PERIÓDICO TCHÊ QUÍMICA
ARTIGO ORIGINAL

ESTUDO DO EFEITO DE CONSERVANTES MULTICOMPONENTES NA QUALIDADE DE PRODUTOS DE CARNE DE CAVALO COZIDA E DEFUMADA

STUDYING THE EFFECT OF MULTICOMPONENT PICKLE ON THE QUALITY OF COOKED AND SMOKED HORSE MEAT PRODUCT

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Received 17 October 2019; received in revised form 22 October 2019; accepted 23 October 2019

RESUMO

A injeção de conservantes multicomponentes contendo proteínas e carboidratos no tecido muscular da carne de cavalo, seguido de massagens, tende a amaciar a carne e melhorar as características organolépticas do produto acabado. A análise dos dados obtidos mostrou que a introdução de aditivos no conservante multicomponente contribuiu para o processo de retenção de umidade na carne de cavalo. Um importante indicador físico e químico dos produtos à base de carne é a capacidade de retenção de umidade, que afeta a consistência dos produtos acabados e o processo de deterioração microbiológica, uma vez que a quantidade de umidade não ligada depende do crescimento do número de microrganismos. É difícil superestimar a importância do pH na tecnologia da carne, pois o valor do pH determina a adequação da carne crua ao processamento. O aumento máximo da capacidade de ligação de umidade da amostra de controle de carne de cavalo em até 70% é alcançado após 90 minutos de massagem e, em seguida, ocorre uma diminuição na hidrofilicidade do sistema devido à destruição física das fibras musculares. O valor de pH se correlaciona com a capacidade de ligação da umidade das matérias-primas e afeta a segurança do produto e sua capacidade de armazenamento. A relação do pH e da capacidade de retenção de umidade com a consistência da carne não está em dúvida. Nesse sentido, no decorrer de estudos experimentais, foram determinados o pH, a capacidade de retenção de umidade e a tensão de punção. Na amostra 1, que continha um extrato de *Goji berries*, a capacidade de retenção de água aumentou 3,4%. Nas amostras 2 (continha farinha de trigo-sarraceno) e 3 (continha um extrato de *Goji berries* e farinha de trigo- sarraceno), com o uso combinado de farinha de trigo-sarraceno e *Goji berries*, que demonstraram altas propriedades de intumescimento, a capacidade de retenção de água aumenta em 6,1% e 7,2 %, respectivamente, 2,7% e 3,8% a mais, respectivamente. Os dados obtidos mostraram que a introdução de aditivos vegetais tem um efeito positivo na consistência do produto de carne defumada cozida, nos protótipos de propriedades estruturais e mecânicas assim como a força de cisalhamento nos protótipos, que foi reduzida em 7, 13 e quase 20%, respectivamente.

Palavras-chave: carne de cavalo, salmoura multicomponentes, propriedades organolépticas, funcionais e tecnológicas, desenvolvimento tecnológico.

ABSTRACT

The multicomponent pumping pickle containing protein and carbohydrate components injected into the muscle tissue of horse meat, followed by massaging, tends to tenderize meat and improve the organoleptic characteristics of the finished product. Analysis of the data obtained showed that the introduction of additives to the multicomponent pickle contributed to the moisture-holding process in horse meat. An important physical and chemical indicator of meat products is the moisture-holding ability, which affects the consistency of finished products and the process of their microbiological spoilage since the amount of unbound moisture depends on the growth of the number of microorganisms. It is difficult to overestimate the importance of pH in meat technology, as the pH value determines the suitability of raw meat for processing. The maximum increase in the moisture-binding capacity of the control sample of horse meat up to 70% is achieved through 90 minutes of massaging, and then there is a decrease in the hydrophilicity of the system due to the physical destruction of muscle fibers. The pH value correlates with the moisture-binding capacity of raw materials and affects the safety of the product and its storage capacity. The relationship of pH and moisture- holding ability with the consistency

DOI: 10.52571/PTQ.v16.n33.2019.274_Periodico33_pgs_259_265.pdf

of meat is not in doubt. In this regard, in the course of experimental studies, pH, moisture-holding ability and puncture voltage were determined. In Sample 1, which contained an extract from Goji berries, the water-holding capacity is increased by 3.4%. In Samples 2 (contained buckwheat flour) and 3 (contained an extract from Goji berries and buckwheat flour), with the combined use of buckwheat flour and goji berries, which demonstrated high swelling properties, the water-holding capacity increases by 6.1% and 7.2%, respectively additional 2.7% and 3.8%. The obtained data showed that the introduction of vegetable additives has a positive effect on the consistency of cooked-smoked meat product, in the prototypes on structural and mechanical properties, as well as shear force in the prototypes which has been reduced by 7, 13 and almost 20%, respectively.

