ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Ecological Aspects Of Nitrate Accumulation In Farm Animal Feed And Safety Of Meat Products.

NN Zabashta[1], AA Nesterenko[1], MP Semenenko[2]*, E V Kuzminova[2], and EP Lisovitskaya[2].

[1]Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, Russia
[2]Krasnodar Research Center for Animal Husbandry and Veterinary Medicine, Krasnodar, Russia

ABSTRACT

Research aimed at studying the degree of accumulation of nitrates, nitrites and nitrosamines in meat raw materials, using feed with different levels of nitrates in rations of bull-calves, revealed that in order to obtain meat that meets the requirements for raw materials for baby nutrition, the amount of nitrates (per NO3) in the daily ration of animals should not exceed 2.5 g per 100 kg of body weight and the amount of nitrites should not exceed 10 mg per 1 kg of feed.

Keywords: bull-calves for fattening, nitrates, nitrites, nitrosamines, feed.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

The problem of toxic accumulation of nitrate nitrogen in agricultural products and its harmful effects on humans is one of the most acute and urgent issue at the present stage. In some countries national values for the maximum allowable levels (MAL) of nitrates in animal feed have not been determined so far. However, the maximum safe concentration is admitted in the range of 0.5-0.8% of the dry matter of the ration [1, 3].

Nitrates and nitrites enter the human body with food, which causes concern for its health. Systematic intake of increased amounts of nitrates is fraught with adverse changes in the life of the body, increasing risk of cancer.

The WHO (World Health Organization) has set the maximum permissible dose of nitrates (5 mg/kg body weight per day), which is harmless to humans when consumed daily with food and water.

Particularly dangerous is the restored form of nitrates – nitrites. The restoration of nitrates by nitrate reductase of microbiological origin is carried out both endogenously – in the gastrointestinal tract and oral cavity [2] and exogenously – during the storage of food [4].

Because of the underdevelopment of the enzymatic reductase system of erythrocytes of children, which transforms methemoglobin into hemoglobin, nitrates and nitrites are the most dangerous for them. In addition, the secretion of hydrochloric acid in stomach of children is reduced that creates conditions for the development of nitrate reductase microflora and, consequently, for the significantly greater restoration of nitrates to nitrites than adults have.

Nitrates and nitrites by blocking redox reactions in a living cell cause a state of hypoxia in tissues as well as teratogenic and embryotoxic effects [5].

Currently, a lot of attention is paid to the study of the ecological role of nitrates and nitrites because they are converted into nitroso compounds in the body, many of which are carcinogenic.

Nitroso compounds are the group of substances that do not have pronounced toxic properties in those concentrations that are found in the environment, including food and food raw materials. However, they are involved in such pathological processes as the occurrence of significant disorders of functionally important macromolecules – DNA and RNA, proteins, inducing tumors of various localizations in experimental animals.

The kinetics of nitrosation of amines and amides is well studied and reflected in the literature. It was also determined that a variety of compounds can affect the rate of nitrosation, slowing down or strengthening it in the environment [6].

Therefore, monitoring of the appearance of nitroso compounds in the environment, raw meat and food products has a paramount practical importance.

Thus, it should be noted that the study of patterns of formation of nitroso compounds and the role of various chemicals in this process is the basis for preventing the formation of carcinogens in the environment.

METHODOLOGY

The experiments were carried out in two series on bull-calves of the black-and-white breed of 16-18 months old with an average body weight of 440 ± 12.5 kg.

In the first series, the animals were divided into two groups of 15 each. The control group of bull-calves received feed of the basic ration (BR) for 20 days, and sodium nitrate – $NaNO_3$ – was added to the animals of the experimental group for 7 days (at the rate of 180 g per head per day).

The feeding ration of bull-calves was calculated to obtain 800-900 g of weight gain per day. According to the set of feed, the BR corresponded to the fattening period in specialized farms supplying raw meat for baby nutrition (kg): compound feed – 3.5; silage – 8; green mass of annual and perennial grasses – 15. The

total nutritional value was 8.3 EFU; at 1 EFU was 90.7 g of digestible protein. Since the content of nitrates in the feed of the basic ration was significantly lower than the MAL (60–67 mg/kg), the addition of $NaNO_3$ to the feed rations of the experimental bull-calves corresponded to the possible intake of NO_3^- ion with the feed.

On the 7th day of the experiment a control slaughter of animals was carried out (3 animals from each group). The concentration of nitrates, nitrites and nitrosamines has been determined in muscles, liver, heart and kidneys. The remaining animals of the experimental group were transferred to the basic ration of the control analogues (without the addition of $NaNO_3$). And then, after 1, 2, 5 and 10 days after feeding the control slaughters in groups were conducted (n = 3).

The second experiment was carried out on three groups of analog bull-calves in accordance with the scheme (Table 1).

The feeding ration consisted of wheat grain (4 kg); silage (15 kg); haylage (5 kg). In the ration of the control group the nitrate concentration was lower than MAL (debris – 70 mg/kg; haylage – 286 mg/kg; silage – 200 mg/kg).

