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Short Communication

Effects of black cumin seed cake on quality and mineral value of steamed cutlets

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Abstract

The introduction of plant raw material into minced meat is considered one way to obtain high-quality meat products with a specified composition. The aim of the research was to study the effects of black cumin seed cake on the quality and mineral value of steamed cutlets. It was found that the introduction of 1.5% of black cumin seed cake resulted in some inclusions of black-brown color into the finished product which corresponded to the category of "very good" quality. Three percent of seed cake caused a greater change in color and made the cutlets spicier which corresponded to the category of "good" quality. Five percent of seed cake gave a herbaceous aftertaste, satisfactory, somewhat dry consistency and an excessively black color to the product which corresponded to the "below average" category. During further tests, 3% of black cumin seed cake introduced 1.70±0.04 g/100 g of dietary fiber to the meat product which contributed to an increase in the content of mineral elements, namely manganese (10×), calcium (3.3×), iron (2.5×), copper (1.7×), magnesium (1.5×), and phosphorus (by 23%) against the background of stabilizing the number of mesophilic microflora during 24-h storage of the steamed cutlets.

Keywords: cutlets, black cumin seed cake, mineral value

1. Introduction

The inclusion of plant raw materials into minced meat is considered one way of obtaining high-quality meat products with regulated properties. In addition to the rational use of raw materials, the development of combined meat products allows for an increase in the volume of products with a high content of dietary fibers, organic acids, mineral components, and bioflavonoids. Furthermore, the economic efficiency of production can be ensured by maintaining a high quality of products and making the products more affordable by reducing the cost (Gavrilova, 2013).

In order to add the desired functional properties, non-traditional plant raw materials have been added to chopped semi-finished products. The plant raw materials were arabinogalactan (Danilov, Gombozhapova, Leskova, & Badmaeva, 2015), amaranth bran (Kharitonova & Komkova, 2016), algae (Vasyukova, Vasyukov, & Mushin, 2016), white cinquefoil (Minochkin, 2017), and flaxseed meal (Miller & Rechkina, 2017).

The well-known black cumin (*Nigella sativa L.*) or black-caraway is a promising raw component in dietary modifications and is used as part of the diet or as a functional ingredient in cereal products (Alhazmi *et al.*, 2014; Baharetha *et al.*, 2013). Black cumin is used in confectionery, in the alcoholic beverage industry, and in the production of yoghurts, marinades, sauces, and salads (Hajhashemi, Ghannadi, & Jafarabadi, 2004; Venkatachallam, Pattekhan, Divakarat, & Kadimi, 2010). Its seeds are widely used as a spice for flavoring bakery products and cheeses and in traditional sweet dishes in Asian and Middle Eastern countries where they are eaten with honey and syrup (Cheikh-Rouhou *et al.*, 2007; Hamrouni-Sellami, Kchouk, & Marzoul, 2008). The seeds of black cumin contain protein (26%), carbohydrates

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(25%), fiber (8.4%), as well as alkaloids (nigellicines and nigelledine), saponins (a-hederin), flavonoids (quercetin, kaempferol, isorhamnetin), pigments, resins, waxes, tannins, coumarins (umbelliferone, scopoletin, herniarin), and ascorbic acid. The seeds are rich in mineral components such as copper, phosphorus, zinc, and iron (Ahmad *et al.*, 2013; Egorova, Bochkarev, & Reznichenko, 2014). Recently, the proven anti-cancer effects of black cumin have attracted more attention of researchers for its use in the fight against oxidative stress, hyperglycemia, and hypercholesterolemia to reduce blood glucose levels and prevent complications from diabetes (Alhazmi *et al.*, 2014; Baharetha *et al.*, 2013; Ramadan & Mörsel, 2003). The aim of the research was to study the effect of black cumin seed cake on the quality and mineral value of steamed cutlets.

