Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

Development and recommendations for the implementation of effective technologies in the beekeeping industry into production

Roza Shimelkova, Zhanibek Parzhanov*, Kulaisha Tlegenova, Ainura Aldiyarova

South-Western Research Institute of Animal Husbandry and Plant Growing, LLP, Kazakhstan, Shymkent, Tassay, 5 Yeskaliev Street

** Corresponding authors' Email: zhanibek_58@mail.ru*

ABSTRACT

The objects of the study were to assess the honey products and artificial feed for bees enriched with biologically active substances. The purpose of the study was the development of effective technologies in the beekeeping industry in addition to generally accepted zootechnical methods for determining the composition and properties of honey products, new feed for the growth and development of bee colonies. A recommendation has been developed for the maintenance of bee colonies for the production of environmentally friendly organic honey products in apiaries. A standard has been developed for organic honey products, production, and processing rules at the Scientific Council No. 3 dated 08/11/2020. Technology has been developed for obtaining stimulative feeding to increase the strength of bee colonies in the early spring and during the autumn to increase the mass of bees. It has been established that the highest stimulating effect on egg-laying capacity and sealed brood is provided by composite feeding inverted syrup with purple coneflower *Echinacea Purpurea* (400 g). Recommendations for the implementation or R&D implementation results including: the research results can characterize the ecological state of the study area, and the quality of the products obtained, expand the combination of biologically active additives, and serve as a scientific basis for the technology of processing and storing honey products. Economic efficiency including the production of brood frames using the combination to stimulate the development of bee families: the total cost was 1230 tenge. In addition, when using the combination of "IS + *E. purpurea"*: the cost of expenses on average was 1181 tenge, while that of the combination of "IS + *Melissa*" was 1123.3 tenge. Forecast proposal for the development of the research object: Further research is needed to develop the technology for processing and storing honey products.

Keywords: Beekeeping, Processing, Honey, Beeswax, Inverted syrup.
Article type: Research Article.

INTRODUCTION

Assessment of the current state of the solved scientific and technical problem. Bees are an integral part of agrobiocenoses, and beekeeping is an important branch of the agro-industrial complex. Honey products have long been used by humans for medicinal purposes, which has the effect of an immunomodulator against diseases. At the same time, there is very little research in the field of deep processing of honey products in the world. When processing and standardizing honey in industrial volumes, in order to preserve the physical properties and nutrients, it is necessary to develop a technology for the production of organic honey products.

Relevance of the research. Beekeeping is one of the most important branches of agriculture, and today it is going through a qualitatively new stage in its history, which is characterized by the widespread introduction of industrial methods for the production of honey and other honey products. The acceleration of scientific and technological progress in beekeeping is primarily due to the fact that over the past 10-15 years honey has become a valuable dietary and medicinal product, and the demand for biologically active substances has also increased significantly.

Propolis, pollen, royal jelly, and bee venom are widely used in medicine and cosmetics. However, an important factor contributing to the acceleration of progress in this area of agricultural production is the growth of bees as pollinators of entomophilous crops. In our country, bees pollinate about 70 types of crops on an area of 10 million hectares. The income from pollination is ten times higher than the cost of the main products of the industry.

In the context of globalization of most sectors of the economy, including beekeeping, competition between individual states for foreign markets is intensifying, and requirements for the quality of honey products, namely their economic purity, and safety, are becoming more stringent. Only those enterprises and products that ensure consumer safety and guarantee quality in accordance with ever-increasing international requirements can get a chance to succeed here. To create a competitive advantage for domestic beekeeping in the world market and to establish imports, to ensure the rights and interests of consumers, a serious reorganization of the regulatory documentation for honey products is necessary.

The novelty of the research. For the first time, a methodology has been developed for the preparation of new feed products by fermentation of sucrose enriched with essential substances. A recommendation has been developed for the maintenance of bee colonies for the production of environmentally friendly organic honey products in apiaries and sanitary and epidemiological requirements for the production of organic honey products for apiaries, inventory, and technology for keeping and feeding bees have been developed. The purpose of the research. Development of effective technologies in the beekeeping industry. To develop technical documentation for the production of organic honey products, to develop new feed products for bees based on the technology of creating a honey substitute, and to analyze the economic efficiency of the production of environmentally friendly honey products. It is necessary to create an industry laboratory for quality control of honey products, in accordance with the requirements of the international standard, since without this it is impossible to enter the international market. Information about the metrological support of research work: when conducting research work, the basic concepts in the field of metrological support of the justification of the technology for the production of environmentally friendly honey products in the south of Kazakhstan are given. The methods and techniques used for conducting research work and the research results are reliable. Choice of the research direction: the production of honey products that are environmentally friendly for humans is an important social, medical, and biological problem, one of the main current and modern tasks in the industry. Taking into account the high cost, insufficient effectiveness, and negative consequences of a number of drugs - derivatives of chemical synthesis, as well as the resurgent interest in apitherapy and the growing scale of biomedical research and clinical trials of biologically active honey products, it can be stated that the demand for the latter will increase, contributing to the further intensification of beekeeping (Agarkov 2009). Bee honey is a sweet product produced by honey bees from nectar, plant or animal honeydew, and sweet juices found in various parts of plants and trees, with the addition of a number of enzymes from the salivary glands of bees (Krivtsov *et al.* 2000). According to Kiryanov (2004), when consuming 100 grams of honey, 300 calories or 0.1 of the total energy required by an adult is released (Encyclopedia of Beekeeping 1993). The chemical composition of honey is quite complex. It contains about 60 substances that have a beneficial effect on metabolic processes in the human body. Almost all trace elements known in nature are present in honey. Based on the new GOST 19792-2001 "Natural honey" (GOST 2001), the water content rate is 21%. The diastatic number of honey according to GOST 19792-87 must be at least 7 Gothe units against 5 in GOST 19792-74. Thus, the requirements for the criteria of maturity and preservation of the initial composition of honey are increasing. The main components of honey are carbohydrates, which amount to up to 95% of dry matter. Protein compounds in honey - 0.3-0.6%, most of them are enzymes. For honey enzymes, the optimum temperature is 37-40 degrees Celsius. The loss of their activity occurs under the influence of heavy metals (lead and mercury; Yeskov 1990). The enzymes of immature honey (24% water content) are more sensitive to temperature effects than mature honey (21% water content). The composition of honey includes salts of calcium, sodium, potassium, magnesium, iron, phosphorus, iodine, and some varieties of honey even contain radium. The amount of some mineral salts in honey is almost the same as the content in human blood serum (Izmalkova 1991). In the spectral analysis of buckwheat and polyfloral honey, carried out in the laboratory of Lomonosov Moscow State University, it was found that honey contains salts of magnesium, aluminum, copper, nickel, zinc, titanium, lead, osmium. In the study of honey varieties of the Chelyabinsk region, an increased content of molybdenum, copper, titanium, silver, vanadium, and zirconium was found (Lebedev 2003). Experiments have established that according to the content of iron, tin, zinc, copper, manganese, and nickel, honey is not harmful to humans (Krivtsov 1995). Pollen collected by bees (pollen pellet) is a natural product. It is a natural combination of nutritional and biologically active components of plant and animal (bee) origin. Beebread is a natural product prepared by bees from pollen and honey with the addition of the secrets of their glands. Pollen contains nitrogenous and mineral substances, carbohydrates, vitamins, acids, and other components (Zaikina 1999). The presence of the enzyme glucose oxidase (Astrauskene 1990) from the hypopharyngeal gland of bees was found in pollen, which was not found in pollen collected by hand. The amount of minerals in polyfloral bee pollen reaches 3% and practically does not change throughout the season. The mineral composition and its quantitative content in polyfloral pollen correspond to the mineral substances of the human body (Volkov 1979). From a comparison of the chemical composition of bee bread and pollen, it can be seen that the content of mineral substances in beebread is 2.43%, and in pollen 2.55% (Gaidak 1960). Burmistrova (1999) conducted a pharmacotoxicological assessment of pollen. It can be seen from the experiments that the live weight of white rats increased by 37% when they were injected with pollen, hemoglobin, erythrocytes, and leukocytes increased in the blood.

MATERIALS AND METHODS

The object of the study was the apiaries of the southern region, located in different environmental conditions and honey products. The experimental part was carried out in IE "Fillipov", Kazygurt district; IE "Normukhamedov", Tolebi district, IE "Ryzhenko", Tyulkubas district; IE "Mirsidikov", Tolebi district, Turkestan region. The research work was carried out according to the above research scheme in accordance with Fig. 1.

