Biochemical status of preweaning calves when using an emulsion based on coriander and fennel essential oils

K.S. Ostrenko[1,*], *A.N.* Ovcharova[1], *N.V.* Nevkrytaya[2], and *I.V.* Kutin[1]

[1]All-Russian Research Institute of Physiology, Biochemistry, and Animal Nutrition - branch of the Rederal Research Center of Animal Husbandry - All-Russian Research Institute of Animal Husbandry named after academician L.K. Ernst, Borovsk, Russian Federation
[2]Scientific Research Institute of Agriculture of the Crimea, Simferopol, Russian Federation

Abstract. One of the promising areas for the animal husbandry development, especially in fattening calves, is the prevention of digestive disorders. One of the effective means of reducing the risks of developing abomazoenteritis in preweaning calves are secondary metabolites of essential oil crops and feed additives based on them. We have developed a phytosomal emulsion based on soy lecithin, containing 10% of a mixture of essential oils (coriander and fennel), for use as a feed additive in a whole milk substitute for preweaning calves. The aim of the study was to evaluate the effect of a phytosomal emulsion with a different proportional content of EM fennel and coriander on the morphological and biochemical parameters of the blood of preweaning calves. During the conducted studies, it was found that against the background of the use of phytoemulsions, the level of erythrocytes significantly increased by 12.3; 16.4, and 21.9%, respectively, and hemoglobin by 3.6; 9.8, and 11.6% relative to the control; a tendency to decrease in leukocytes was noted. Consequently, the use of essential oil emulsions led to erythropoiesis intensification. In animals of the 3rd group, the maximum increase in protein and fat metabolism was revealed: an increase in the level of total protein by 19.1%, albumin fraction - by 11.4%; creatinine content - by 17%; cholesterol - by 8.6%, HDL - by 13.7%, triglycerides - by 2 times. The content of calcium, iron, and magnesium was also higher in the experimental groups. Thus, the introduction of EO emulsions into the diet had a beneficial effect on the metabolic processes in the body of calves, characterizing the intensity of protein metabolism and, as a result, the intensification of muscle mass gain.

1 Introduction

Essential oils have been used in various spheres of life for more than 6 thousand years. Aromatic plants and extracts from them were used in all the great cultures of antiquity. The most ancient medical treatises list many aromatic plants and the purpose of their use in

* Corresponding author: ostrenkoks@gmail.com

Ancient Rome, Greece, the Near and Far East. For thousands of years, people have used essential oils not only as ingredients in perfumes or seasonings for flavoring food, but also in folk medicine due to various biological properties, including antimicrobial [3].

Essential oils are defined as volatile secondary metabolites of plants that give a plant a characteristic smell, taste, or both. The oil-forming process depends on many factors. Essential oil is accumulated in specialized secretory structures such as glands, secretory cavities, and channels that form in various organs of plants, most often in flowers and fruits. Despite the content of two or three main components in the essential oil at the level of 20-70%, they are very complex mixtures. Consisting mainly of terpenes, terpenoids, and phenylpropanoids, essential oils can also contain many other compounds such as fatty acids, oxides, and sulfur derivatives [8].

Essential oils have growth-stimulating properties, which are mainly associated with their effect on the gastrointestinal tract - increasing the taste quality of food, stimulating the secretion of digestive fluids, improving intestinal morphology, stabilizing the intestinal microbiome, reducing inflammation [10, 11]. Essential oils contribute to better absorption of nutrients by increasing the digestibility of feed, which has been studied in pigs and poultry [1]. They can affect the digestibility and speed of food passage through the digestive tract, affecting the synthesis of bile, increasing the secretion of saliva, bile, and mucus and increasing the activity of enzymes [2].

Essential oils added to animal diets have a positive effect on the body's metabolic processes, but their use is associated with certain problems and limitations. The strong taste and smell of some essential oils, such as carvacrol, can negatively affect feed intake, reducing the appetite of the animal. The stability and biological activity of essential oils can be reduced due to temperature, light, contact with metals, as well as the presence of water and oxygen in the environment. Some researchers note a lower biological effect of essential oils when added to diets containing a lot of plant fibers and protein [6].