2. Materials and Methods

2.1 Preparation of cutlets with black cumin seed cake

Steamed cutlets cooked from poultry meat (chicken fillet) according to the traditional recipe (Golunova, 2003) were used as a control sample. Experimental tests were performed with the addition of Siberian black cumin seed cake in the amount of 1.5% (experiment No. 1), 3% (experiment No. 2), and 5% (experiment No. 3). The seed cake was produced by Altaiskii Kedr and supplied by VELAKedrovy Rai, Moscow, Russia. The amounts of black cumin seed cake were experimental. The introduction of the seed cake in higher concentrations was unacceptable for this type of meat product because of the specific color scale (black-brown color) of the plant material being tested while the introduction in lower concentrations does not make sense in terms of increasing the nutritional value of the combined product. The semi-finished products were heat treated in a combi-steamer at 100 °C for 30 min until done. The weight of a finished steamed cutlet was 125 g. Model samples of steamed cutlets were stored at a temperature of 4±2 °C for 24 h.

2.2 Testing the raw material

The seed cake of black cumin was tested for the following organoleptic properties: appearance and color were determined visually; smell and taste by tasting; and the presence of impurities by sieving. The mass fraction of moisture was determined by distilling the water from the cake slurry in a solvent to form an azeotropic mixture with water followed by measuring the volume of the distilled water. The mass fraction of crude fiber was determined by removing acid-alkaline substances from the raw material and measuring the remainder which was assumed to be fiber. The phosphorus content was determined using its ability to combine with ammonium molybdenum to form phosphomolybdic acid which is reduced by the amidol reagent and gives a blue color.

2.3 Testing the finished product

A scale from one to nine was used during the tasting evaluation of steamed cutlets to determine the compliance of organoleptic properties with the requirements of regulatory documents. The mass fraction of sodium chloride was determined by titrating the chloride ion extracted from the product with silver ions in a neutral medium in the presence of potassium chromate. The mass fraction of moisture was determined by drying a given weight of the product at 103±3 °C to a constant mass in the laboratory oven followed by the calculation of the indicator under question. The content of dietary fiber was determined by hydrolysis and removal of protein and starchy substances by enzymes analogous to enzymes of the human digestive tract from plant-based dietary supplements. The mass fraction of phosphorus was determined by mineralization of the sample with nitric and sulfuric acids and the precipitation of phosphorus in the form of quinoline phosphomolybdate and determination of the precipitate mass. The presence *Escherichia coli* group bacteria was determined by sowing the product into a selectively diagnostic nutrient medium, incubating the crops at 37±1 °C for 24±3 h and then counting the typical and atypical colonies and determining the possibility of bacteria from these colonies to ferment lactose to form gas.

The quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM) was determined by inoculating a sample of the product into meat-peptone agar, incubating the crops at 30±1 °C for 72 h and then calculating all of the grown visible colonies. The quantity of sulfite-reducing clostridia was determined by inoculating a sample of the product into a nutrient medium with the presence of iron sulfite agar, incubating the crops at 37±1 °C for 24–48 h, and then counting the colonies of different intensity of black color.

The contents of calcium, manganese, magnesium, iron, copper, and zinc in the plant raw material and in the meat products were determined by the method of flame atomic absorption. The mass fraction of protein was determined using the Kjeldahl method which consisted of mineralization of the sample and photometric measurement of the intensity of the indophenol blue reaction which is proportional to the amount of ammonia in the mineralized substance. The mass fraction of fat was determined by the extraction method in the Soxhlet apparatus. The mass fraction of ash was determined by complete combustion of the organic part of the sample of the raw material with the subsequent gravimetric determination of the test item (Skurikhin & Tutelian, 1998). The daily norm of consumption of mineral components for an adult was taken from the existing standards (Tutelian, 2009).

2.4 Statistical analysis

All measurements were repeated three times. Statistical analysis was performed using Microsoft Excel XP and Statistica 8.0. Statistical error did not exceed 5% with a 95% confidence level.

3. Results and Discussion

3.1 Research of black cumin seed cake

In the first stage of the experiment, much attention was paid to the study of the organoleptic, individual physical and chemical properties and the mineral value of the black cumin seed cake to establish the applicability of the non-traditional plant raw material as a component to increase the nutritional value of a combined meat product (Table 1).

Table 1. Quality parameters and mineral composition of the black cumin seed cake.