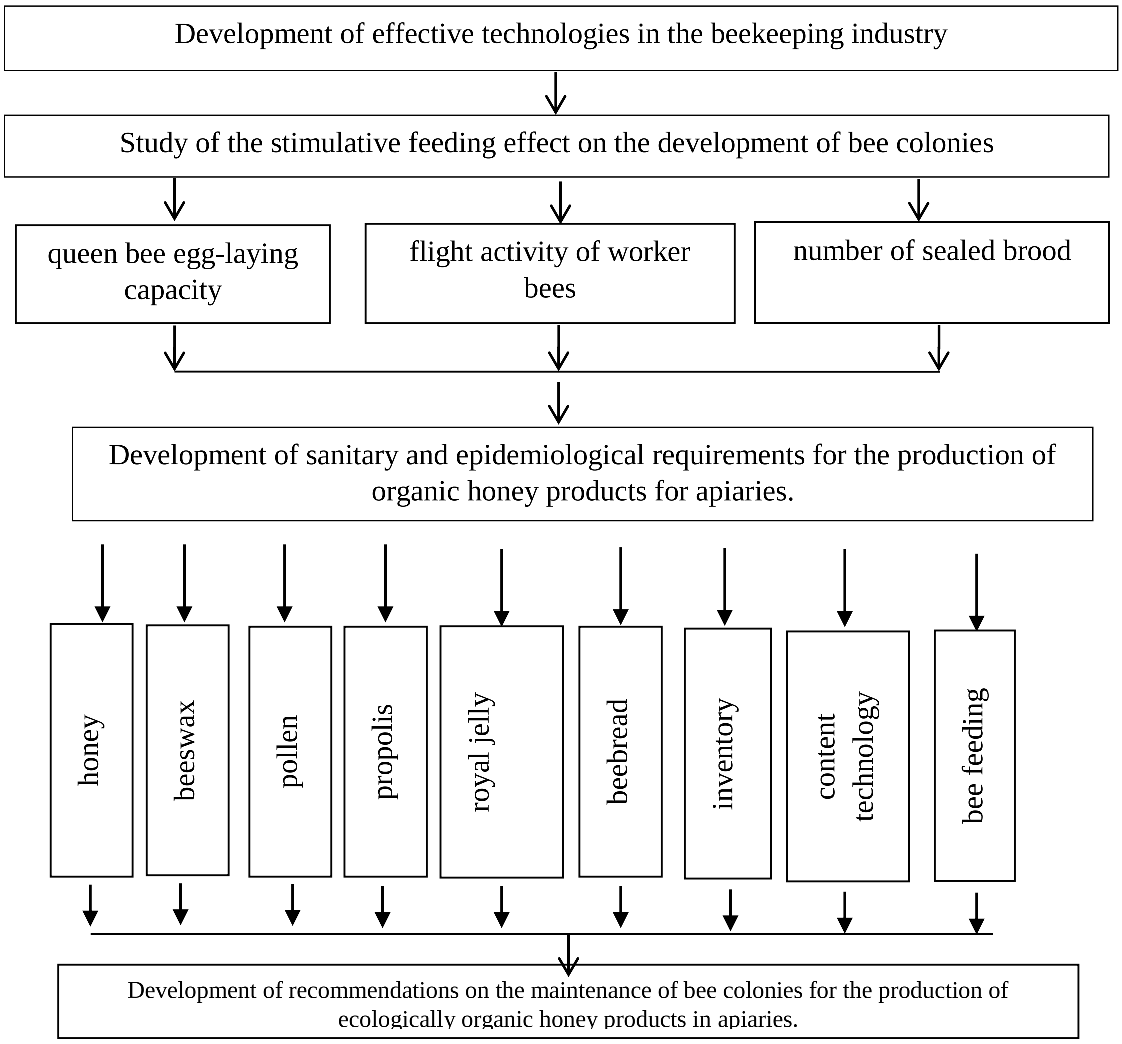


Fig. 1. Scheme of the study (2018-2020).

So, in order to enrich the feeding for bees, various concentrations of preparations were developed to select the optimal formulation. Two medicinal plants were selected for the full reliability of the components action for the growth and development of bee colonies. For a comparative analysis of "IS + *E. purpurea*", the control group was fed based on "*Compsition to stimulate the development of bee colonies*" (Farkhutdinov 2015) for "IS + *Melissa*": "*Feed for bees*" (Balyakin 1996), "IS + *Malva*": *60% sugar syrup*. For the preparation of medicinal feed, dried plants were taken in the amount of 200 g, 400 g, and 600 g, poured with 10 liters of water, and boiled for 30 minutes, after cooling to the temperature of fresh milk, the broth was filtered. To prepare the finished feed, we used 500 mL of decoction mixed with 500 mL of 4% inverted syrup until completely dissolved. The experimental families were fed with the prepared solution three times, 0.5 L each, with an interval of 7 days. For the control group: 1 liter of ready-made syrup, 0.8 kg of sugar should be mixed with 0.6 L water. For evaluation of the influence of autumn feeds we used 10% inverted syrup + *E. purpurea* (Treatment I: T_I); 10% inverted syrup + *Melissa* (Treatment II: T_{II}); 10% inverted syrup (control group). Such indicators were as sealed brood and vigor in the spring. The study of the effect of autumn feed on winter hardiness and spring development was carried out in the basic farms of IE "Fillipova" and IE "Mirsidikov". Approbation of incentive feeding "*E. purpurea* + 4% inverted syrup" was carried out in the base farm of IE "Normukhamedov", "*Melissa* + 4% inverted syrup" in IE "Ryzhenko". To set up experiments on the preparation and testing of new feeds, 3 groups of 5 bee colonies each were formed. The groups were formed according to the principle of families - analogs, that is, taking into account the age of the queens, the strength of the families, and the food supply in the combs. Every 12 days, control examinations of colonies were carried out, during which the strength of colonies, the number of printed brood, and the egg-laying capacity of queen bees were taken into account. The strength of the family was determined in the streets while taking into account the number of full streets. The amount of sealed brood was determined using a grid frame, standard size 435 × 300 mm with a wire stretched inside forming squares 50 × 50 mm (25 cm^2), which corresponds to the area of one hundred cells of the sealed brood (4 cells in 1 cm^2). The total number of sealed brood in a colony was calculated by summing up the number of squares on each frame. The queen bee egg-laying capacity rate was obtained by multiplying the total number of squares of sealed brood by 100 cells in each square and dividing by 12 (the number of days after which the young bees will emerge from the sealed cells). Groups of bee colonies for the experiment were formed in early March, during the first control examinations after wintering. Stimulative feeding was carried out in three stages in the spring. According to the experimental scheme, feeding was carried out three times with an interval of 7 days; in the control group, the bees received stimulating feeding of 4%, inverted syrup. A single dose of syrup was 2 liters per family. For feeding the bees, standard intra-hive frame feeders were used. At each stage, the colonies of the control group received the "Combination to stimulate the development of bee colonies", "Feed for bees", and 60% sugar syrup. Inspection of families, to assess the effectiveness of stimulative feeding, was carried out with an interval of 12 days. To determine the flight activity of the compared breeds, we took into account the number of departures in different periods of the life of bee colonies (maintaining honeybees, before the main honey collection, during the main honeybee), by counting bees three times, namely the number of arrivals within 3 minutes at 08.00, 14.00 and 18.00, To study the effect of new stimulating feedings on the amount of sealed brood, it was measured with a grid frame. Accounts were taken every 12 days. This time period is due to the fact that during this period the bees have time to feed and seal the larvae. To determine the average daily egg-laying capacity of the queen in a particular period of the season, using a grid frame, the number of all eggs in the nest for the date of interest to the beekeeper-breeder is taken into account and divided by 3. The number of eggs laid is always higher than the actually fed brood (Petrov 2014)

During the research, samples of honey products were selected, according to the Practice on beekeeping (Kozin *et al.* 2005). Gross honey productivity was determined by accurately accounting for the amount of honey taken from the hive and the amount of honey left in the hive for the winter. The amount of honey was determined by weighing the honeycombs on a spring balance, followed by a deduction from the total mass of the comb with a frame. A freshly built honeycomb with a frame weighs of 0.4 kg, and brown 0.6 kg. On combs with brood, the amount of honey was determined by the area occupied, based on the calculation that a comb completely occupied with honey contains 3.6 kg of honey (2-5 kg in multiple hives). Features of the growth and development of bee colonies were determined by counting the number of printed brood in colony nests (using a grid frame) regularly every 12 days. The same data characterize the average daily egg-laying capacity of queens, and the sum of three counts of sealed brood, given after 12 days, characterizes the total number of bees in the colony on the 12th day after the last count. The study of the quality of honey products was carried out in accordance with GOST 21179-2000 "Beeswax, GOST 19792-2001 "Natural Honey", GOST 28886-90 "Propolis. Specifications", GOST 28887-90 "Flower pollen (pollen pellet). Specifications" (GOST, 1991; GOST, 2000; GOST, 2011). The study of the effect of new stimulative feedings on flight activity during the period of supporting honey collection was carried out according to "the Method for obtaining and using honey products" (Krivtsov *et al.* 1993). Economically useful and biological characteristics of the vital activity of bee colonies were assessed according to "the Methodology for conducting research work in beekeeping" (Boradachev, 2000). The obtained material was processed by the method of variation statistics according to the method of N.A. Plokhinsky (Plokhinsky 1969).