Despite thousands of years of experience in the study and application of essential oils, their effect on the biochemical parameters of the blood of animals, in particular calves, has not been studied enough. There is practically no data on the effect of their nanocapsulated forms in the form of phytosomal emulsions on the body of dairy calves [8, 10]. In this regard, we set the task of creating emulsions based on fennel and coriander essential oils, and studying their effect on the biochemical profile of dairy calves. Fennel and coriander oils were chosen due to their availability and relatively low cost, which is especially important for agriculture.

Common fennel (*Foeniculum vulgare* Mill.) belongs to the parsley family. It is a widely cultivated plant in temperate regions, relatively unpretentious in agricultural technology. Fennel has a rich history of use in folk medicine. Its fruits are used to stimulate digestion, relieve symptoms of digestive disorders and as an effective remedy for diabetes, bronchitis, chronic cough, and urolithiasis, has antispasmodic properties [6]. In addition to its effect on the digestive system, fennel essential oil has pronounced anxiolytic properties [6].

Coriander (*Coriandrum sativum* L.) is an annual plant of the parsley family, known since ancient times, grown everywhere, widely used as a spicy, honey–bearing, essential oil and medicinal crop. In terms of areas occupied by essential oil crops, coriander ranks first in Russia. Linalool, which content in coriander fruit essential oil reaches 65-75%, determines its biological properties, such as antitumor, anti-inflammatory, and antioxidant [4]. In addition to linalool, the essential oil contains many polyphenolic compounds, the characteristic properties of which are antiradical and antioxidant activity. The large amount of polyphenols in coriander essential oil makes it a suitable reducing agent, inhibitor of lipid peroxidation, scavenger of free radicals and singlet oxygen. Coriander essential oil also affects the metabolic processes of the body, is effective in obesity, diabetes, and metabolic syndrome [5].

With a large number of studies on the composition and biological effects of fennel and coriander essential oils, their combined use and possible synergism of action are poorly understood.

The purpose of the study was to evaluate the effect of phytosomal emulsions of fennel and coriander EO on morphological and biochemical parameters of the blood of preweaning calves.

2 Materials and Methods of research

The study was conducted on the basis of the Laboratory of Immunobiotechnology and Microbiology and the vivarium of All-Russian Research Institute of Animal Physiology, Biochemistry, and Nutrition – a branch of the All-Russian Research Institute of Animal Husbandry n.a. L.K. Ernst in 2023-2024. Essential oils of coriander and fennel and information about their component composition were obtained from the Federal State Budgetary Research Institution Scientific Research Institute of Agriculture of the Crimea.

To carry out the research, phytosomal emulsions based on soy lecithin containing 10% essential oils (EM emulsions) were obtained according to the method developed by the authors – an emulsion of EM coriander and an emulsion of EM fennel EO.

The effect of the obtained phytosomal emulsions was studied on Holsteinized calves of the Black-and-White breed, from the age of 20 days to the age of 3 months. The calves were divided into 4 groups of 10 heads each. The calves of the control group received a basic diet (BD), which consisted of 750 g of dry calf milk replacer (CMR), 150 g of starter compound feed as complementary food, and 500 g alfalfa hay per 1 head per day. The calves of the experimental groups were daily injected into the CRM feed complex with fennel and coriander essential oils in the form of a mixture of emulsions – only 10 ml (1 ml of essential oils) per the calf. The ratio of emulsions was as follows: in the 1st group — 7 ml of fennel essential oil emulsion and 3 ml of coriander seed essential oil emulsion; in the 2nd — 5 ml of fennel essential oil emulsion and 5 ml of coriander seed essential oil emulsion; in the 3rd — 3 ml of fennel essential oil emulsion and 7 ml of emulsion of coriander seed essential oil. Calves were weighed monthly throughout the study. To study the biochemical and morphological parameters, at the end of the experiment, blood was taken from the jugular vein of calves in compliance with the rules of asepsis and antiseptics in two sterile test tubes. In one of the tubes, the blood was stabilized with EDTA, and the other was used to obtain serum, with further determination of biochemical and hematological parameters using the ERBAXL-100 automatic biochemical analyzer (Erba Lachema, Czech Republic) and the DF50 Vet automatic hematology analyzer (Dymind, China).