Test item	Test results
Appearance and consistency	Homogeneous, free-flowing powder, particle size less than 0.3 mm
Color	Black-brown, uniform throughout the mass
Smell	Typical, neutral. Not musty, moldy, rancid or any other foreign smell.
Taste	Moderately bitter taste with no flavor. Not musty, moldy, rancid or any other foreign aftertaste.
Mineral impurities	Not crunchy from mineral impurity when chewing.
Extraneousimpurities	Not detected
Metalforeignmatter	Not detected
Infestation of grain pests (insects or their larvae) or the presence of trace contamination	Not detected
Mass fraction of moisture, %	7.20±0.70
Mass fraction of crude protein on dry basis, %	40.60±1.40
Mass fraction of crude fat on dry basis, %	10.20±0.50
Mass fraction of crude fiber on dry basis, fat-free, %	18.90±0.40
Mass fraction of total ash on dry basis, fat-free, %	6.46±0.03
Phosphorus content, mg kg^{-1}	781.00±166.00 *(97*)*
Calcium content, mg kg^{-1}	3869.70±1393.09 *(387*)*
Copper content, mg kg^{-1}	19.59±1.96 *(1959*)*
Iron content, mg kg^{-1}	411.28±41.13 *(4113* – for men, 2285* – for women)*
Magnesium content, mg kg^{-1}	3720.50±1004.50 *(930*)*
Manganese content, mg kg^{-1}	41.80±13.79 *(2090*)*
Zinc content, mg kg^{-1}	51.60±5.16 *(430*)*

Note: here and below * - meeting an adult person's daily physiological needs, %

The results of organoleptic studies revealed specific flavor characteristics of the cake (without foreign taste and smell), such as a typical neutral smell, moderately bitter taste, and a typical black-brown color. None of the following were detected in the test samples: extraneous impurities; metallic foreign matter; contamination or pest infestation.

The oil content of the cake under analysis (10.20±0.50%) was within normal limits for oilseed cakes used in food (not more than 25%). The content of protein (40.60±1.40%) and moisture (7.20±0.70%) revealed in the non-traditional raw material also conformed to the norms which are not less than 30% and not more than 9%, respectively. The dietary fiber found in the cake allowed enrichment of the meat product that initially lacked certain components. The ash content was 6.46±0.03% which is explained by the high content of mineral elements, namely iron, manganese, copper, magnesium, and zinc. Consumption of 10 g of the analyzed raw material meets the adult daily requirement of iron by 41% (23% for women), manganese by 21%, copper by 19%, magnesium by 9%, zinc by 4%, calcium by 4%, and phosphorus by 1%.

3.2 Research of the model samples of steamed cutlets

The second stage of the research was dedicated to the effect of the seed cake in different amounts on the quality of model samples of steamed cutlets. The results of the research of organoleptic properties are given in the Figure 1 and in Table 2. The results of an organoleptic evaluation of the model samples illustrate the degree of changes in consumer properties of the products with an increase in the amount of black cumin seed cake. The amount of 1.5% seed cake changed the appearance of the product only slightly by introducing some inclusions of black-brown color resembling ground black pepper. The experimental samples scored 48.9±0.3 points which corresponded to "very good" quality. The amount of 3% seed cake caused a greater change in the color and taste of the finished product. The taste became a little spicier but consistency and juiciness remained acceptable. During the tasting evaluation, the test samples scored 42.9±0.2 points which corresponded to "good" quality. An increase to 5% of the seed cake worsened the taste of the cutlets by causing an unpleasant herbaceous aftertaste. The color in experiment No. 3 was excessively black and was also visually unacceptable since it negatively affected the appearance of the combined meat product. As a result, the product's quality decreased to "bad". The consistency of the combined products during chewing was satisfactory but somewhat dry. The overall evaluation of experiment No. 3 was 23.9±0.3 points which caused the quality to be identified as "below average".

Based on the results, experiment No. 2 was chosen for further studies because the amount of non-traditional plant raw material in the steamed cutlets still retained acceptable consumer characteristics. The results of the physical, chemical, and microbiological quality parameters of the model samples in a comparative aspect are given in Table 3.

While testing the steamed cutlet samples, it was found that the mass fractions of moisture, protein, fat, and sodium chloride were in the same quantitative range in both the control and test samples. However, the test samples proved to contain soluble and insoluble dietary fibers. According to many scientists, these dietary fibers help increase adsorption, ionic, and buffer capacities, increase intestinal motility, and excrete carcinogenic substances and other harmful metabolic products, which are very important for the health of consumers (Gavrilova, 2013; Egorova, Bochkarev, & Reznichenko, 2014; Danilov, Gombozhapova, Leskova, & Badmaeva, 2015). The ash content in experiment No. 2 was higher than the control sample by 16%, which complies with the results of studying the mineral value of the model samples of steamed cutlets presented in Table 4.