RESULTS AND DISCUSSION

So, we have studied GOST 33980-2016 Products of organic production. Rules for production, processing, labeling, and marketing (as amended). In paragraph 7 of the Rules for Organic Beekeeping in subparagraph 7.1 Origin of bees (Table 1).

Table 1. Conducting organic beekeeping

№	According to GOST	Recommendations
1	origin of bees. When choosing a breed of bees, it is necessary to take into account its ability to adapt to the climatic conditions of a particular area and resistance to diseases.	must be supplemented according to the Breeding Farm Plan.
2	essential for the prevention of the most common diseases of bees are also: - selective selection of bee colonies; - replacement of the queen bee if necessary; - regular renewal of beeswax;	timely zootechnical methods of combating and preventing diseases of bees
	- control of a sufficient amount of beebread and honey in families; - monitoring the state of the drone brood; - regular cleaning and disinfection of inventory; - isolation or destruction of diseased bee colonies, if necessary.	
3	if the application of preventive measures did not give the appropriate results, for the treatment of bee colonies in organic beekeeping, it is allowed to use formic, lactic, acetic, oxalic acids, as well as menthol, eucalyptus or camphor.	not allowed for antibiotic treatment.
	bee colonies, for the treatment of which chemically synthesized drugs were used, should be isolated for the period of treatment. In the future, these families must go through a transitional period of one year with a complete replacement of beeswax with organic.	it is necessary to add “In the future, these families must go through a transitional period of one year with the complete replacement of frames and beeswax with organic”.

A standard has been developed for organic honey products, production, and processing rules at the Scientific Council No. 3 dated 08/11/2020. A recommendation has been developed for keeping bee colonies for the production of environmentally friendly organic honey products in apiaries.

Recommended for the production of environmentally friendly bee products included:

1. Certification of the production of organic honey products in the country should be carried out mainly by representatives of domestic standards.
2. It is necessary to inform beekeepers as widely as possible (in particular through their public organizations) about the possibilities of the market for organic products.
3. Honey bees and the quality of their products are biological indicators of the cleanliness of the environment, as they provide a systematic test of the ecological balance of the ecosystem state. This is the key to early detection of the negative impact of agroecological conditions on agricultural production, including organic production.
4. Determining the concentration of heavy metals in bee products can be used as a methodological element of the biological value and quality assessment system.
5. It is necessary to carry out the choice of the breed according to the selection plan of the farm.
6. Carrying out timely zootechnical methods of combating and preventing diseases of bees.

Monitoring of the state of the territory and food base of bee plants was carried out. The Turkestan region is located within the eastern part of the Turan lowland and the western spurs of the Tien Shan. About 50% of the territory belongs to the desert zone (Kyzylkum, Muyukum sands, and Betpak-Dala desert). The central and southern parts of the territory of the region belong to a subtropical foothill desert-steppe zone highly supplied with heat. The ecological situation in the region is becoming more and more urgent. In recent years, there have been more and more sources of emissions of harmful substances into the environment of the region. By the growth of environmental degradation, the state of health of the population of the South Kazakhstan region is deteriorating. This presents environmental, economic, and social problems, both for the region and for the country as a whole.

On the territory of the region, the main surface sources are the rivers Syrdarya, Keles, Badam, Arys, Bugun, and Sairamsu. In total, there are 118 small rivers in the region with a length of 10 to 200 km, 28 reservoirs, and 25 lakes. They serve as a source of water supply for settlements and are used for irrigation. Under the influence of intensive economic activity, there have been certain qualitative and quantitative changes in water resources, and the sanitary condition of river floodplains within the boundaries of settlements and large industrial enterprises has deteriorated. The food base of the region is not diverse. So, in the Turkestan beekeeping zone, bees can be transported to the foothills for early honey collection from trees, shrubs, fruit and berry gardens, as well as to salt tree thickets in the floodplain of the Syrdarya and Chu rivers. In the second half of May and in June, bees can roam the desert steppes of the Turkestan region, where the main honey collection is provided by thickets of breadroot drupes and stock roses. In June-July, camel thorn thickets and meadow herbs bloom in the floodplain part of the Syrdarya River, and in July and August dodder and mountain herbs of Shymkent and Zhambyl regions. In addition, the autumn honey harvest can be used by organizing the migrations of apiaries for cotton crops. Thus, the potential threat of introducing toxic substances into honey products is posed by harmful emissions into the atmosphere of industrial enterprises and road transport. Chemical waste causes great damage not only to bees but also to the person who consumes honey products. Honey products traditionally include honey, beebread, pollen, beeswax, comb caponization, royal jelly and propolis. An analysis was made of the composition and properties of honey, propolis, beeswax, and pollen produced in the southern region of the country. The results obtained are shown in Table 5 exhibiting the physicochemical, chemical-toxicological, and radiological properties of honey, for 2018-2019. According to the results of the organoleptic research method, it can be seen that this made it possible to determine the presence of a typical honey smell in almost all studied samples of honey from different regions. In terms of consistency, all samples, with the exception of the above, were shrunken, i.e. either already crystallized, or this process has already begun. In color, honey from different apiaries ranged from light yellow through amber to light brown. The taste was mostly sweet, sweet-sour, with a tart and delicate, mild aftertaste.

The average value of the mass fraction of water in all samples was 14.6%, the water content of honey shows its maturity and determines its suitability for long-term storage. The water content of honey can be affected by climatic conditions during the pumping season, the presence of inverted sugar and sucrose, and storage conditions. The sucrose levels in the main study groups did not exceed the permissible content norm. The next reliable criterion for assessing the quality of honey was the determination of the diastase number. Diastase is sensitive to heat, which allows it to be used as an indicator of honey heat treatment and storage conditions. The average value of the diastase number in the studied samples was 13.9 Gothe units, which meets the criteria of GOST 19792-2001 at least 7 Gothe units. The determination of the content of hydroxymethyl furfural made it possible to reveal the naturalness of honey and the degree of preservation of its natural qualities, as well as to reveal its authenticity. The formation of hydroxymethyl furfural occurs during long-term storage of honey and high temperatures and when heated from 55 °C as a result of the breakdown of fructose and glucose. In 1 sample, a positive value of hydroxymethyl furfural was revealed, since the pumped honey was stored in an unprotected place from direct sunlight, so, an increase in this indicator was observed. According to the results of studies in 2019, it was clear that the average values of the diastase number in the studied samples were 10.9 Gothe units, which meets the criteria of GOST 19792-2001 of at least 7 Gothe units. In 3 samples, a positive value of hydroxymethyl furfural was revealed, since the pumped honey was stored in an unprotected place from direct sunlight, so, an increase in this indicator was observed. Thus, the quality of natural bee honey depends on organoleptic, microscopic, and physicochemical parameters. In the three study areas, these indicators corresponded to the standards of GOST 19792–2001 “Natural honey.

Specifications: These honey samples can be characterized as quality products with acceptable taste and aroma properties. Therefore, it is necessary to adhere to the rules for the production and storage of organic products.

Thus, based on the results of the study of propolis samples taken in apiaries, we can draw the following conclusions: firstly, it is necessary to strictly adhere to the technology of propolis production in apiaries to obtain high-quality products; secondly, propolis produced in apiaries has a sufficiently high biological activity, which is of great importance for the use of propolis in various industries; thirdly, to assess the suitability of propolis for medicinal purposes, it is necessary to additionally regulate in GOST several other indicators, the composition and quality of propolis and, in particular, the permissible content of heavy metal compounds, carcinogens, pesticides, etc. Protein feeding is necessary for the early spring when bees are in dire need of protein substances to grow offspring, but there are still few or no flowers that give pollen (the main source of proteins). For the active development and strengthening of the immunity of bee families, a decoction of hot red pepper + flower pollen and a decoction of wormwood + flower pollen were used.

Table 2. Assessment of spring feeding with 4% inverted syrup of bee colonies for 2018 (n = 5: Σ_n = 15).

Study groups	Decoction of hot red pepper + pollen			Decoction of wormwood + pollen		
	Sealed brood (in frames)	Strength of families (beeways)	Egg-laying capacity (pcs. eggs per day)	Sealed brood (in frames)	Strength of families (beeways)	Egg-laying capacity (pcs. eggs per day)
Control	4.8 ± 0.70	7 ± 1.4	1228.5 ± 0.76	5.0 ± 0.71	6 ± 1.2	1345.0 ± 0.70
I-experimental	6.6 ± 0.03	9 ± 1.8	1612.3 ± 0.92	7.2 ± 0.02	8 ± 1.6	1702.8 ± 1.02
II-experimental	7.2 ± 0.02	9 ± 1.6	1685.1 ± 0.98	6.8 ± 0.03	8 ± 1.6	1697.3 ± 0.99

An analysis of the evaluation of spring feeding with 4% inverted syrup shows that the addition of natural biologically active additives has a beneficial effect on the growth and development of bee colonies in the spring. So, when feeding a decoction of hot pepper + pollen in the experimental groups, spring development increases by 2 frames and 2 beeways (Table 3).