Biochemical studies of blood serum included: total protein, g/l; albumin, g/l; globulin, g/l; urea, mmol/l; creatinine, mmol/l; bilirubin, mmol/l; ALT, ME/L; AST, ME/L; alkaline phosphatase, mmol/l; cholesterol, mmol/l; triglycerides, mmol/l; phospholipids, mmol/l; glucose, mmol/l; calcium, mmol/l; phosphorus, mmol/L. The content of erythrocytes, leukocytes, hemoglobin, and hematocrit was determined from hematological parameters [8].

All the obtained digital material was statistically processed by the method of Student variation statistics using the Microsoft Excel program within the following significance levels:*- $P<0.05$.

3 Results and Discussion

The obtained phytosomal emulsions made it possible to effectively dose essential oils and provided good solubility in CRM. When studying the biochemical parameters of blood, some changes in the biochemical status of experimental calves were revealed (Table 1).
The introduction of emulsions of coriander and fennel essential oils had an impact on protein metabolism. The content of total protein, albumin, and globulin fractions significantly increased. The ratio of albumins to globulins in the experimental groups decreased due to the high content of globulins.

Table 1. Biochemical parameters of blood serum of preweaning calves (M±m, n=10).

Indicators	Control group	1 experimental group 70 % fennel EO emulsion / 30 % coriander EO emulsion	2 experimental group 50 % fennel EO emulsion / 50 % coriander EO emulsion	3 experimental group 30 % fennel EO emulsion / 70 % coriander EO emulsion
Total protein, g/l	56.32±5.9	64.4±5.7	63.7±7.7	67.1±3.1*
Albumin, g/l	21.8±1.3	22.7±1.1	22.7±2.2	24.3±1.4*
Globulins, g/l	34.6± 2.3	41.7± 6.4	41.0±2.8*	42.6±1.7*
A/G	0.63	0.54	0.55	0.57
Urea, mmol/l	3.19±0.38	2.86±0.69	2.61±0.52	2.78±0.49
Creatinine, mmol/l	67.09±3.18	71.12±5.98	75.23±3.78*	78.52±8.26*
Alkaline phosphatase, mmol/l	183.2±20.1	292.1±69.6	316.5±29.7	324.1±31.6*
Glucose, mmol/l	6.21±0.40	5.92±0.26	5.40± 0.39*	4.96±0.47*
ALT, IU/L	38.5±26.81	34.36±31.95	28.54±10.12	25.03±10.69*
AST, IU/L	131.81±10.89	116.6±28.53	114.17±19.60	90.26±13.89*
Cholesterol, mmol/l	2.20±0.35	2.22±0.43	2.35±0.56	2.39±0.39
HDL	1.02±0.03	1.08±0.04	1.14±0.03	1.16±0.05*
LDL	0.83±0.05	0.83±0.04	0.92±0.07	0.99±0.06*
VLDL	0.34±0.03	0.31±0.04	0.29±0.05	0.24±0.06*
Triglycerides, mmol/l	0.25±0.06	0.4±0.1	0.45±0.1*	0.56±0.06*

* $P<0.05$

The urea content was lower and creatinine was significantly higher in the experimental groups. The above changes allow to judge the activation of protein metabolism under the action of EO emulsions. The indicators of fat metabolism differed in the experimental and control groups. The introduction of an emulsion containing 70% fennel essential oil into the calves' diet had practically no effect on the cholesterol content, nevertheless, with an increase in the percentage of coriander essential oil, an increase in cholesterol was observed, the same pattern was noted in an increase in triglycerides. For optimal functioning of the body, not only the total amount of lipids of various fractions is important, but also their ratio.

The concentration of glucose in the blood is the main indicator of carbohydrate metabolism. When studying the glucose content in the blood of calves, a decrease in glucose levels was observed in all groups. The same pattern was noted as with the indicators of lipid metabolism – with an increase in the content of coriander essential oil, the changes are more pronounced. The effect of coriander essential oil on carbohydrate metabolism has been highlighted in the research of foreign scientists.

