Influence of coniferous-wormwood extract on the viability of bee colonies in Eastern Siberia

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Abstract. The article is devoted to the problems of maintaining viability and increasing the productivity of honey bees in Eastern Siberia. The benefits of coniferous wormwood extract for autumn-spring feeding of bee colonies are described. The researches have shown that bees more actively took food with coniferous wormwood extract than regular sugar syrup. Feeding bees with syrup with extract positively influenced the course of wintering of bees: in the experimental group there was 100% safety. A positive effect of the extract on the development of bee colonies, flight activity of bees was noted: it was seen that the individuals were strong and active. As a result of the researches, it was noticed that after a six-fold feeding of bees with coniferous wormwood extract, the strength of the bee colonies, the average honey and wax productivity, the number of brood and received nucleus increased. The daily increase of population made it possible to maintain an optimal microclimate in the brood nest. It was found that stimulative feeding with the extract increased resistance to such common diseases as varroatosis (there was an 82.8% reduction in the mite strike of bee colonies), nosematosis and ascospherosis. These observations indicate that bee colonies had a huge army of working bees, the microclimate inside the nest was healthy, and it made the maximum use of forces for further increase of individuals and making products.

1. Introduction
Bees are the oldest inhabitants of our planet. They appeared 50-60 thousand years earlier than human beings. Different species and populations of bees live on all continents, with the exception of Antarctica. These small insects do a great job; flying from flower to flower they transfer pollen on their bodies from male flowers to female flowers and thereby contribute to the formation of seeds. The fact that our planet in the warm season is covered with vegetation is a merit of bees [1].

Performing pollination of various agricultural plants such as fruit, berries, vegetables, melons, grains, oilseeds, industrial and forage crops, the bees thereby ensure their productivity and the effectiveness of further use [2].

Beekeeping is an important link in agricultural production, so the increase of the yield of fodder crops and the manufacturing of animal products monumentally depend on its successful development. Over the past 20 years there has been a destruction of the beekeeping industry [3].

As the researchers showed, the beneficial effect of bees and their products on the human body lies in the fact that they have active, well-defined prophylactic and therapeutic properties. Beekeeping provides valuable nutritious, dietary and medicinal products [4].
Krasnoyarsk region has vast territories of meadows, pastures, thickets of fireweed, raspberries, and also has large areas of forage crops, which allow containing more than 500 thousand bee colonies and receive at least 50 kg of marketable honey from each [3].

Such unique features of bees and their products are underestimated by human beings and an indicator of this is the average consumption of bee products in the world and in Russia: if 3 kg of honey per capita is consumed annually in the world, then in Russia there are only 400 grams per capita. Beekeeping is one of the most profitable sectors of agriculture. Our country has enormous resources and opportunities for the development of beekeeping. Today, Russia produces 50-60 thousand tons of honey per year, although the potential opportunity is 700-800 thousand tons. Beekeeping could provide employment. From this it follows that beekeeping as an industry has huge unexploitable opportunities and prospects for its development [5].

Bee pollination of buckwheat, sunflower, vegetable and melon, fruit and other crops increases their productivity by 20-30%, improves the commodity and sowing qualities of seeds, fruit and vegetables. However, only healthy bees can pollinate plants fully and produce products. From a healthy colony from 40 to 150 kilograms of honey and other products are received for the season, and a sick colony is an extra labor for the beekeeper, unjustified material costs, loss instead of income. In beekeeping, the losses from diseases and poisoning of bees, despite the measures taken, remain significant [6]. The need for urgent measures to protect the honey bee became apparent at the end of the XX century. In the 1990s the contribution of pollinators to the world economy was estimated at 65-75 billion dollars. It is believed that 3 thousand plants supplying humanity with food, including 1.3 thousand “semi-wild” tropical ones, depend on them [5].