Table 3. Assessment of spring feeding of bee colonies with a decoction of hot red pepper + pollen in 2018 (n = 5).

Groups / concentration	Sealed brood (in frames)					
	2%	4%	6%	8%	10%	12%
Control	4.3 ± 0.08					
I-experimental	2.8 ± 0.07	6.6 ± 0.03	6.7 ± 0.09	6.4 ± 0.15	4.8 ± 0.18	4.0 ± 0.12
II-experimental	2.5 ± 0.07	7.2 ± 0.02	6.9 ± 0.07	6.9 ± 0.07	5.1 ± 0.09	3.7 ± 0.11
	Strength of families (beeways)					
Control	7 ± 1.4					
I-experimental	7 ± 0.10	9 ± 1.8	8 ± 0.07	7 ± 0.10	5 ± 0.08	3 ± 0.08
II-experimental	6 ± 0.09	9 ± 1.6	9 ± 0.14	7 ± 0.10	6 ± 0.09	4 ± 0.12
	Egg-laying capacity (pcs. eggs per day)					
Control	1228.5 ± 0.76					
I-experimental	1204.1 ± 0.68	1612.3 ± 0.92	1620.7 ± 0.66	1500.5 ± 1.0	1470.8 ± 0.70	1400.5 ± 0.76
II-experimental	1287.6 ± 0.87	1685.1 ± 0.98	1692.4 ± 0.98	1530.6 ± 1.3	1405.2 ± 0.76	1385.3 ± 0.68

A similar picture with the experimental groups treated with a decoction of wormwood + pollen. It can be concluded that a decoction of red pepper and wormwood is a good stimulant for flight activity, increasing the working capacity of bee colonies. Also, an assessment of the infestation of bee colonies was carried out, by the method of visual inspection, scree of the varroa mite was found on pallets to a small extent. Consequently, the results of the experiments show that the experimental groups are ahead in growth and development by an average of 2.2 beeways compared to the control group. Experienced groups were in full readiness for the start of the main honey collection. So, we used the concentration of inverted syrup in 2%, 4%, 8%, 10%, and 12% with the addition of decoctions of hot red pepper + pollen and wormwood + pollen (Table 3). The results of the study showed that when using 2% inverted syrup with decoctions of hot red pepper + pollen, the sealed brood ranged from 2.5 ± 0.07 to 2.8 ± 0.07 frames, and wormwood + pollen from 5.3 ± 0 .10 to 5.5 ± 0.10 frames, respectively. The situation was similar in terms of colony strength and egg-laying capacity of queen bees. A comparative analysis of 4% and 6% inverted syrup showed that they are identical in terms of basic indicators. Notably, with 6% inverted syrup, more components were consumed than with 4%, which was not economically viable. In addition, at 8%, 10%, and 12% inverted syrup, all indicators were declining. This may be due to that the bees, using thicker syrup, begin to reduce the oviposition of the uterus and store the syrup in the form of a food reserve. Therefore, in the spring, the optimal concentration of inverted syrup for feeding bee colonies was 4% concentration (Tables 4-5). The period of winter dormancy and the results of wintering are very important in the life of a bee colony. The nature of the development of colonies and their productivity in the coming season largely depends on how the bees endured the wintering. In the autumn 2018, experimental groups were formed for wintering with the strength of bee colonies in T_I was 8.7 ± 0.22, in T_{II} 8.8 ± 0.22, and in the control group 8.2 ± 0.29 for beeways filled with bees. At the same time, the inverted syrup was chosen for autumn feeding in two concentrations: in T_I 10%, the amount of feed was 14.3 ± 0.68 kg; and in T_{II} 12% was 11.5 ± 0.74 kg, while in the control group was 12.7 ± 0.76 kg sugar syrup. When determining winter hardiness in the experimental and control families in the spring 2019, a slight deterioration of nests was revealed, where the strength of the family in T_I was on average 6.2 ± 0.70 beeways and the amount of food consumed was 9.4 ± 0.66 kg, which is 2 beeways was higher in comparison with T_{II} (4.5 ± 0.71; 7.2 ± 0.67 kg) and in the control group (5.3 ± 0.70; 8.1 ± 0.68 kg).

Table 4. Assessment of spring feeding of bee colonies with a decoction of hot red pepper + pollen (n = 5).

Groups / Concentration	2%	4%	6%	8%	10%	12%
	Sealed brood (in frames)					
control	4.3 ± 0.08					
Treatment I	2.8 ± 0.07	6.6 ± 0.03	6.7 ± 0.09	6.4 ± 0.15	4.8 ± 0.18	4.0 ± 0.12
Treatment II	2.5 ± 0.07	7.2 ± 0.02	6.9 ± 0.07	6.9 ± 0.07	5.1 ± 0.09	3.7 ± 0.11
	Strength of families (beeways)					
control	7 ± 1.4					
Treatment I	7 ± 0.10	9 ± 1.8	8 ± 0.07	7 ± 0.10	5 ± 0.08	3 ± 0.08
Treatment II	6 ± 0.09	9 ± 1.6	9 ± 0.14	7 ± 0.10	6 ± 0.09	4 ± 0.12
	Egg-laying capacity (pcs. eggs per day)					
control	1228.5 ± 0.76					
Treatment I	1204.1 ± 0.68	1612.3 ± 0.92	1620.7 ± 0.66	1500.5 ± 1.0	1470.8 ± 0.70	1400.5 ± 0.76
Treatment II	1287.6 ± 0.87	1685.1 ± 0.98	1692.4 ± 0.98	1530.6 ± 1.3	1405.2 ± 0.76	1385.3 ± 0.68

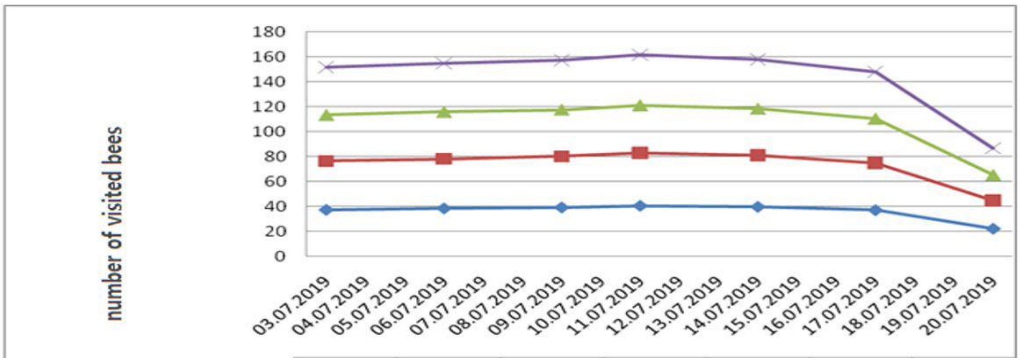
Table 5. Assessment of spring feeding of bee colonies with a decoction of wormwood + pollen for 2018 (n = 5).

Groups / concentration	2%	4%	6%	8%	10%	12%
	Sealed brood (in frames)					
control	5.0 ± 0.71					
Treatment I	5.3 ± 0.10	7.2 ± 0.02	7.0 ± 0.10	6.3 ± 0.15	5.8 ± 0.07	4.7 ± 0.18
Treatment II	5.5 ± 0.10	6.8 ± 0.03	6.6 ± 0.03	6.2 ± 0.17	5.4 ± 0.10	4.6 ± 0.18
	Strength of families (beeways)					
control	6 ± 1.2					
Treatment I	6 ± 0.09	8 ± 1.6	9 ± 0.14	7 ± 0.10	6 ± 0.09	4 ± 0.12
Treatment II	6 ± 0.09	8 ± 1.6	8 ± 0.07	7 ± 0.10	5 ± 0.08	3 ± 0.08
	Egg-laying capacity (pcs. eggs per day)					
control	1345.0 ± 0.70					
Treatment I	1500.2 ± 1.0	1702.8 ± 1.02	1695.2 ± 0.98	1580.5 ± 1.2	1483.2 ± 0.71	1380.5 ± 0.69
Treatment II	1485.0 ± 0.70	1697.3 ± 0.99	1652.0 ± 0.96	1600.6 ± 0.66	1500.0 ± 1.0	1455.4 ± 0.70