Keywords: horse meat, multi-component brine, organoleptic, functional and technological properties, technology development.

1. INTRODUCTION

Horse meat has been known as a food raw material for more than a thousand years. Horse meat is widely used for the preparation of meat products in the countries of Central Asia, Russia, some countries in Western Europe, e.g. France, Sweden, Belgium, and Japan. Horse meat has a high nutritional value. Compared to other widely used types of raw meat, horse meat is characterized by the highest protein content with optimal amino acid composition, vitamins A and B, hypoallergenic properties, a series of lipids with low atherogenicity, with a minimum level of carbohydrates (Uzakov, 2006).

According to Arihara, the development of functional meat products requires using natural antioxidants. This direction has been worked out and new functional meat products have been developed. Some studies were conducted before concerning the effect of pumpkin seeds on whole-piece horse meat products. No literature available provides information or applications of goji berries in restructured horse meat products (Silvius S., 2014 and etc.).

A method of producing meat products is known, which provides for the preparation of raw materials, the preparation of brine with the introduction of an enzyme preparation, syringing, aging in brine, molding, cooking, Smoking and cooling (Russia, Patent No. 2030884, A23L 1/31, publ. 1995). The disadvantage of the method is the use of an expensive enzyme preparation pepsin.

Russian scientists have developed a method of producing meat product from the rib part of beef by salting, massaging, introducing spices, aging in milk, molding, Smoking, cooking (Russia, Patent No. 1785642, A23L 1/31, publ. 1993). The disadvantage of the method is a long process of massaging and aging up to 48 hours.

Scientists have developed a method for the production of dried meat delicacies from horse meat (Kazakhstan, Patent No. 29358, A23L 1/31, publ. 2006.01). The disadvantage of the method is the use of an expensive bacterial preparation TEXELDCM-1.

Regular use of goji berries improves gastrointestinal function, increases energy levels, improves sleep, reduces fatigue and stress significantly. Goji berries have antioxidant and anti-inflammatory properties (Makangali, 2018; Arihara, 2006 and etc.)

The purpose of the work was to study the effect of multicomponent pumping pickle on the quality indicators of cooked and smoked horsemeat product.

2. MATERIALS AND METHODS

2.1 Samples

Laboratory studies of test samples were held in the research laboratory of the V.M. Gorbatov All-Russian Research Institute of the Meat Industry (Moscow, Russian Federation). In this study, cooled horse meat (pH 5.56) and horse fat were used. Horse meat was purchased from Kainar LLP (Almaty, Kazakhstan).

The test samples were produced at the meat processing research center of Almaty Technological University (Almaty, Republic of Kazakhstan).

The reference pickle contained table salt, sodium nitrite, sugar, and water. The pickle samples additionally contained the following: Sample 1 contained an extract from goji berries, Sample 2 contained buckwheat flour, and Sample 3 contained an extract from goji berries and buckwheat flour.

The meat product was shaped of semi-circular pieces not heavier than 0.4 kg with a thickness of about 10 cm. The meat pieces were injected with brine containing 2.5 kg salt and 150 g sugar per 100 kg of raw material with a density of 1.0923–1.1065 g/c and then were flooded with

the rest brine and were refrigerated. The salted meat was massaged in tenderizer for 40 min. The meat product was boiled in cooking-smoking chambers to a temperature in the center of 74-75^{0}C for 2–2.5 h until the temperature at the center of the product had reached 72^{0}C. The boiled product was chilled and smoked for 30 min at a smoke temperature of 40^{0}C.

2.2 Chemical composition

The chemical composition of meat and meat products was determined by commonly known methods.

Two-hundred grams of product sample were placed in plastic containers, frozen and then dried in a thermal freeze dryer (Modulyol-230, Milford-UK) for 5 days under 100-mbar pressure at −50 °C. The frozen dry samples were ground to a homogeneous mass in a grinder (Panasonic-Mixergrinder-Model MX119N-Japan) for chemical analyses. The moisture was determined by weighing 200 g meat sample before and after drying in a thermal freeze dryer for 5 days. The proximate chemical composition of the product was determined according to the standard methods of the AOAC (2000).

Protein was determined using a Foss Kjeltec 2300 nitrogen/protein analyzer (State standard P 50258). Fat was determined by Soxhlet extraction method using petroleum ether (State standard 23042-86). Ash content was determined by ashing samples in a muffle furnace at 500 °C for 24 h (State standard 31727-2012)

2.3 Determination of the rheological properties

The following indicators were determined in the finished products: the total water content by drying to a constant weight; water-binding capacity (WBC) by pressing method; water-holding capacity (WHC) by Vartanyan method; heat treatment losses by the difference of sample mass before and after heat treatment; cutting force with a Warner-Bratzler device.