The bacteria of the *E. coli* group and the sulfite-reducing clostridia were not detected in a certain mass of the

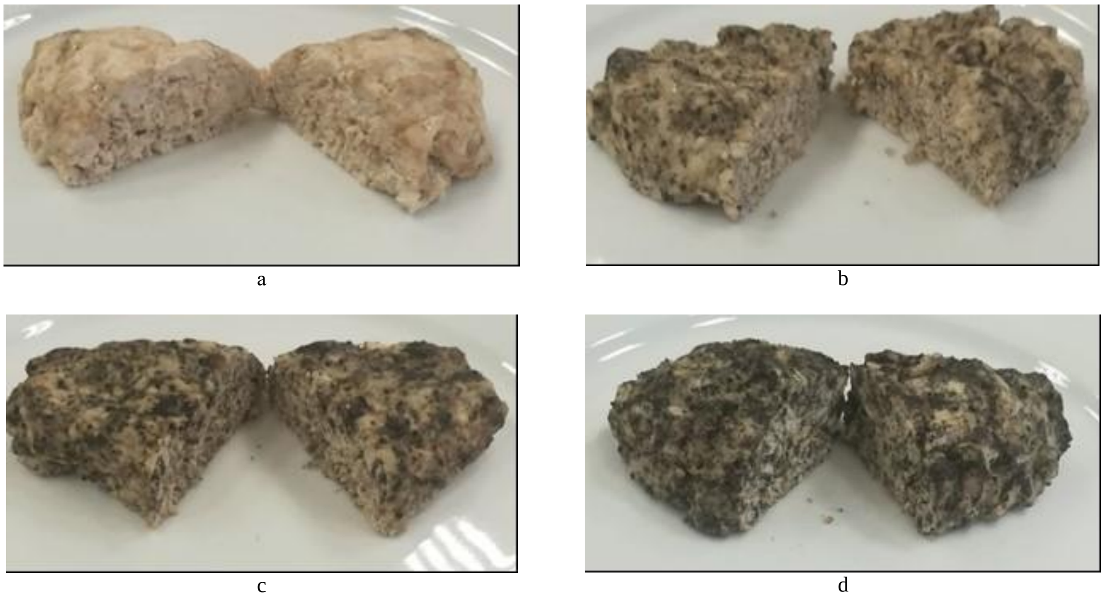

Figure 1. Appearance of model samples of steamed cutlets: (a) control; (b) experiment No. 1; (c) experiment No. 2; (d) experiment No. 3.

Table 2. Organoleptic properties score of the model samples of the steamed cutlets.

Sample	Average score according to properties						Total quality score
	Appearance	Color on cutlet	Flavor	Taste	Consistency	Juiciness	
Control	8.6±0.2	8.4±0.5	8.3±0.3	8.1±0.5	7.9±0.1	8.0±0.5	49.3±0.3
Exp. No. 1	8.4±0.3	8.2±0.3	8.2±0.2	8.1±0.3	7.9±0.3	8.1±0.3	48.9±0.3
Exp. No. 2	6.7±0.3	6.5±0.2	7.8±0.3	7.3±0.4	7.4±0.2	7.2±0.2	42.9±0.2
Exp. No. 3	3.3±0.2	3.1±0.3	5.2±0.1	3.0±0.3	5.3±0.3	4.0±0.5	23.9±0.3

Table 3. Quality parameters of the model samples of the steamed cutlets.