When studying hematological parameters, all indicators were within the age norm for cattle, but the intergroup data varied (Table 1). Thus, in calves of 1-3 experimental groups,

there was a significant increase in the level of erythrocytes by 12.3; 16.4; and 21.9%, respectively, and hemoglobin by 3.6; 9.8' and 11.6% relative to the control. Thus, the use of phytosomal EO emulsions in various proportions led to the intensification of erythropoiesis.

The leukocyte content in calves of all experimental groups was lower than the control values: in the 3rd group, which received 70% coriander EO emulsion and 30% fennel EO emulsion, it was significantly lower by 28%, in the remaining experimental groups, the decrease in leukocytes was noted at the trend level.

In the control group, this indicator was at the upper limit of the norm, which may indicate the possibility of inflammatory processes.

Table 2. Morphological blood parameters of preweaning calves (M±m, n=10).

Indicators	Control group	1 experimental group 70 % fennel EO emulsion / 30 % coriander EO emulsion	2 experimental group 50 % fennel EO emulsion / 50 % coriander EO emulsion	3 experimental group 30 % fennel EO emulsion / 70 % coriander EO emulsion
Red blood cells, RBC, 10*12L	7.3 ±0.7	8.2±0.6	8.5±0.6	8.9±0.7*
Hemoglobin, HGB, q/L	108.6±6.2	112.5±4.2	119.3±6.3	121.2±5.6*
Hemotocrit, HCT, %	36.8±4.03	38.8±2.1	37.3±1.7	37.1±1.2
Mean cell volume, MCV, fl	36.9±1.1	37.1±1.2	37.2±1.7	38.9±1.0
Mean cell haemoglobin, MCH, pq	13.8±1.0	14.4±0.5	14.0±0.5	14.2±0.7
White blood cells, WBC, *10*9L*	10.70±1.45	8.02±2.04	8.62±1.38	7.70±1.01
Neutrophils, Neu *#, 10*9L*	11.7±1.0	10.4±2.4	8.4±1.8	8.9±1.1*
Lymphocytes, Lym *#, 10*9L*	25.5±6.2	34.7±3.9	34.7±3.2	39.9±5.4*
Monocytes, Mon *#, 10*9L*	57.7±3.7	50.6±8.7	56.0±5.5	64.6±9.5
Eosinophils, Eos *#, 10*9L*	6.8±2.1	3.9±2.8	3.8±2.2	2.1±2.0*
Basophils, Bas *#, 10*9L*	0.5±0.03	0.4±0.03	0.4±0.02	0.5±0.03
Platelets, PLT, *10*9L*	410.87±117.27	405.4±88.15	465.37±110.30	418.22±115.72

* P<0.05

A decrease in leukocytes in calves treated with a phytosomal emulsion allows to conclude that this indicator is normalized, considering the pronounced anti-inflammatory properties of fennel and coriander essential oils, highlighted in the works of other researchers [11].

4 Conclusion

As a result of the conducted research, it was revealed that the use of phytosomal emulsions makes it possible to effectively dose essential oils in the diet of preweaning calves, due to their high solubility in CRM. There was no decrease in animal appetite and other negative clinical manifestations against the background of the introduction of oils.

Phytosomal emulsions containing fennel and coriander essential oils in various proportions had a pronounced positive effect on the metabolic processes of the body. The

most effective is the ratio of essential oils in the emulsion of the 3rd experimental group - 30/70% fennel and coriander EO.

In calves of 1-3 experimental groups, there was a significant increase in the level of erythrocytes by 12.3; 16.4; and 21.9%, respectively, and hemoglobin by 3.6; 9.8; and 11.6% relative to the control; a tendency to decrease leukocytes was noted. Thus, the use of EO emulsions led to the intensification of erythropoiesis.

In experimental animals, an increase in protein and fat metabolism was revealed. A significant increase in total protein level in the 3 experimental groups was 19.1%, albumin fraction – 1.4%, an increase in creatinine content – 17%; cholesterol – 8.6%, HDL – 13.7%, the number of triglycerides increased 2 times.

The conducted studies confirm the effectiveness of the of essential oils for the intensification of metabolic processes in preweaning calves and, as a result, a high productive potential. The expediency of using essential oils in the form of phytosomal emulsions makes it possible to include this technology in intensive calf rearing.

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