Determination of the pH of meat and meat products. The pH of meat products was monitored using a portable pH meter (Hanna waterproof pH meter, Model Hi 9025) fitted with a plastic body open junction, conic (Hanna FC200B) and a temperature adjusting probe. The pH probe and the thermometer were inserted into the product to a similar depth (2 cm).

2.4 Mineral composition

A mixed standard solution was prepared from a 1000 µg/ml multi-element solution (Darmstadt, Germany) and inhouse standard reference materials used for validation of the method. Evaluation of mineral levels in the samples was carried out after complete digestion using a Milestone 1200 MDR microwave system at a temperature of 200 °C in closed (PTFE) vessel. In brief 5 ml of conc. HNO_3 and 1 ml of 30% H_2O_2 were added to each digestion vessel. They were then heated to 200 °C over a 5-min period and then held at 200 °C for another 20 min. The digest obtained was collected in 50-ml volumetric flasks and made up to volume. Measurements were carried out on the ICP-OES system (Perkin Elmer Model 3300) equipped with a low-flow Gem Cone nebulizer in addition to an ultrasonic nebulizer for low concentrations.

2.5 Sensory indicators of meat products

Sensory evaluation was carried out using score assessment. Five points scores of intensity and desirability scales were used in the experiment. There was from 1 point (very slight) to 5 point scores of intensity (very strong) and similar for desirability: from 1 point (undesirable) to 5 points (very much desirable). All processed meat products were sensory investigated by six-panel. Products were prepared as half of chubs and 2.5 mm slices and presented to panelists on disposable dishes in white glow light (250 1x). The next sensory parameters were investigated: 1-taste, 2 – smell and aroma, 3 – appearance, 4 – consistency, 5 – view at the cut, 6 – juiciness. (State standard 9793-74, 23041-78).

3. RESULTS AND DISCUSSION:

The pickle ingredients were selected due to their functional properties and the required organoleptic characteristics of the finished horsemeat product. The concentration of each ingredient in the pickle was defined taking into account the established rates of their use and the allowable content of each ingredient in the finished product, as well as the amount of pickle to the mass of pumping material (Table 1).

After the different variants of multicomponent pumping pickle were injected into horse meat, the water-binding capacity of the reference and test samples was studied. Changes in the hydrophilic characteristic of horse meat in the process of massaging were studied;

the results of the research are presented in Figure 1.

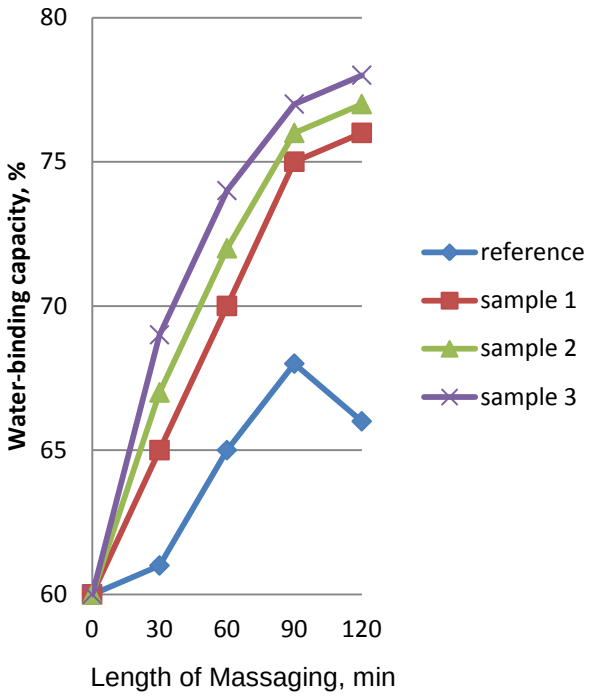

Figure 1. *Water-binding capacity of horse meat in the course of massaging*

The maximum increase in the water-binding capacity of the reference sample of horse meat to 70% is achieved after 90 minutes of massaging, and then the hydrophilic property of the system reduces due to the physical destruction of muscle fibers.

With the introduction of the protein component to the pickle, WBC of horse meat (Sample 1) stabilizes and increases to 76% after 90 minutes of massaging. Goji berries added to the pickle contribute to the additional stabilization of the meat system due to their ability to increase the stickiness both inside the meat pieces and on the surface.