Test item	Test results	
	Control	Experiment No. 2
Freshly prepared samples		
Mass fraction of moisture, %	67.60± 0.70	67.20±0.70
Mass fraction of protein, %	28.2± 0.88	29.8±0.88
Mass fraction of fat, %	8.50± 1.53	8.30±1.49
Content of soluble and insoluble dietary fiber, g/100 g	Not detected	1.70±0.04
Mass fraction of sodium chloride, %	0.70± 0.08	0.70±0.08
Mass fraction of ash, %	1.61± 0.03	1.87±0.03
QMAFAnM, CFU g^{-1}	7.7×10^{2}	7.1×10^{2}
Escherichia coli (coliforms) in 1 g	Not detected	Not detected
Sulfite-reducing clostridia in 0.1 g	Not detected	Not detected
Samples after 24 h of storage		
Mass fraction of moisture, %	66.40± 0.70	66.70±0.70
QMAFAnM, CFU g^{-1}	9.9×10^{2}	6.8×10^{2}
Escherichia coli (coliforms) in 1 g	Not detected	Not detected
Sulfite-reducing clostridia in 0.1 g	Not detected	Not detected

QMAFAnM = quantity of mesophilic aerobic and facultative anaerobic microorganisms;

Table 4. Mineral value of model samples of steamed cutlets.

Test item	Test results	
	Control	Experiment No. 2
Phosphorus mass fraction, %	0.170±0.010	0.210±0.013
Calcium content, mg kg^{-1}	72.16±28.14 *(7*)*	236.96±92.41 *(23*)*
Copper content, mg kg^{-1}	0.48±0.05 *(48*)*	0.81±0.08 *(81*)*
Iron content, mg kg^{-1}	13.01±1.30 *(130* for men, 72* for women)*	32.73±3.27 *(327* for men, 182* for women)*
Magnesium content, mg kg^{-1}	160.54±60.20 *(40*)*	239.28±89.73 *(60*)*
Manganese content, mg kg^{-1}	0.13±0.05 *(7*)*	1.33±0.53 *(66*)*
Zinc content, mg kg^{-1}	9.73±0.97 *(81*)*	10.03±1.00 *(83*)*

* An adult person's daily physiological needs, %

control sample and experiment No. 2 throughout the entire experiment period. The results of bacterial contamination studies of the model samples showed that QMAFAnM was within normal limits (not more than 1.0×10^3) in the control and test samples even at the end of the shelf life (24 h). In experiment No. 2, the quantity of mesophilic aerobic and facultative anaerobic microorganisms after 24 h of storage tended to decrease, while in the control it increased by 28%. Stabilization of the QMAFAnM can be explained by the well-known ability of black cumin seed in various amounts to inhibit the growth of *Bacillus sebus, Bacillus subtilis, Pseudomonas aeruginosa, Listeria innocua, Staphylococci, Aspergillus flavus, Fusariumgraminearum, Fusariummonoliforme,* and *Penicilliumviridicatum* (Ramadan & Mörsel, 2003; Venkatachallam *et al.,* 2010).

The positive effects of black cumin seed cake in the studied concentrations were established for the first time. The macronutrients of the experimental samples of the steamed cutlets contained more calcium (3.3×), magnesium (1.5×), and phosphorus (by 23%). The microelements of manganese, iron, and copper were greater by 10×, 2.5×, and 1.7×, respectively. The content of zinc in the model samples of steamed cutlets was within one quantitative range.

Estimates suggest that adding black cumin seed cake at 3% of one steamed cutlet (125 g) helps to better meet an adult person's requirement of mineral elements, namely iron (41% for men and 23% for women), copper (10%), manganese (8%), magnesium (7%), and calcium (3%). It helps optimize the diet in relation to individual micronutrients and prevent a number of alimentary-dependent diseases.

Thus, in the course of the tests, the seed cake proved to possess the following specific characteristics: a typical neutral smell; moderately bitter taste with no flavor; black-brown color; and high contents of mineral elements: iron (411.28±41.13 mg kg^{-1}), manganese (41.80±13.79 mg kg^{-1}), copper (19.59±1.96 mg kg^{-1}), magnesium (3720.50±1004.50 mg kg^{-1}), and zinc (51.60±5.16 mg kg^{-1}).

4. Conclusions

Adding 3% of ground black cumin seed cake to the formula of the steamed cutlets contributed to 1) a dark shade in the color of the finished product while maintaining acceptable flavor characteristics, 2) increased contents of mineral elements, namely manganese (10×), calcium (3.3×), iron (2.5×), copper (1.7×), magnesium (1.5×), and phosphorus (by 23%), 3) dietary fiber in the meat product, 4) maintaining microbiological safety of the product during storage by stabilizing the number of mesophilic microflora.

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