Development of a new technology for improving the quality of food raw materials of animal origin

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Abstract. The use of silver, which is a potent antibiotic, has attracted our interest in testing it as an anti-stress drug for technological stresses such as transportation and pre-slaughter handling. Based on the results, we have developed a new technology for improving the quality of food raw materials, including the intramuscular injection of ultrafine particles (UFP) of silver at a dose of 0.01 mg / kg of live weight. This allows improving the quality characteristics of by-products (liver, kidneys, lungs), which is characterized by an increase of both saturated fatty acid (namely, palmitic one) by 23.7% and unsaturated (oleic) acid by 38.6%; and at a dosage of 0.05 mg / kg of live weight – in terms of myristic, palmitic and oleic fatty acids compared to the control group without the drug administration. This contributed to a decrease in the activity of free radical oxidation in animals and increased adaptive abilities. However, the best adaptive qualities with an increase in the amount of corresponding fatty-acids were animals who were intramuscularly injected with UFP of silver at a dose of 0.01 mg/kg of body weight.

1. Introduction

During transportation animals get under the influence of many factors, i.e. transport, climatic factors (temperature, humidity, gases, etc.). The animal’s reaction to the effects of transport stress creates a complex interaction between neurons and hormones. The result of such interactions is clinically manifested in changes in the physical (external changes), hematological, biochemical and hormonal parameters (internal changes) of the body.

Transport stress negatively affects productivity, for example, causing loss of live weight, which varies from 3 to 12 percent depending on the duration and conditions of a trip [1]. The application of UFP has generated great interest in several areas, including biotechnology, biomedical sciences, and veterinary medicine [2, 3]. Its application in the field of veterinary has not reached a high level and remains at a relatively innovative stage. More recently, UFP have been used as nutraceuticals, biocides, diagnostic tools, reproductive agents, as well as for the delivery of drugs and nutrients in veterinary medicine, and have shown potential as an alternative to conventional antimicrobials [4]. Currently, ultrafine particles (UFP) are widely used in animal husbandry and poultry farming [5].

Silver has strong antimicrobial and antifungal properties [6]. These signs are the main reason for the widespread use of UFP of silver. The use of silver UFP as a powerful disinfectant due to its antibacterial properties contributed to its use in animal husbandry [7].

Fatty-acids (FA) play an important role in homeostasis, the structure of a cell and the entire animal organism [8]. First of all, they are the main components of all biological membranes embedded in phospholipids, glycolipids and lipoproteins. Secondly, it is a source of energy stored in
triacylglycerols. Thirdly, various FA metabolites serve as the most important intracellular and extracellular lipid mediators and hormones [9–11]. Thus, FAs have almost unlimited possibilities to modulate the immune functions of a cell, affecting its structure, metabolism and function, acting through surface proteins (receptors associated with the G-protein; GPR), intranuclear receptors, or membrane transporters [12, 13].

This study evaluates the impact of stress and anti-stress substance (UFP of silver) on the fatty-acid composition of internal organs.

The purpose of the study: To study the features of the effect of UFP of silver on the fatty acid composition of internal organs during transport and preslaughter stress.

2. Materials and Methods of Research

The studies were conducted on black-and-white bulls of 18 months of age, with an average live weight of 481.6 to 491.1 kg in the agricultural company Nur OJSC of Sterlibashevsky District of the Republic of Bashkortostan. Three groups were formed, i.e. one control group and two experimental groups. The animals were injected intramuscularly (into the femoris muscle) with a suspension (pH 9.5, redox potential Eh = –450 mV) with UFP of silver at a dose of 0.01 and 0.05 mg/kg of body weight for seven days before the beginning of exposure to stress factor. Live weight was determined by weighing.

UFPs of silver were up to 100 nm in size (chemical and phase composition: 99.99 % of metallic silver, adsorbed gases: up to 0.01 % – CH₄, CO₂, Ar, N₂, production method: electric explosion in argon atmosphere, specific surface area: Ssp = 6.5 m²/g ). To prepare an injection suspension, the amount of silver UFP depending on the live weight of the animal was mixed with catholyte and subjected to dispersion in an ultrasonic disperser UZDN-2T in 0.5 A, 44 kHz mode. The emulsion was administered to the animals in the femoris muscle.

The animals were weighed on a VSP4-ZhsO electronic scale; a suspension with UFP of silver was introduced by a veterinary syringe.

3. Results and Discussions

Studies have shown that UFP of silver administered intramuscularly did not accumulate in the liver, lungs, and kidneys. The dose of UFP did not significantly affect the deposition of silver in the internals of the body. It was less than 0.0008 %. Moreover, the accumulation of a small amount of silver in the lungs in an amount of 0.013 % in group II was identified.

The main fatty-acids in the liver are palmitic (16: 0), stearic (18: 0), oleic (18: 1n-9), linoleic (18: 2n-6) acids (Fig. 1).

![Figure 1. Fatty-acid composition of liver in calf](image-url)
The data obtained from animals that were injected with silver UFP intramuscularly were compared with the control group. Carrying out a comparative analysis of the obtained data, it was found that in animals that were administered with the UFP of silver at a dose of 0.01 mg/kg of body weight, there was an increase in the level of saturated fatty-acids (palmitic) by 4.9 % and unsaturated fatty-acids (oleic) by 11.0 % compared to the control group. In bulls of group II (UDC of silver at a dose of 0.05 mg/kg live weight), the advantage was 0.1 and 3.2 % for myristic and palmitic saturated fatty-acids and 0.8 % for oleic unsaturated fatty acid compared with the control group.