The pickle with buckwheat flour injected into the horse muscle tissue contributes to the formation of a single matrix due to the interaction of the negatively charged surface of the polysaccharide with salt-soluble muscle proteins and cations. In addition, buckwheat flour has a high drying capacity, which also leads to increased WBC of the sample.

An extract of goji berries and buckwheat flour was added to Sample 3. After 90 minutes of massaging Sample 3 reached the maximum WBC value of 79% and stabilized it at this level.

The process of color formation is important for the cooked and smoked product; the process was studied by determining the content of nitric oxide pigments in the samples when the raw material was left curing for 4 hours after massaging (Figure 2).

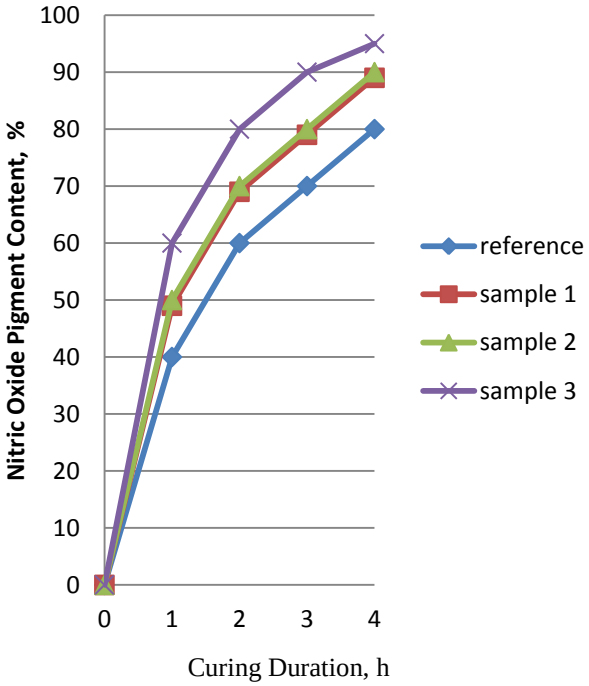

Figure 2. *Accumulation of nitric oxide pigments in the horse meat muscle tissue when curing*

As a result of biochemical transformations of the meat pigment – myoglobin –during curing, the product color is formed and stabilized. Among the factors affecting the process of color formation, an important role is played by reducing agents, e.g. reducing sugars and ascorbates.

Figure 2 shows that the introduction of an extract from goji berries into the pickle accelerates the formation of nitric oxide pigments.

The introduction of buckwheat flour, which plays an important process role, has virtually no effect on the color formation of the products.

The greatest acceleration of the color formation process in horse meat product is observed in the pickle with the combined use of an extract from goji berries and buckwheat flour (Sample 3). Goji berries contain ascorbic acid, which contributes to the conversion of sodium nitrite to nitric oxide, recovers metmyoglobin already contained in raw materials, binds oxygen well, and thereby protects meat pigments from oxidation.

After massaging and curing, the process parameters of the cured horse meat were determined (Table 2).

Analysis of the data obtained showed that the introduction of additives to the multicomponent pickle contributed to the water-holding process in horse meat. In Sample 1, WHC is increased by 3.4%. In Samples 2 and 3, with the combined use of buckwheat flour and goji berries, which have high swelling properties, WHC increases by 6.1 and 7.2%, i.e. by an additional 2.7 and 3.8%.

Polysaccharide-containing additives contribute most to the water-holding process in the meat system due to their high hydrophilic capacity. This has been proven by the results of the study of mass losses after heat treatment of cured horse meat (Table 2). The data shows a significant reduction in losses with the introduction of carbohydrate additives. The use of a series of process additives in the pumping pickle is aimed at improving the cohesive adhesion processes in the meat system. Goji berries and buckwheat flour are involved in both intra- and interphase changes.

The introduction of goji berries and buckwheat flour to the pickle contributes to the formation of a solid spatial grid after the heating-cooling cycle. Thus, the complex combination of proteins and carbohydrates makes it possible to benefit from the synergistic effect of the pickle components for the formation of high-quality indicators of cooked and smoked horse meat.

After massaging and curing, some samples of cooked and smoked horse meat products were developed. Consistency of meat products is an important qualitative parameter, which can be examined with the help of the shear stress value (Figure 3).

The data obtained showed that the introduction of additives had a positive effect on the consistency of the product; in the samples, the shear force decreases, respectively, by 7, 13 and almost 20%. The greatest effect is manifested in Sample 3 with the entire complex of additives.