The results obtained showed that in Treatment I the score for winter hardiness was 20 points, while in T_{II} and control 19 points. A study of the general state of wintering of bee colonies was carried out using a phonendoscope. When listening to the bee colonies, a uniform rumble emanated, which means the prosperous state of the bee colonies. In some hives, the unrest of bees was recorded, but a discordant rumble was not recorded. In all experimental groups, a slight deterioration of the nest area was revealed, from which it follows that the bee colonies were carefully prepared for wintering and fed with stimulating additives. When determining winter hardiness in experimental and control families in the autumn 2019, the main indicator of those who received "IS + *E. purpurea*" stimulative feeding distinguished themselves, in particular, their strength of families in T_{II} (IS + 400 g) was 9.5 beeways, the groups that received "IS + *Melissa*" T_{III} (IS + 600 g) were 9.6 beeways, compared to the control group 9.2 and 9.3 beeways, respectively. In the winter period of 2020, a slight deterioration of the nests was revealed, where the strength of the colony in all experimental groups "IS + *Melissa*" ranged from 8.2 to 9.0 beeways and the amount of feed consumed from 9.1 to 9.6 kg, while in the experimental groups "IS + *E. purpurea*", the strength of families was from 8.3 to 8.9 beeways, the amount of feed consumed was from 8.7 to 9.8 kg, and in the control groups from 8.6 to 9.3 kg. The obtained results showed that in the experimental groups, "IS + *E. purpurea*" the average score for winter hardiness was 19.5, while in the experimental groups "IS + *Melissa*" 19.8 and in control 20.3 points. Three types of medicinal plants were collected: *E. purpurea, Melissa,* and *Malva*. By the onset of spring, significant changes are observed in the life of bee colonies. The early spring growth of colonies begins, that is, an increase in the number of bees in the hives. In the strongest colonies, by the end of spring, the queens lay 1500 or more eggs per day. The collection of honey by bees, the production of beeswax, and other honey products depend on the pace of spring development. The main task of beekeepers in the spring is to create the most favorable conditions for the development of bee colonies and place them near the arrays of flowering honey plants and pollen plants to provide a sufficient amount of carbohydrate and protein feed. The intensity of metabolic processes in the bee colony increases sharply in early spring when the bees begin to use the protein reserves of the body to produce milk and grow brood. Within a month after the first flight, the wintering bees change to young ones and their number in the family doubles, while a month later, the second doubling occurs. Analysis of studies shows that the positive effect of using 10% inverted syrup on the development of bee colonies that left wintering in 2019 was noted on April 22, where the number of sealed brood was higher than in the control by 40.6% and T_{II} (12%) by 41.8%. By the end of the accounting period, the difference between treatments and control decreased. Before the honey harvest, it reached 21.1% and 8.1%. Notably in T_{I} (10%) with inverted syrup, the strength of the family averaged 8.0 ± 0.31 hives compared to the control (7.6 ± 0.63 hives), and in T_{II} (12%) it reached 6.0 ± 0.70 hives, respectively. One can note the high rates of development of families that received 10% inverted syrup before wintering. In addition, 12% inverted syrup for bees was too concentrated, so for a successful wintering, it was necessary to use a 10% concentration of inverted syrup. According to studies in 2020, a positive effect on the development of bee colonies of experimental groups that emerged from wintering from the use of "inverted syrup + *E. purpurea*" was noted in the period from 24.04, and until 25.05 2020. So, during examination on April 24, the number of sealed brood in T_{II} (IS + 400 g *E. purpurea*) 873 ± 9.15 hundred cells was revealed, while the control group was 11 hundred cells less. The highest number of sealed brood was recorded at 25.05 in T_{II}: 1864 ± 10.04 hundred cells, while in the control group: 1860 ± 10.06 hundred cells, respectively. Consequently, T_{II} was ahead of its peers in the active period in terms of the number of brood in the entire period being higher than in the control and T_{III} (41.8%). By the end of the accounting period, the difference between experimental and control decreased. In the analyses of Treatments I and III receiving stimulating feeding IS + *E. purpurea* varied from 301 ± 1.20 to 1802 ± 9.65 hundred cells behind in comparison with the control group (from 339 ± 1.10 to 1860 ± 10.06 hundred cells). Thus, according to the results of T_{III} (IS + 600g *Melissa*), the number of sealed brood was 869 ± 9.19 hundred cells, while the control group showed 1857 ± 10.14 hundred cells. The highest rate was recorded at 25.05 in Treatment III, the number of sealed brood was higher than in the control group (by 0.2%). Whereas in Treatments I and III, there is a lag from the control group by an average of 0.03%. Thus, it can be noted that of the three types in two combination s, in terms of the amount of brood, the best exposures were inverted syrup with *E. purpurea* 400 g and inverted syrup with *Melissa* 600 g.

Assessment of the vital activity of bee colonies during feeding. One of the primary factors influencing the biology and development of the organism of bees is full feeding. In the spring, in the absence of a supporting honey collection, sugar syrup was used to feed bees, but it could not satisfy their needs for essential nutrients. So, according to the results of our study, we can say that in 2019, the brood was placed in all experimental groups on 3 combs, which occupied an area of 102 squares. This change in brood numbers is the reason why the number of individuals is small and they cannot produce more brood. Therefore, during this period, the influence of growth stimulants is small. So, with a 3-fold count, it can be seen that when feeding "IS + *E. purpurea*" (IS + 200 g) of the group in the first measurement, the number of sealed brood was 822 ± 0.70 hundred cells; in the second measurement 1952 ± 11.10 hundred cells; and in the third 4094 ± 1.25 hundred cells. When compared to the control group, in this group, slow development was observed in the first and second measurements, and by the third measurement, the group (IS + 200 g) intensively increased the sealed brood by 132 hundred cells. A similar pattern in dynamics was observed in T_{II} (IS + 400 g) and T_{III} (IS + 600 g), where the number of sealed brood varied from 847 ± 0.76 to 4348 ± 1.35 hundred cells; in a comparative analysis with the control group, between the initial group in the initial and subsequent periods, a low rate of brood rearing was observed in T_{III} (IS + 600 g) in the first measurement of 1.38 hundred cells; in the second 1.37 and in the third 0.29 times respectively. The highest levels in brood rearing were recorded when stimulating bee colonies of all categories with combination II (IS + 400 g). The peculiarity of growing brood here was that by the second observation period, it increased from 847 ± 0.76 to 2164 ± 10.9 hundred cells. So, according to the results of the third measurement, this indicator reached a peak level of 4348 ± 1.35 hundred cells. At the same time, the multiplicity of the increase in the described parameter was 1.22, in comparison with the control. A similar picture was observed in the egg-laying capacity of queen bees. So, in all the studied groups with the combination of IS + 200 g, the egg-laying capacity of queens ranged from 512 ± 0.89 to 1340 ± 15.89 eggs per day, significantly inferior to the control group (from 589 ± 0.85 to 1439 ± 15.88 eggs per day). The level of egg-laying of queens in T_{III} with the combination of IS + 600 g for the first term lagged behind by 69 eggs and in the second by 49 eggs. By the third term, there was a slight increase in eggs (90 pcs) in comparison with the control group. More dynamic egg laying was observed in T_{II} with combination of IS + 400 g. So, in the initial period, there was a low laying rate (539 ± 0.82 eggs per day) compared to the control (589 ± 0.85 eggs per day). In the second period, an elevation in the egg-laying capacity of the initial group was recorded, by the third observation period its level was upraised, compared to the initial value by 11.4 times, amounting to 1680 ± 14.95 eggs per day. At the same time, it exceeded the control group by 2.41 times. An analysis of the data on assessing the vital activity of bee colonies when feeding with "IS + *Melissa*" and "IS + *Malva*" showed that in all combination s, the number of sealed brood noticeably lagged behind the control (feed for bees) group (804 ± 0.79, 2069 ± 12, 4, 4010 ± 1.87 hundred cells). So, the combination of IS + 600 g dynamically sealed the brood in the initial measurement. It was 800 ± 0.79 hundred cells, in the middle of the inspection (2002 ± 12.2 hundred cells), and at the end (3920 ± 9.6 hundred cells). According to the egg-laying capacity of queen bees, it can be seen that the combination of IS + 600 g started a good laying eggs (567 ± 0.71 eggs per day). Further examinations revealed a decrease in the rate of egg laying (1018 ± 19.4 and 1503 ± 14.6 eggs per day), in comparison with the control in the second and third measurement (1025 ± 19.5 and 1385 ± 14.6 eggs per day, respectively). Stimulation of the development of bee colonies by feeding "IS + *Malva*" did not have a positive effect on the number of sealed brood and egg-laying capacity of queen bees. The control group, which received sugar syrup in all groups, increased in terms of the number of sealed brood and fluctuated in the context from 932 ± 1.1 to 3825 ± 9.7 hundred cells. So, the average daily egg-laying capacity ranged from 572 ± 0.73 to 1238 ± 11.9 eggs per day and with a 3-fold count for 2020. It can be seen that when feeding IS + *E. purpurea* of the group in the first measurement, the average number of sealed brood was 831 hundred cells; in the second measurement 2048, and in the third 4231 hundred cells. The group IS + *Melissa* was slightly behind the group IS + *E. purpurea* in all three measurements by an average of 20.9 squares. A similar picture was observed in the egg-laying capacity of queen bees. Thus, in all the studied groups with the combination of "IS + *E. purpurea*", the egg-laying capacity of queens ranged from 511 ± 0.90 to 1557 ± 15.7 eggs. The maximum egg-laying capacity of queen bees was observed in T_{II} (IS + *E. purpurea* 400g) from 551 ± 0.84 to 1557 ± 15.7 eggs (averaged 1024.6 eggs), while in the control group, egg laying averaged 1018 eggs. Therefore, in T_{II}, there was a slight increase in eggs by 6.6 pieces in comparison with the control group. More dynamic egg laying was observed in T_{III} with the combination of IS + *Melissa* 600 g. So, in the initial period, an average laying rate was observed (513 ± 0.89 eggs per day). In the second period, an elevation in the egg-laying capacity of the initial group was recorded. By the third observation period, its level increased, compared to the initial value by 10.3 times, amounting to 1523 ± 15.6 eggs per day. At the same time, it exceeded the control group by 2.6 times. Thus, the highest stimulating effect on egg-laying capacity and sealed brood was provided by composite feeding of IS + 400 g. At the same time, the peak values of the cultivation of sealed brood were 1.22 times higher than the control group.