In the control group, which was subject to technological stress (transportation), palmitoleic (unsaturated) fatty-acids increased by 0.6 %; 0.5 %; stearic (saturated) – by 7.8 %; 2.0 % and linoleic (unsaturated) – by 6.8 %; 1.5 % compared with the animals from groups I and II.

An analysis of the content of fatty-acids in the lungs and kidneys when using UFP of silver during transportation and preslaughter care revealed the features of their deposition in these internals.

The fatty acid composition of lungs is shown in Fig. 2.

![Figure 2. Fatty-acid composition of lungs of calf](image)

The largest deposition in the lungs of animals was observed in palmitic and palmitoleic acid, which were administered with UFP of silver at a dose of 0.01 mg/kg of live weight compared to group II by 6.9 %; 1.8 % and with a control group of 8.7 %; 1.7 %. Compared with the liver in the lungs of group I there was observed a greater deposition of palmitoleic acid by 1.3 %. There is also a difference in oleic acid. In the lungs, it is greatest in group II by 12.4 % and 9.4 % compared with peers from other groups. In the lungs, as well as in the liver, in the control group there is an increase in linoleic and linolenic acids by 6.4 %; 7.1 % and 0.3 %; 0.3 %.

The content of fatty-acids in kidneys in the studied groups of animals was almost at the same level (Fig. 3).

Deviations were observed only in individuals of group II in terms of myristic, palmitic and linoleic decrease by 0.8 %; 1.2 and 0.8 % (average); the increase was observed in palmitoleic, stearic and oleic fatty-acids by 0.3 %; 0.6 and 1.6 % (on average) compared with the control group and group I.

Arachic (saturated fatty) acid, which is often associated with the idea of a negative effect on fat metabolism, on function and condition, was found only in light animals in the control group in the amount of 0.1 %.
Today, silver UFPs are widely used as effective antimicrobial agents affecting the physiological parameters of the body [6]. In this experiment, there was investigated the effect of UFP of silver on animals during the stress; there are a limited studies in this area in the available literature.

The use of silver UFP at a dose of 0.01 and 0.05 mg/kg of live weight is practically not deposited in the internals. When examined the concentration was less than <0.0008 %.

Evaluation of the fatty-acid composition of the calf’s liver after transport (the distance to the meat processing plant is 150 km) and preslaughter stress showed that in the animals whose stress had a significant effect (control group). There was an increase in only two stearic fatty-acids (saturated) – by 7.8 %; 2.0 % and linoleic (unsaturated) – by 6.8 %; 1.5 % compared with the animals from groups I and II. It is known that these acids have antioxidant, anti-inflammatory, immunostimulating, and protective properties [10]. In addition, an increase in linoleic acid can lead to the development of cholesterol plaques, blood clots, and an increase in pressure [11].

Intramuscular administration of a suspension with UFD of silver at a dose of 0.01 mg / kg of live weight contributed to an increase in the level of saturated fatty acids (palmitic) in the liver – by 23.7 % and unsaturated (oleic) – by 38.6 %. These acids reduce the activity of free radical oxidation in animals and increase stress resistance. At a dose of 0.05 mg/kg body weight, myristic, palmitic saturated fatty acids increase by 5.3 and 15.5 % and oleic unsaturated fatty acids by 2.8 %, which contributes to an increase in bactericidal, viricidal and fungicidal activity, leading to suppression of the development of pathogenic microflora [14].

By the amount of fatty-acids in the lungs in animals of group II, there was an increase in the number of palmitic and palmitoleic acids, which exhibit cytoprotective properties, and also effectively lower the level of atherogenic low-density lipoproteins, reduce the activity of free radical oxidation in animals by 6.9 %; 1.8 and 8.7 %; 1.7 % compared with group II and the control group. The amount of oleic acid was greater in group II by 12.4 and 9.4 % compared with the animals from other groups. In calves that were subject to stress, linoleic and linolenic acids increased by 6.4 %; 7.1 and 0.3 %; 0.3 %, which is consistent with data from other authors [15].

In kidneys of all animals, almost the same amount of fatty acids was observed. Only in group II, the calves, which were injected with 0.05 mg/kg of live weight of UFP of silver had a lower amount of myristic, palmitic and oleic acid by 0.8 %; 1.2 and 0.8 % (average), and more palmitoleic, stearic and oleic fatty acids by 0.3 %; 0.6 and 1.6 % (on average) compared with the control group and group I [16].

In this study, a protective feature of UFP of silver was revealed. This is manifested in the fact that in no animal was found arachinic (saturated fatty) acid, which often negatively affects fat metabolism, liver function and condition [11]. It was found only in the control group in the amount of 0.1 %, which was subject to technological stresses. The results of preliminary studies show that UFP of silver has a stable antioxidant effect, which is useful for mitigating the effects of technological stress.
4. Conclusion
The technology of intramuscular administration of a silver suspension in a dosage of 0.01 mg / kg of live weight contributes to an increase in the body's stress resistance and the optimal ratio of fatty acids in the internal organs of bulls.

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