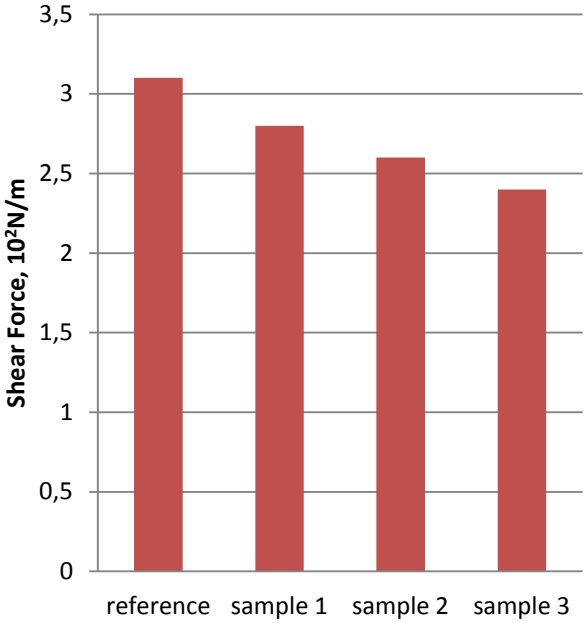

Figure 3. *Shear stress of the cooked and smoked horse meat*

The data presented in Figure 4 showed that Sample 3 had the best organoleptic characteristics with the introduction of goji berries and buckwheat flour. The data obtained showed that under the influence of multicomponent pumping pickles, finished products acquire a stable color and delicate texture. Due to the high water-holding capacity of the meat system, the juiciness of the products is formed, which improves the taste.

4. CONCLUSIONS:

Thus, the introduction of an extract of goji berries and buckwheat flour, which contains a number of functional components, to the pickle, contributes to the formation and stabilization of the quality indicators of the cooked and smoked horsemeat product. The multicomponent pickle consisting of an extract of goji berries and buckwheat flour helps to bind water through the protein system and polysaccharides, which maintains the stability of the finished product, reduces heat treatment losses, increases the juiciness and the yield of the product. The introduction of goji berries also contributes to the stability of the color of the finished product.

5. ACKNOWLEDGMENTS:

The study was performed as part of the research work No.0457/GF4 Study of the Functional and Biocorrective Characteristics of Plant-Animal Complexes and the Development of

the Technology of National New-Generation Meat Products on their Basis Using Local Raw Materials funded by the Ministry of Science and Education of the Republic of Kazakhstan.

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Table 1. *Composition of pumping pickle*

Component	Content of pickle components, kg per 100 kg			
	Reference	Sample 1	Sample 2	Sample 3
Goji berries	-	+	+	+
Buckwheat flour	-	-	+	+
Goji berries + buckwheat flour	-	-	-	+
phosphates	+	+	+	+
Table salt	+	+	+	+
Sodium nitrite	+	+	+	+
Granulated sugar	+	+	+	+
Water	+	+	+	+
Total	100	100	100	100

Table 2. *Process parameters of horse meat*

Parameter	Reference	Sample 1	Sample 2	Sample 3
Water-holding capacity,%	82.5±2.0	85.3±1.7	89.0±1.8	89.9±1.6
Medium pH	5.71±0.1	5.7±0.1	5.7±0.1	6.2±0.2
Heat treatment losses, %	38.9±0.5	35.8±0.8	23.9±0.6	20.8±0.6

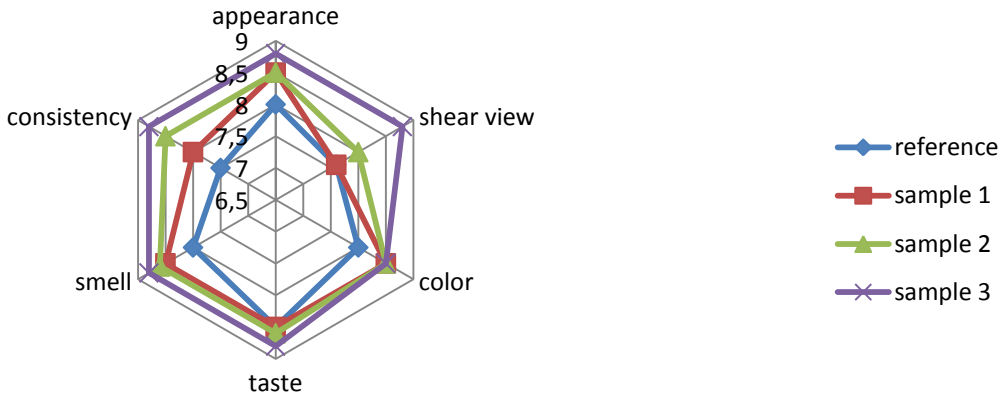

Figure 4. *Organoleptic evaluation of cooked and smoked horse meat products*