Study of the production of honey products. Humans have a special relationship with bees. Having valued them in ancient times for honey and beeswax, they gradually brought the bees closer to their home, increasing the volume and range of services charged from them. Honey is a sweet viscous liquid with a pleasant smell (bouquet) obtained by honey bees from the nectar of flowers or plant honeydew (a pad is a sweet discharge on leaves of plant or animal origin). Therefore, there are two types of natural honey: flower and honeydew. The color of honey comes in all shades, from light yellow to brown, depending on the type of plants from which the bees collected nectar. Flower honey is usually divided into homogeneous (monofloral), obtained from the nectar of flowering plants of the same genus or species (linden, buckwheat, sunflower, etc.), and polyfloral, obtained from a variety of flowering plants. The latter is distinguished by the place of growth of these plants (mountain or steppe). Honey has a complex chemical composition. It contains about 20% water and 80% dry matter, of which grape sugar is 35% and fruit sugar 40%. In addition, honey contains sucrose 1.3% - 5%, maltose 5% - 10%, and dextrins 3% - 4%. The amount of proteins in flower honey is 0.04% - 0.29%. Honey contains 20 amino acids. There are malic, lactic, tartaric, oxalic, citric, succinic, and other acids. Honey contains enzymes such as invertase, diastase, catalase, lipase, etc. Vitamins in honey include thiamine (B_1), riboflavin (B_2), pyridoxine (B_3), pantothenic, nicotinic (PP), ascorbic acid (C) predominate, etc. An indicator characterizing the flight activity is the number of bees that fly out or return to the hive per unit of time. The accuracy of such an analysis increases by the frequency or duration of flight activity counts, depending on a large complex of abiotic and biological factors. The meteorological situation is important. Flight activity is significantly affected by the productivity of the forage area. Of no small importance is also the physiological state of the bee family and the specific motivations (motives) of individuals flying out of the dwelling. The main result of the flight activity of bees is nectar, the supply of which mainly depends on the number of departing and arriving bees per unit of time. Naturally, the stronger the family, the more bees work in the honey collection, and the more intense the accumulation of nectar. However, this indicator is also affected by the species of bee colonies, so we studied the patterns of flight activity of colonies of different breeds. Observations on the attendance of bees were carried out on an array of camel thorns at an average air temperature of +36 °C. All the studied families were in equal conditions. According to the results of studies of Figs. 2 and 3, it can be seen that in 2019, the flight activity of experimental families that received "IS + *E. purpurea*" top dressing at the beginning of observations on June 3, this indicator was 1.3 times higher than the control group, this trend was observed until the end of the experiment. So, at the end of the observation (July 20), flight activity noticeably decreased on average (22.5 bees). This is due to the fact that the camel thorn ends the nectar phase, and the bees begin to search for new honey plants. A similar picture is observed in the experimental groups with the combination of "IS + *Melissa*". So, according to the results of observation, an increase in the entrepreneurial spirit of bees on a honey-bearing array was revealed. It has been established that the number of visited bees ranged from 21.4 pcs up to 40.6 pcs bees compared to the control. In 2020, the flight activity of experimental families that received stimulative feeding "IS + *E. purpurea*" at the beginning of observations (05/28/2020) was 4.1 times higher than the control.



	03.07.2019	06.07.2019	09.07.2019	11.07.2019	14.07.2019	17.07.2019	20.07.2019
IS+*Melissa*	38.2	39.1	39.8	40.6	39.5	37.6	21.4
IS+*Malva*	36.8	37.6	37.3	38	37.3	35.5	20.5
IS+*Echinacea purpurea*	38.9	39.5	40.8	42.3	41.1	37.6	22.4
Control group	37.6	38.7	39.5	40.8	40	37.3	22.5

Fig. 2. The effect of various stimulative feedings on the flight activity of worker bees (2019).

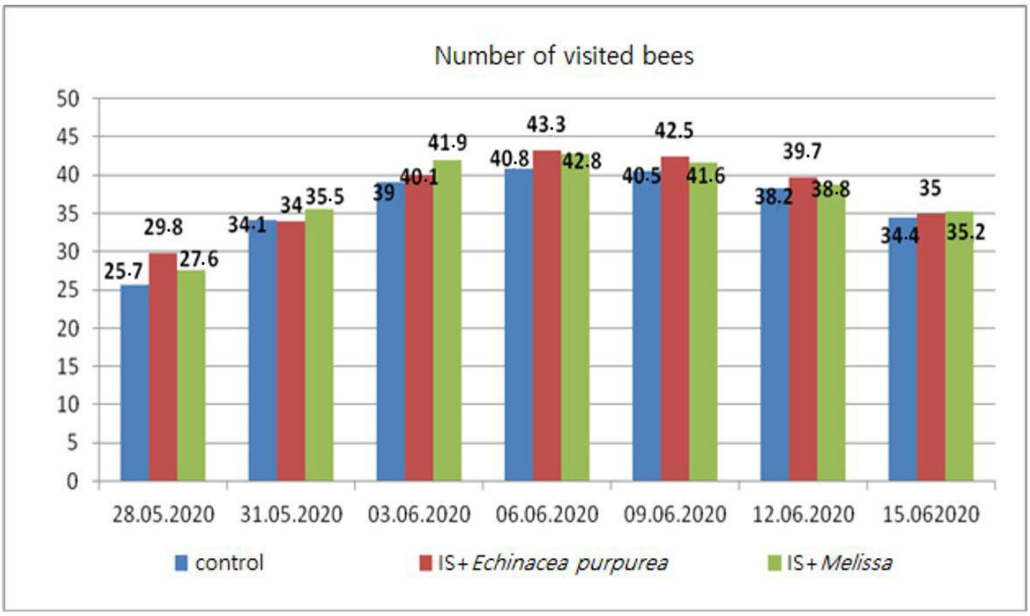


Fig. 3. The effect of stimulative feeding on the flight activity of bees (2020).

This trend was observed until the end of the experiment. At the same time, at the end of the observation (July 20), flight activity noticeably decreased on average (34.8 bees), which may be due to the fact that the nectar production phase ends in honey plants, and the bees begin to search for new honey plants. A similar picture was observed in the experimental groups with the combination of "IS + *Melissa*". So, according to the results of observations, an increase in the entrepreneurial spirit of bees on a honey-bearing array was revealed. It has been established that the number of visited bees ranged from 27.6 pcs up to 42.8 pcs bees compared to the control group. Thus, the use of "IS + *E. purpurea*" supplement exhibited a positive effect on the flight activity of families, so that, the maximum value was 1.1 times higher than in the control. Therefore, the feeding of bees with inverted syrup with the addition of *E. purpurea* contributed to the intensive development of bee colonies and led to an elevation in the flight activity of bees.

Influence of feeding on the productivity of bee colonies. In beekeeping, the main sources of production are worker bees. By the right selection of crossing, the productive qualities of the offspring upraise. A comparative analysis of natural preparations for the productivity of bee colonies showed that in experimental colonies, those who received stimulative feeding tended to dynamically increased productivity. However, this process displayed a different degree of severity and was in all terms of the experiment.

Table 6. Effect of stimulative feeding on the productivity of experimental groups (2019-2020; n = 5; $\sum_n = 50$).

