ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Technological Properties of Raw Meat from Animals Fed Rations Supplemented With Minerals.

Sergey Yu Smolentsev[1]*, Rustam Kh Ravilov[2], Leysan F Yakupova[2], Nikita V Nikolaev[2], Fazil A Medetkhanov[2], Galina S Stepanova[3] and Aygul Z Karimova[3]

[1]Mari State University, Lenin Square 1, Yoshkar-Ola city, 424000, Russia.
[2]Kazan State Academy of Veterinary Medicine by N.E. Bauman, Sybirsky Tract Street 35, Kazan, 420029, Russia.
[3]Kazan cooperative institute (branch) Russian university of cooperation, N. Ershov street 58, Kazan city, 420081, Russia.

ABSTRACT

Nano structured vermiculite, particle size ranging from 50.0 to 160.0 nm, was produced from vermiculite supplied from the Krasnoyarsk deposit (Russia) and included as a fodder additive in the rations of feeder bulls. Long-term dietary administration of vermiculite at the optimal dosage of 1.0 % dry matter, as well as nanostructure vermiculite in doses of 1.0, 0.6 and 0.2 % dry matter led to a reduction of 0.2-2.3 % in the moisture content of meat from treated animals. The water binding capacity of beef increased by 10.2-21.3% due to nanostructure vermiculite and by 1.6 - 5.4% due to vermiculite as compared with the control. An increase of 9.6-17.6% in the water holding capacity was found in the meat from bulls treated with nanostructure vermiculite added to their diets. The introduction of vermiculite into the animal rations was less effective and resulted in increasing the water holding capacity of meat by 2.0-2.6% as compared to the control. In terms of the functional and technological properties of beef, the meat from the bulls fed diets supplemented with nanostructure vermiculite was of higher quality and more favorable for further processing.
Keywords: beef, moisture content, water binding capacity, water holding capacity.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Since the second half of the 20th century and the beginning of the 21st century, the development of nanotechnology has led to the emergence of new globally and nationally marketed technologies and products based on the use of nanomaterials. Successful application of nanomaterials in animal husbandry involves using them as highly effective feed additives [1].

According to many researchers, biotic doses of nanomaterials promote the growth and enhance the productivity of animals. However, there is no sufficient evidence regarding the effects of nanomaterials as feed additives on the quality characteristics of animal meat including its functional and technological properties.

The functional and technological properties can be defined as a set of parameters characterizing the levels of emulsification capacity, water binding capacity, fat absorption capacity, water absorption capacity, and gel forming capacity of raw meat, its structural and mechanical properties (viscosity, ductility, etc.), sensory attributes (color, flavor, odor), as well as levels of output and losses due to heat treatment [2].

The research aimed to study the effects of vermiculite and nanostructure vermiculite on the functional and technological properties of beef.

MATERIALS AND METHODS

Research and industrial experiments involving the use of vermiculite and nanostructure vermiculite as feed additives in the rations of bulls were carried out at Agrofirma AU LLC in the Arsky District of the Republic of Tatarstan. Exfoliated (thermal-, mechano-activated) vermiculite supplied from the Krasnoyarsk Territory, Russia, was utilized in the research. The chemical composition of vermiculite is as follows (percent composition): SiO_2 - 42.6; TiO_2 - 1.2; Al_2O_3 - 11.3; Fe_2O_3- 15.9; FeO- 0.3; MnO- 0.1; CaO- 1.6; MgO- 19.2; Na_2O - 0.3; K_2O - 4.5; P_2O_5 - 0.2; SO_3 = 0.03; LOI - 2.8. The mineral composition of vermiculite is as follows (percent composition): opal cristobalite– 5.0-7.0; clinoptilolite - 20.0-30.0; calcite - 8.0-10.0; montmorillonite - 7.0-15.0; hydromica – 26.0-50.0; opaltridimide - 8.0-12.0. Nanostructured vermiculite with the particle size ranging from 50.0 to160.0 nm was obtained byultrasonic dispersion in the Kazan Research Centre for Innovation Application "Nanotechnologies and Nanomaterials" [3,4].