According to a number of researchers, the reason for the decrease in the natural resistance of bees to diseases is connected with many factors; the most important factors are drugs with a chemical composition, the systematic use of which decreases resistance of bees to ticks and pathogenic microorganisms; queens often die; silent theft is noted; parasites are becoming more dangerous from year to year; bee products that are dietary are contaminated. In addition, prolonged use of chemicals contributes to the emergence of bee-resistant pathogen populations resistant to them. The treatment of bees with herbs and their decoctions does not have addictive property among agents of disease; it is well tolerated by the insects themselves and does not cause harm to people who use bee products for food.

Given the environmental situation and the decrease in the resistance of bee colonies to diseases, especially with a mixed form of their course, it is necessary to search for unconventional treatments. In terms of preserving the health of bees and increasing their natural stability, it is necessary to use environmentally friendly methods and means that do not pollute beekeeping products for the prevention and treatment of diseases [6]. This problem is currently the most urgent, the solution of which could positively affect the general well-being of the population. Herbal remedies of plant origin can be close to the satisfaction of all these conditions. One of such reserves in increasing apiary productivity, in our opinion, is the use of coniferous wormwood extract in autumn and spring feeding of bees.

We decided to test this theory by practical experimenting. To do this, we conducted an analysis of the state of production of beekeeping products in the APLC “Krasnopolyanskoye” Nazarovsky district and researches to study the effect of coniferous wormwood extract on the viability and productivity of bee colonies.

2. Materials and methods
In practice, many beekeepers use decoctions, tinctures from herbal remedies to feed the bees, thereby increasing the resistance of bees to diseases. The composition of medicines obtained by processing plant materials includes biologically active substances that cause a certain physiological effect when introduced into the body even in small quantities. Preparations from needles, pine buds and other conifers are quite common.
According to B.P. Tokin (1980) [7], phytoncids of some plants have bactericidal properties, others have an effect on animalculines, still others exhibit bactericidal and fungicidal properties. The last species should be referred to conifers. Conifer needles also have bactericidal properties; they are able to kill many bacteria, including pathogens for humans and animals.

According to available literature data, the use of coniferous extract in beekeeping in the European part of Russia has been known since the 80s of the last century and much attention is paid to it. However, in the cited sources there is no information about the use of the drug, its effect on the life expectancy of bees, the development of colonies and the manifestation of diseases in Siberia.

Therefore, the aim of our research was to study the effect of coniferous extract on the development of colonies and increase their resistance to diseases in Eastern Siberia.

The test of coniferous wormwood extract in apiary conditions was carried out on a large group of bee colonies of the Central Russian breed [8, 9, 10].

For the experiment by the method of pairs of analogues, on August 18, two groups of 35 bee colonies were formed. Bees were kept in the hives of Dadan-Blatt design. Bee colonies were monitored throughout the year. Bee colonies were given 2 liters of syrup (3 times in autumn and 3 times in spring) every 5-7 days (as they were eaten). In the experimental group, coniferous wormwood extract was added to sugar syrup in the amount of 15 ml per 1 liter, after preliminary stirring it with a small amount of water (the optimal dosage of coniferous extract was determined by L.F. Solovieva in 2004-2006 in the laboratory, in the experimental apiary of the department of prevention and disease control of bees of SSI of Scientific Research Institute of Beekeeping of the Russian Agricultural Academy). The control group was colonies which received syrup without extract. Syrup feeders were set on frames under an insulating pillow. To prepare the coniferous wormwood extract, raw materials were taken in the ratio: 50 g of pine buds, 50 g of bitter wormwood during the growing season and 900 g during flowering for 10 liters of water. Spring feeding of bees with the addition of coniferous wormwood extract is carried out after the first flyby. For this, it is better to choose rainy, windy days. The presence of any impurities, including coniferous extract, in honey is undesirable. In this regard, feeding the bees with coniferous wormwood extract should be stopped a month before the main honey collection.

For the research, bee colonies of the same strength, the same weight were taken, which determines the number of bees and honey.