Type	**Statistical indicator**	**Groups and feeding options**			**Control group**
		Treatment I	**Treatment II**	**Treatment III**	
		2019			
		"IS + *E. purpurea*"			
Honey productivity (kg)	M ± m	24.8 ± 0.39	25.4 ± 0.37	22.2 ± 0.38	23.0 ± 0.39
	C_v (%)	6.8	6.7	7.3	7.4
Beeswax productivity (g)	M ± m	251 ± 0.68	262 ± 0.76	230 ± 0.96	239 ± 0.87
	C_v (%)	1.17	1.12	1.27	1.23
% to control		105.2	109.6	96.2	100.0
		"IS + *Melissa*"			
Honey productivity (kg)	M ± m	23.8 ± 0.49	22.3 ± 0.37	23.1 ± 0.39	22.5 ± 0.36
	C_v (%)	7.1	7.6	5.3	7.6
Beeswax productivity (g)	M ± m	231 ± 0.88	238 ± 0.78	243 ± 0.76	237 ± 0.78
	C_v (%)	1.27	1.09	1.20	1.09
% to control		98.1	100.3	102.5	100.0
		"IS + *Malva*"			
Honey productivity (kg)	M ± m	21.6 ± 0.33	22.9 ± 0.40	22.7 ± 0.35	22.8 ± 0.40
	C_v (%)	6.9	7.4	7.5	7.4
Beeswax productivity (g)	M ± m	240 ± 0.49	233 ± 0.76	232 ± 0.95	230 ± 0.76
	C_v (%)	1.22	1.20	1.26	1.20
% to control		103.4	101.2	100.7	100.0
		2020			
		"IS + *E. purpurea*"			
Honey productivity (kg)	M ± m	17.8 ± 0.39	18.7 ± 0.39	18.2 ± 0.38	18.4 ± 0.39
	C_v (%)	6.8	6.1	7.3	5.9
Beeswax productivity (g)	M ± m	219 ± 0.68	224 ± 0.76	220 ± 0.96	220 ± 0.77
	C_v (%)	1.17	1.20	1.27	1.15
% to control		99.3	101.6	99.9	100.0
		"IS + *Melissa*"			
Honey productivity (kg)	M ± m	18.0 ± 0.49	18.1 ± 0.37	18.5 ± 0.40	18.3 ± 0.39
	C_v (%)	7.1	7.6	5.9	5.9
Beeswax productivity (g)	M ± m	219 ± 0.88	217 ± 0.78	223 ± 0.76	221 ± 0.76
	C_v (%)	1.27	1.09	1.31	1.15
% to control		99.0	98.2	101.3	100.0

Analysis of the data presented in Table 6 shows that the maximum amount of marketable honey in 2019 was registered in the experimental groups receiving stimulative feeding "IS + *E. purpurea*": in T_I 24.8 ± 0.39 kg, in T_{II} 25.4 ± 0.37 kg, in T_{III} 22.2 ± 0.38. In the case of beeswax, we recorded 251 ± 0.68 g; 262 ± 0.76 g; and 230 ± 0.96 g, respectively. In the control group, honey productivity reached 23.0 ± 0.39 kg and beeswax productivity 239 ± 0.87 g. In a comparative analysis of feeding "IS + *E. purpurea*" to the control, in T_{II} (IS + 400 g) reached 109.6%, in T_I (IS + 200 g) 105.2%, and in T_{III} (IS + 600 g) 96%, 2% lower than control. A different picture was observed in other types of dressings. Thus, T_{III} (IP + 600 g) receiving stimulative feeding "IS + *Melissa*" showed a high rate (102.5%), while in T_I (IS + 200 g) distinguished itself in groups "IS + *Malva*" (103.4%) in comparison with the control group. Intermediate values according to treatments I, II, III "IS + *Melissa*" and treatments I, II, III "IS + *Malva*" showed from 23.8 ± 0.49 kg to 23.1 ± 0.39 kg and from 21.6 ± 0.33 kg to 22.7 ± 0.35 kg respectively. Beeswax productivity ranged from 231 ± 0.88 g to 243 ± 0.76 g and from 240 ± 0.49 to 232 ± 0.95, respectively. At the same time, in 2020, the maximum amount of marketable honey registered in T_{II} which received stimulative feeding "IS + *E. purpurea* 400 g" it was 18.7 ± 0.39 kg, in Treatment I 17.8 ± 0.39 kg, in T_{III} 18.2 ± 0.38 kg, and in the case of beeswax we recorded 224 ± 0.76 g; 219 ± 0.68; and 223 ± 0.76 g, respectively. In the control group, honey productivity was 18.4 ± 0.39 kg and beeswax productivity was 220 ± 0.77 g. In the study of the combination of "IS + *Melissa*", a high indicator was shown by T_{III} (IS + *Melissa* 600 g) as 101.3%, in comparison with the control group. Thus, when conducting research on all signs in the current honey collection season, the combination s of "IS + *E. purpurea*" at a dosage of 400 g and "IS + *Melissa*" at 600 g were the best options for feeding while having a positive effect on the productivity of bee colonies. The main task of the beekeeper in the autumn is to create strong colonies with a large number of young bees. Such families tolerate wintering well, develop rapidly in spring, and use all bribes. Therefore, at the end of the main flow, all care for the bees should be aimed at ensuring high egg-laying capacity of the queens and good feeding of the brood (Table 7).

Table 7. The effect of stimulative feeding on the increase in the winter of the autumn generation of worker bees (2019-2020; n = 5; $\sum_n = 60$).

Type	Statistical indicator	Groups and feeding options			
		Treatment I	Treatment II	Treatment III	Control group
2019					
"IS + *E. purpurea*"					
The strength of families (hives)	M ± m	9.4 ± 0.06	9.5 ± 0.06	9.4 ± 0.06	9.2 ± 0.07
	C_V (%)	14.5	14.4	14.5	15.0
Amount of feed (kg)	M ± m	9.8 ± 0.06	10.2 ± 0.05	10.0 ± 0.05	10.0 ± 0.05
	C_V (%)	17.4	16.7	17.1	17.1
Mass of worker bees (mg)	M ± m	103.6 ± 0.23	104.1 ± 0.20	103.8 ± 0.23	104.2 ± 0.21
	C_V (%)	0.38	0.38	0.39	0.38
"IS + *Melissa*"					
The strength of families (hives)	M ± m	9.3 ± 0.06	9.4 ± 0.06	9.6 ± 0.06	9.8 ± 0.05
	C_V (%)	14.5	14.5	17.4	17.9
Amount of feed (kg)	M ± m	10.0 ± 0.05	10.1 ± 0.05	10.1 ± 0.07	10.3 ± 0.06
	C_V (%)	17.1	17.1	15.0	16.7
Mass of worker bees (mg)	M ± m	104.0 ± 0.20	103.9 ± 0.23	104.4 ± 0.21	104.5 ± 0.21
	C_V (%)	0.38	0.38	0.38	0.38
"IS + *Malva*"					
The strength of families (hives)	M ± m	9.5 ± 0.06	9.3 ± 0.07	9.4 ± 0.06	9.6 ± 0.06
	C_V (%)	17.4	17.4	14.5	17.4
Amount of feed (kg)	M ± m	10.3 ± 0.06	10.2 ± 0.05	10.1 ± 0.05	10.5 ± 0.06
	C_V (%)	16.7	16.7	17.1	16.8
Mass of worker bees (mg)	M ± m	104.3 ± 0.21	104.1 ± 0.20	103.5 ± 0.23	105.0 ± 0.19
	C_V (%)	0.38	0.38	0.38	0.37
2020					
"IS + *E. purpurea*"					
The strength of families (hives)	M ± m	9.5 ± 0.06	9.7 ± 0.05	9.4 ± 0.06	9.3 ± 0.05
	C_V (%)	14.5	17.3	14.5	16.5
Amount of feed (kg)	M ± m	9.9 ± 0.06	10.6 ± 0.06	10.1 ± 0.05	10.0 ± 0.05
	C_V (%)	17.4	16.8	17.1	10.4
Mass of worker bees (mg)	M ± m	103.5 ± 0.23	105.2 ± 0.19	103.1 ± 0.23	103.0 ± 0.24
	C_V (%)	0.38	0.37	0.39	0.38
"IS + *Melissa*"					
The strength of families (hives)	M ± m	9.2 ± 0.06	9.5 ± 0.06	9.6 ± 0.06	9.0 ± 0.04
	C_V (%)	14.5	14.5	17.4	16.3

Amount of feed (kg)	M ± m	10.1 ± 0.05	9.9 ± 0.06	10.4 ± 0.05	10.2 ± 0.06
	C_V (%)	17.1	17.1	16.7	10.5
Mass of worker bees (mg)	M ± m	102.8 ± 0.20	103.4 ± 0.23	104.2 ± 0.21	103.2 ± 0.25
	C_V (%)	0.38	0.38	0.38	0.39

An analysis of the data in Table 7 shows that in 2019, the bee colonies that received the “IS + *E. purpurea*” stimulative feeding distinguished themselves in particular in terms of strength, whereas T_{II} (IS + 400 g) exhibited an average of 9.5 hives and in the group receiving "IS + *Melissa*" III (IS + 600 g) it was 9.6 hives. In addition, in the group "IS + *Malva*" I (IS + 200 g), it was 9.5 hives compared to the control group (9.2 hives). The maximum parameters of the described indicator (strength of colonies) were recorded in "IS + *Melissa*" III (IS + 600 g). According to the number of feed reserves stored after the cleansing flight of young bees, their maximum reserves varied from 9.8 kg to 10.3 kg. A similar picture was observed in the mass of worker bees from 103.5 mg to 104.4 mg, respectively. For the entire period of the experiment in 2020, the amount of feed and the strength of colonies in two combinations, i.e., "IS + *E. purpurea*" and "IS + *Melissa*" were equal to the control groups. Thus, the strength of families in three variants of feeding averaged 9.5 hives, the amount of feed was 10.2 kg, in comparison with the control (9.3 hives; 10.0 kg with a mass of bees 103.0 mg). When taking into account the combination of "IS + *Melissa*", the strength of colonies varied from 9.2 ± 0.06 to 9.6 ± 0.06 hives, the amount of feed from 9.9 ± 0.06 kg to 10.4 ± 0.05 kg, in comparison with the control group (9.0 ± 0.04 hives; 10.2 kg with a mass of bees 103.2 mg). Thus, feeding colonies with stimulating feedings in the autumn period contributes to the qualitative growth of colonies and the accumulation in them of a sufficient amount of feed for bees. The treatments "IS + *E. purpurea*" II (IS + 400 g) and "IS + *Melissa*" III (IS + 600 g) exhibited the best effect on the growth of worker bees in the winter in the autumn.