The research into the effects of vermiculite and nanostructure vermiculite on beef quality involved a total of 125 feeder bulls aged 15 months. Based on the principle of analogues in terms of animals' body weight, age and physiological condition, the bulls were divided in five groups of 25 animals each: animals from Group 1 served as the control and received the basic ration (BR) of the farm; in addition to BR, bulls from experimental Group 2 received vermiculite at a dose of 1.0% dry matter of the ration; bulls from experimental Groups 3, 4 and 5 were given nanostructure vermiculite in the doses of 1.0%, 0.6% and 0.2%, respectively, additionally to BR. The administration of the feed additives lasted for 90 days. The bulls were slaughtered for meat at the age of 18-19 months.

Meat samples for sanitation and hygiene assessment were selected in compliance with the Russian National Standard GOST R 51447- 99. Functional and technological properties of meat derived from the rib and sirloin cuts were subject to examination involving the estimation of the beef moisture content, water binding capacity and water holding capacity. To measure the moisture content of the meat, the technique of drying at a temperature of 103 ± 2 ° C was employed; the water binding capacity was measured using press method; water holding capacity of meat was found as the difference between the moisture content in the raw meat and the amount of moisture lost during heat treatment [5].

RESULTS

The investigation of functional and technological properties of meat is of practical importance since it contributes to the rational use of meat, as well as the forecasting and targeted regulation of the quality, sanitary and hygienic characteristics of finished products.

It is generally accepted that there is a direct correlation between moisture content and shelf life of food products. Therefore, the key method for extending the shelf life of foods is based on reducing the

moisture content of products. The moisture content of the meat derived from animals fed diets containing mineral supplements was found to be lower than in the meat from the control (Table).

Table - Functional and technological characteristics of beef

Characteristics	Group (n=5)				
	Control (BR)	BR + 1.0% vermiculite	BR + 1.0% nanostructure vermiculite	BR+ 0.6% nanostructure vermiculite	BR+ 0.2% nanostructure vermiculite
Meat from of the rib cut					
Moisture content, %	75.1±1.0	74.1±1.4	73.5±1.0	73.8±1.2	74.0±1.3
Water binding capacity, % of meat weight	61.9±1.2	67.3±2.1	71.4±3.1	70.8±1.5	68.2±0.9
Water holding capacity, %	35.4±1.3	37.4±1.4	40.2±0.9*	38.9±1.1	38.6±1.7
Meat of the sirloin cut					
Moisture content, %	74.8±0.9	73.9±1.1	73.1±1.4	73.5±1.1	73.7±1.2
Water binding capacity, % of meat weight	60.7±3.4	62.3±5.2	75.1±4.7*	73.1±1.8	73.0±2.9
Water holding capacity, %	35.2±1.2	37.8±1.5	41.4±1.4*	40.5±1.3	39.8±1.1

* $P<0.05$

In the beef from control animals, the moisture content was 75.1±1.0% in the meat derived from the rib cut and 74.8 ± 0.9% in the meat of the sirloin cut. The moisture content of the same muscle groups in bulls treated with vermiculite was 74.1±1.4 and 73.9 ± 1.1%, respectively. In the case of bulls from Groups 3, 4 and 5 exposed to different doses of nanostructure vermiculite added to BR, the moisture content was below control values by 1.6; 1.3 and 1.1%in the rib cut meat, and by 1.7; 1.3 and 1.1%in the sirloin cut, respectively. The lowest moisture content was found in the meat from bulls treated with nanostructure vermiculite at a dose of 1.0%. In terms of the moisture content, the beef from animals fed diets supplemented with vermiculite appeared to be comparable with the meat from bulls treated with nanostructure vermiculite added to BR at a dose of 0.2%.

The moisture content of the raw meat was found to be dose-dependent: the use of a larger dose of nanostructure vermiculite was associated with a larger reduction in the moisture content of beef.

The water binding capacity (WBC) of meat reflects the nature of interaction within the system 'protein-water' which is influenced by a variety of factors such as the solubility of protein systems, concentration, protein composition, etc. Increased WBC values indicate improvement of meat texture, tenderness and juiciness [6].