The 2nd group of animals in a mixture with concentrates got sodium nitrate at the rate of 7.5 g per head per day to achieve the maximum permissible level of nitrate in the ration.

The 3rd group of bull-calves got 150 g of $NaNO_3$ per head per day in the ration. The animals were fed for 7 days, and then a control slaughter was made from each group (after 3 hours, 1, 3, 5, 14 and 20 day after the animals were transferred to the control group ration). At the same time, for the analysis of the concentration of nitrates, nitrites and nitrosamines, muscles and internal organs were selected (a common sample was formed from the internal organs).

RESULTS

As a result of monitoring the health of the bull-calves of the first series of the experiment, no visible deviations of the clinical state of the animals of the physiological norm with sodium nitrate were found.

According to the results of the analysis of meat and internal organs, it was concluded that nitrates have mild cumulative properties. In the experimental animals immediately after slaughter nitrates were found in insignificant quantities (muscles – 0.4 mg/kg; liver – 0.64 mg/kg; kidneys – 0.19 mg/kg; heart – 2.02 mg/kg). On the 5th day after exclusion of $NaNO_3$ from the ration, nitrates and nitrites in the muscle tissue and internal organs were practically absent.

The total concentration of N-nitrosamines in the samples of experimental bull-calves did not differ from the samples of control analogues after 3 and 24 hours after feeding with the addition of sodium nitrate, but after 48 hours their concentration increased and reached the maximum on the 5th day (Table 2).

The concentration of nitrosamines in muscles and internal organs of animals 5 days after the cessation of feeding with high doses of nitrates was 2.2-5.0 times higher than the maximum allowable amounts of these compounds in raw meat for baby nutrition. After 10 days their number decreased, approaching the control level, but in muscles and in the heart these values still exceeded the permissible level.

Therefore, during the second series of studies we determined the time during which N-nitrosamines formed endogenously in tissues were reduced to an acceptable level.

The presence of nitrates and nitrites in tissues of animals of the experimental groups was noted already after 3 hours after the cessation of feeding with sodium nitrate $NaNO_3$ (2nd group – 0.2-3.4 mg/kg NO_3^- and 0.0-0.1 mg/kg NO_2^-; 3rd group – 1.6-22.1 mg/kg (NO_3^-) and 0.0-0.2 mg/kg (NO_2^-), respectively. Residual amounts of nitrates and nitrites were maintained for 5 days. And then, in muscles and internal organs of bull-calves nitrosamines were found, moreover, in the 2nd group – 2 times higher and in the 3rd group – more than 6 times higher than the determined norms (Table 3).

Thus, the use of feed with the concentration of nitrates both at the level of MAL and above it contributes to the accumulation of carcinogenic nitrosamines in raw meat.

CONCLUSION

According to the results of the analysis of meat and internal organs, we can conclude that nitrates have poorly expressed cumulative properties. They are found in small amounts in experimental animals 3 hours after the last feeding with sodium nitrate in the ration (muscles – 0.4 mg/kg; liver – 0.64 mg/kg; kidneys – 0.19 mg/kg; heart – 2.02 mg/kg), and nitrites – in the range of 0.0-0.5 mg/kg. On the 5th day after exclusion of $NaNO_3$ from the ration, nitrates and nitrites in the tissues were practically absent. At the same time, the total content of nitrosamines in the test samples does not differ from the control after 3 and 24 hours after the last feeding with the addition of sodium nitrate, but it increases after 48 hours and reaches maximum level on the 5th day.

It was determined that the concentration of nitrosamines in muscles and internal organs of animals remains more than 5 times higher than the maximum permissible level, even one week after the cessation of addition to the ration of bull-calves of sodium nitrate. Therefore, to guarantee prevention of nitrosamines from entering raw meat for baby nutrition, constant monitoring of nitrates and nitrites in feed is necessary.

REFERENCES

[1] Maistrenko VN, Khamitov RZ, Budnikov GK. Ecological and analytical monitoring of supert oxicants. Chemistry. 1996; 5: 14-15.
[2] Pimenova VV, Zhukova RF, Arkhipova GN. The content of carcinogenic compounds in food. Nitrition issues. 1985; 3: 66-70.
[3] Riger AN, Kulpina NV. Features of cultivation of environmentally friendly feed in the farms-suppliers of livestock raw materials for the production of baby nutrition. Scientific basic principles of livestock and fodder production: Anniversary collection of scientific papers, SKNIIZH. Krasnodar, 1999; 433-438.
[4] Rubenchik VL, Kaprilovskaya ED. Nutritional inhibitors of the formation of carcinogenic nitroso compounds. Nitrition issues. 1985; 1: 48-51.
[5] Chen J, Ohshimo H, Jang H. A correlation compounds and cancer mortality in China: Inform and cancer mortality results. II JARS Sci. Rube. 1987; 84: 503-506.
[6] Podhorsky M. Feed, raising the content of organochlorine pesticides in meat of farm animals. Animal husbandry. 1985; 2: 21-24.