Economic efficiency. Economic efficiency is an integral part of research work. One of the main tasks of breeding honey bees is to increase the strength of colonies with the help of natural supplements. Analysis of Table 8 shows that in the production of a frame with brood using a combination to stimulate the development of bee colonies, the cost of the total expenses was 1230 tenge.

Table 8. Economic efficiency of various stimulative feedings for bee colonies

Groups and types of feedings	Cost of 1 unit (tenge)	Realization price of 1 unit (tenge)	Profit (tenge)	Profitability of frame production with brood (%)
		"IS + *E. purpurea*"		
Control	1230	2500	1270	100.0
I experimental	1181	2500	1319	103.9
II experimental	1060	2500	1440	113.4
III experimental	1302	2500	1198	94.3
		"IS + *Melissa*"		
Control	1260	2500	1240	100.0
I experimental	1090	2500	1410	113.7
II experimental	1280	2500	1220	98.3
III experimental	1000	2500	1500	121.0

In addition, when using the combination of "IS + *E. purpurea*", the cost of expenses on average was 1181 tenge, while in the case of "IS + *Melissa*" it was 1123.3 tenge. The use of stimulative feedings in the form of "IS + *E. purpurea*" displayed a positive effect on profits in comparison with the control group. Thus, the studied groups significantly exceeded the control group in terms of profitability from 103.9% to 113.4%. At the same time, in terms of the life of bee colonies during the period of active growth, the most effective feeding option was T_{II} "IS + *E. purpurea*". Whereas the control group is a chemical drug. In addition, according to the combination of "IS + *Melissa*", the best option for life during the period of active growth of bee colonies was the III experimental group. Thus, the use of stimulating feedings has a positive effect on the growth and development of bee colonies during the active period. Stimulating feeding has an impact on the increase in the load of the honey stomach, flight activity, honey, and beeswax productivity, which indicates the possibility of successful use of this component.

CONCLUSION

A recommendation has been developed for the maintenance of bee colonies for the production of environmentally friendly organic honey products in apiaries. Certification of the production of organic honey products in the

country should be carried out mainly by representatives of domestic standards. It is necessary to inform beekeepers as widely as possible (in particular through their public organizations) about the possibilities of the market for organic products. Honey bees and the quality of their products are biological indicators of the cleanliness of the environment, as they provide a systematic test of the ecological balance of the state of the ecosystem. This is the key to early detection of the negative impact of agroecological conditions on agricultural production, including organic production. Determining the concentration of heavy metals in honey products can be used as a methodological element of the biological value and quality assessment system. It is necessary to carry out the choice of the breed according to the selection plan of the economy as well as timely zootechnical methods of combating and preventing diseases of bees. A standard has been developed for organic honey products, production, and processing rules at the Scientific Council No. 3 dated 08/11/2020. When choosing a breed of bees, it is necessary to take into account its ability to adapt to the climatic conditions of a particular area and its resistance to diseases. It is necessary to add “breed selection carried out in accordance with the breeding plan of the farm”. Essential for the prevention of the most common diseases of bees are, it must be added, timely zootechnical methods of combating and preventing diseases of bees. If the application of preventive measures did not give the appropriate results, for the treatment of bee colonies in organic beekeeping, it is allowed to use formic, lactic, acetic, and oxalic acids, as well as menthol, eucalyptus or camphor, while antibiotic treatment is not allowed. Bee families, for the treatment of which chemically synthesized drugs were used, should be isolated for the period of treatment. It is necessary to add “In the future, these families should go through a transitional period of one year with a complete replacement of frames and beeswax with organic”. Technology has been developed for obtaining stimulative feedings to increase the strength of bee colonies in the early stages of spring and during the period of autumn increase in the mass of bees. In this study, T_I revealed 1864, the control group 1802, and T_{II} 1800 hundred cells. So, T_I (41.8%) was ahead of its peers in the active period in terms of the number of brood in all of them is higher than in the control and T_{II}. By the end of the accounting period, the difference between experimental and control decreased. Therefore, it can be noted that the dynamic development of bee colonies is recorded in those received inverted syrup from *E. purpurea*, which proves the effectiveness of autumn feeding before wintering.
An analysis of the economic efficiency of the production of a frame with brood using combination to stimulate the development of bee colonies was made. The cost of the total cost was 1230 tenge. In addition, when using the combination of "IS + *E. purpurea*", the cost of expenses on average was1181 tenge, while in "IS + *Melissa*" it was 1123.3 tenge. It has been established that the use of stimulating feedings in the form of "IS + *E. purpurea*" has a positive effect on profits in comparison with the control group. Thus, the studied groups significantly exceed the control group in terms of profitability from 111.6 to 135.8%.

REFERENCES

Agarkov, N 2009, Increase production efficiency. Economics of Agriculture, No. 3.

Astrauskene, AE 1990, What do we know about Perga. *Beekeeping.* 7: 30-32.

Balyakin, BN 1996, Patent for the invention "Feed for bees" RU 2064252 dated 27.07.1996.

Boradachev, AV, Burmistov, AN, Kasyanov, AI 2000. Guidelines for setting up experiments in beekeeping. Rybnoye.

Burmistrova, LA 1999, Physicochemical analysis and biochemical assessment of the biological activity of drone brood. Candidate of Dissertation, Ryazan, 22 p.

Farkhutdinov, RG, Ilyasov, RA, Ivanov, AA, Tuktarova, YuV, Shafikova, VM, Voronkov, YuP 2015, Patent for the invention "Composition for stimulating the development of bee families, prevention and treatment of ascospherosis" RU 2552672 dated 10.06.2015.

Gaidak, MO 1960, About the pollen substitute. *Beekeeping*, No. 3.

GOST 19792-2001, Natural honey. Specifications. Interstate Council for Standardization, Metrology and Certification. Minsk, 15 p.

GOST 21179-2000, Beeswax. Specifications. Minsk: Interstate Council for Standardization, Metrology and Certification, 15 p.

GOST 28886-90, Propolis. Specifications. Moscow, USSR State Committee for Product Quality Management and Standards, 13 p.

GOST 28887-90, Flower pollen (pollen). Specifications. Moscow, Standartinform, 12 p.

Izmalkova, NA 1991, The miracle of the bee. Voronezh Center, Chernozem Publishing House, 79 p.

Kiryanov, YuN 2004, Beekeeping inventory and apiary equipment: textbook for colleges. Moscow, Mir, 175 p.

Kozin, RB, Irenkova, NV, Lebedev, VI 2005, Workshop on beekeeping. Lan City: 2005.

Krivtsov, NI, Kiryanov, YuN, Lebedev, VI 2000, Technology of maintenance of bee colonies during the year. Samara, 80 p.
Krivtsov, NI, Lebedev, VI 1993, Obtaining and using honey products. Moscow, 25 p.
Krivtsov, NI, Lebedev, VI 1995, Honey products. Moscow, Niva of Russia, 253 p.
Lebedev, VI, Murashova, YeA 2003, Ecological purity of honey products. *Beekeeping*, 4: 42-44.
Petrov, YeM 2014, Modeling of egg-laying capacity of the queen bee and its use in technologies for keeping bee colonies, Achievements of Science and Technology of the Agro-Industrial Complex, 11: 62-65.
Plokhinsky, NA 1969, Guide to biometrics for zootechnicians. Moscow, 256 p.
Volkov, GK 1979, Veterinary-sanitary and zoohygienic problems of industrial animal husbandry. Moscow.
Yeskov, YeK 1990, Ethology of the honey bee. Moscow, Rosagropromizdat, 221 p.
Zaikina, VI 1999, Examination of honey and methods for detecting its falsification. Textbook, Moscow, Dashkov and K, 142 p.