'ясі страуса порівняно з яловичиною. Виявлено обернено-пропорційну залежність між параметрами величини граничного напруження зсуву та вологозв'язувальної здатності досліджуваних зразків м'ясної сировини, а також міцний кореляційний зв'язок між ними. Встановлено, що втрати маси під час термічної обробки напівфабрикатів м'ясних січених виробів майже на 20% нижчі, ніж виготовлених із яловичини. Наведено результати лабораторного відпрацювання рецептур січених біфштексів із м'яса страуса та яловичини в різних співвідношеннях. За результатами оцінки якості м'ясних січених виробів за органолептичними показниками пропонується використання м'яса страуса в поєднанні з яловичиною у співвідношенні 1:1 для виробництва січених біфштексів.

Ключові слова: м'ясо страуса, м'ясні січені вироби, вологозв'язувальна здатність, втрати маси

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