The introduction of mineral supplements into animal diets led to an increase in the water binding capacity of raw meat as compared to the control. During the metabolic processes in the muscle tissues of animals, macro-elements and microelements of vermiculite form stable compounds with proteins which leads to the formation of oxide compounds and the binding of water. The more active the connections are the more moisture is retained in the meat, and the larger the increase in the weight of meat products is. Muscles contain free and bound water (moisture). With regard to WBC, the bound water content is more relevant as it increases the weight of the meat product.

The largest amount of bound water was recorded in the meat from bulls treated with nanostructure vermiculite added to their diets. The bound water content was 68.2-71.5% in the beef of the rib cut and 73.0-75.1% in the sirloin beef, which exceeded control values by 6.3-9.5% and 12.3-14.4%, respectively. In the meat from bulls exposed to vermiculite, the values were lower by 5.4 and 1.6%, respectively. It was noted that the

bound moisture content altered in proportion to the total moisture content: an increase in the total moisture content of meat was accompanied by an increase in the bound moisture content.

Water holding capacity (WHC) is another important characteristic of the technological properties of meat. Resulting from the physical, chemical, and colloid-chemical changes induced by heat treatment, part of water held within the muscle tissue is lost as weight losses of finished products. The amount of moisture retained in the muscle tissue is characterized by the water holding capacity of meat which is defined as the difference between the moisture content in the raw meat and the amount of moisture lost during heat treatment [7].

The water holding capacity of meat from test animals was found to be greater and amounted to 37.4 - 41.4% against 35.2-35.4% as compared to the control values. The beef from control animals was characterized by a WHC of 35.4 ± 1.3% in the rib cut meat and 35.2 ± 1.2% in the sirloin cut meat. In the meat from bulls of Groups 3, 4 and 5 that had received different doses of nanostructure vermiculite added to BR, the water holding capacity increased by 4.8 ($P < 0.05$); 3.5 and 3.2% in the rib meat, respectively, and by 6.2 ($P < 0.05$); 5.3, and 4.6% in the sirloin meat, respectively, in comparison with the control. The water holding capacity of the same muscle groups in vermiculite treated bulls increased insignificantly by 2.0 and 2.6%. The increase in the water holding capacity of meat derived from test bulls treated with vermiculite and nanostructure vermiculite was determined by the prolonged intake of bioavailable macro-elements and microelements by the animals. This resulted in increased concentrations of mineral substances forming stable compounds with water molecules including proteins, lipids, carbohydrates, enzymes, etc.

CONCLUSION

The use of nano-structured vermiculite in the doses of 0.2-1.0% dry matter in the rations of bulls reduced the free water content by 1.5-2.3% , as well as increased the water binding capacity and water holding capacity by 10. 2 - 21.3% and 9.6-17.6% ($P < 0.05$)in the meat from the rib and sirloin cuts, respectively, as compared with the control. These alterations were less pronounced in the case of meat from animals treated with vermiculite added to their diets: the free water content reduced by 0.9-1.0%, the water binding capacity and water holding capacity increased by 1.6-5.4% and 2.0-2.6% in the meat derived from the rib and sirloin cuts, respectively. The dose-dependent nature of the effects of nanostructure vermiculite on reducing the moisture content and increasing the water binding and water holding capacities of meat was established. In terms of the functional and technological properties of meat, the beef from animals fed rations supplemented with vermiculite and nanostructure vermiculite proved to be of higher quality and more favorable for further processing. The achieved characteristics of meat from test animals ensured higher attractiveness of the meat for processing into meat products, as well as its long-term storage.

REFERENCES

[1] Aniksevich ON et al. Food industry: science and technologies 2011; 3 (13): 38–42.
[2] HellbergR S et al. Food Control 2017; 80: 23-28
[3] Semenov E.I.et al. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2016;7(1): 1860-1868.
[4] Tomasevic I, Rajkovic A. Procedia Food Science 2015; 5: 285-288
[5] Petracci M et al. Trends in Food Science & Technology 2013; 33: 27-39
[6] Mani-LópezE et al. Food Research International 2012; 45: 713-721
[7] Semenov E.I. et al. Bali Medical Journal 2017; 6(2): 110-114.