The experiment was carried out according to the scheme presented in table 1.

| Group assignment | Differences | Number of bee colonies, pcs | Strength of bee colonies, kg |
|-----------------|-------------|-----------------------------|-----------------------------|
| Control         | sugar syrup feeding | 35                          | 6                           |
| Experimental    | sugar syrup feeding with coniferous wormwood extract in the amount of 15 ml per 1 liter | 35                          | 6                           |

During the entire experiment, in each group, the daily supply of nectar was determined by weighing the control hives.

Visual observations of the behavior and life activity of the studied colonies: flight activity, the behavior of bees when examining the nest, the nature of honey folding and capping, the choice of fodder plants, and the number of brood, productivity, fullness of swarms, winter hardiness, and mite infection were made.

Fullness of swarms was determined by the method given by V.A. Gubin (2001). The number of bee colonies that came into the swarm state, the number of released swarms and the built swarm queen bee’s cells per colony were calculated [11].
The flying activity of bees was determined by counting the number of individuals flying or returning to the hive per unit time. Within 10 days, the number of arrivals and departures of bees from the beehive entrance in 30 families in 5 minutes every hour was counted (Zingler, 1984; Yeskov, 1990) [12, 13].

Attendance of flowers by honey bees was studied at dedicated registration sites. The number of insects perched on a honey plant for 10 min during daylight hours was calculated (Kortowski, 1996) [14].

The effect of coniferous extract on increasing the resistance of bees to major diseases, in particular, varroosis, nosematosis and ascospherosis, the most common in apiaries, was studied.

3. Results and discussion

Empirically, in the conditions of an apiary, the attractiveness and speed of picking up syrup by bees with the addition of coniferous wormwood extract and without coniferous wormwood extract was determined. Daily weighing of syrup feeders in the experimental and control groups showed that the bees more actively took food with coniferous wormwood extract (1.4 times more active than in the control group).

The positive effect of the extract on the development of bee colonies is noted.

When feeding food with the extract, there were no dead bees at the bottom of the hives, no brood was released, queen bees continued to work; the behavior of the bees did not differ from the control group. The research results are presented in table 2.

Table 2. Research results.

| Indicators                                      | Control group | Experimental group |
|------------------------------------------------|---------------|--------------------|
| Weight of the control hive with bees, kg       |               |                    |
| At the beginning of the experiment             | 30            | 30                 |
| At the end of the experiment                   | 73,1          | 89,76              |
| Number of broom frames, pcs                    |               |                    |
| At the beginning of the experiment             | 5             | 5                  |
| At the end of the experiment                   | 6             | 9                  |
| Gross yield of honey per bee colony, kg        | 41,1          | 56,76              |
| Amount of marketable honey per bee colony, kg  | 26,1          | 41,76              |
| Quantity of marketable wax per bee colony, kg  | 2,2           | 2,4                |
| Strength of bee colony, kg                     | 6             | 6                  |
| At the beginning of the experiment             | 7             | 10                 |
| At the end of the experiment                   |               |                    |
| Average daily egg production, pcs              | 1672          | 2039               |
| Number of wintering colonies, pcs              | 31            | 35                 |
| Varroasis disease                              | 6,3           | 6,4                |
| At the beginning of the experiment, %          | 6,4           | 1,1                |
| At the end of the experiment, %                |               |                    |
| Summer activity of bees, pcs                   | 60,8          | 79,1               |
| Number of nucleuses                            | 20            | 28                 |

At the beginning of the experiment, the colonies of the experimental and control groups practically did not differ in accounting indicators. At the end of the experiment, the colonies of the experimental group were significantly superior in strength to colonies of the control group.

As researches have shown, for each colony in the experimental group an average of 41.76 kg of marketable honey and 2.4 kg of wax were obtained. The average honey productivity in the control group was 26.1 kg; the wax productivity was 2.2 kg. In bee colonies receiving the extract, scaling of beeswax foundation was also more intensive, which is very important for a better sanitary condition and renewal of the nest of bees and increase their immunity to diseases.
The number of brood frames in the experimental group was averaged 9, and in the control group only 6 pieces per bee colony. Accordingly, strong young colonies came out of the experimental group, able to produce more honey, wax, raise brood, and easier to winter.

Based on experimental studies, it was found that after six-fold feeding of bees with coniferous wormwood extract, the strength of bee colonies increased by 42.85% relative to the control group.

Feeding with coniferous wormwood extract has a beneficial effect on the work of queen bees and bee brood rearing. An increase in the number of brood in comparison with the control group by 28.4% was noted.

Feeding the bees with syrup with coniferous wormwood extract had a positive effect on the course of wintering of bees: in the experimental group there was 100% safety, while in the control group during wintering there was loss of 4 bee colonies (11.4%). After the exhibition of hives from the winter hut, observations on the state of bee colonies and the behavior of bees were made. It was noticed that individuals were strong and active. Their daily increase in numbers made it possible to maintain a stable temperature in the nest. At the slightest opportunity, a cleansing fly was made.

It was noticed that the bees departed without complications even at a temperature of +7 - +8°C. At the same time, there was a cheerful hum and the absence of a languid crawl along the front walls. There were no liquid stools with an unpleasant aroma on the entrance and the walls of the hive. And if a warm day unexpectedly came out, then thousands of active working bees, together ready to use any opportunity to search for fresh nectar and pollen, flew out from the summer openings of the bee hives. These observations testify to many things: colonies retained a huge army of working bees, the microclimate inside the hive is healthy, and it makes the maximum use of forces for further building up.

It was established that six-fold feeding with the extract helped to reduce the mite infection of bee colonies: when feeding coniferous wormwood extract, the damage of bees with varroa mite was reduced by 82.8%, i.e., feeding without extract was 5.8 times less effective in relation to bee resistance to varroatosis. This is due to the fact that when feeding syrup with coniferous wormwood extract, its bioactive substances pass into mites through the hemolymph of bees. And this leads to sterility of male mites, thereby breaking the mite propagation chain. In addition, feeding the bees with coniferous wormwood extract helped to reduce the manifestations of nosematosis and ascoferosis: these diseases were not found in the colonies of the experimental group.

The influence of coniferous-wormwood fertilizing on the flying activity of bees was determined, which in early June amounted to an average of 79.1 bees per 5 min, which is 1.3 times higher than the activity of summer control bees. Flight of bees was also more energetic in the experimental group in July and August. This can be explained by a larger number of bees in the colonies of the experimental group.

On average, 1.4 times more nucleuses were made in the experimental groups than in the control group.

During the experiment, stopwatch study of the time spent on the execution of individual technological operations was carried out. The surveys showed that the care of colonies of the experimental group occupied 1.5% more working time than the care of colonies in the control group.

Consequently, coniferous wormwood extract increases the honey productivity of bee colonies, queen bee’s fertility, increases the vitality and winter hardiness of bees, and has a positive effect on increasing resistance to such common diseases as varroatosis, nosematosis and ascopherosis. It is in such conditions that the prerequisites are made for creating viable, highly productive colonies.

4. Conclusion
Based on results of the research to determine the effectiveness of using coniferous wormwood extract in autumn-spring stimulative feeding obtained during the experiment, it can be concluded that the use of coniferous wormwood extract at a dose of 15 ml per 1 liter of sugar syrup (1.5:1) will lead to a decrease in the incidence of disease of bee colonies, an increase in their strength, an improvement in
the work of the queen, better survival and brood development, and ultimately to a greater volume of production from a single hive.

It is worth pointing out that the cost of products obtained in the form of a yield increase from bee pollination of various crops is 10-15 times higher than the cost of honey and wax obtained from bees.

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