Creating functional foodstuffs from high-technological larval raw materials

I A Prokhoda1,2*, E V Eliseeva1, N P Katunina1, Е N Stratienko1, O V Kukhareva1 and F N Tseeva1

1 Bryansk State University named after Academician I. G. Petrovsky, 14 Bezhitskaya str., Bryansk 241036 Russia
2 Small innovative enterprise Apiproduct Ltd., 16a Bezhitskaya str., Bryansk 241036 Russia

E-mail: irina.proxoda@yandex.ru

Abstract. The possibility of using the apiproducts of the larval origin from the drone larvae in the production of functional foodstuff, such as bakery, confectionery and honey products enriched with high-grade protein, biologically active high-functional substances and complexes that gave them therapeutic and prophylactic, and immune-modulating properties is substantiated in the paper. The recipes for the functional foodstuffs, such as the “Bilar-api” bread, “Pchelka” api-dragee, “Bilar” api-honney, “Bilar” api-honney with bee glue (propolis), enriched with apiprodut from the drone larvae have been developed. To impart an immune-modulating and functional effect to the products, the “Bilar” api-product with a high content of SH-groups, decenoic acids, vitamins, as well as flower pollen, honey, and bee glue in the form of a water-alcohol extract have been used. Preference for these substances has been given because phenolic compounds with Ρ-vitamin activity, unsaturated compounds of isoprene nature, have antioxidant, and fungicidal impacts. They are manifested in their ability to protect the body from the destructive effect of various damaging factors (ionizing radiation, free oxidation radicals, reactive oxygen species, etc.). The “Bilar” powder has a major content of high-grade protein (50-51%), which contains all essential amino acids, and on lysine, tryptophan and histidine exceeds the level of ideal protein on the FAO/WHO scale by almost two times, on the fatty acid composition practically corresponds to the formula of balanced nutrition, vitamins, and decenoic acids (7.9%), as well as sulphhydryl compounds (1160.1 mg %). Decenoic acid has pronounced antibiotic properties and antitumor effect, exerting an inhibitory effect on the malignant tumors. New functional food products were manufactured on the basis of traditional production technologies using sparing technological regimes and with utilization of apiproducts (the “Bilar” powder, pollen, etc.). Based on the results of the comprehensive study, the increase in the quality and quantity indicators of functional foodstuffs in comparison with control, the increase in biological and nutritional value, as well as improved organoleptic and physics and chemical parameters have been established.

1. Introduction
In recent years, a new direction has been formed in the science of nutrition, that is, the functional nutrition, which includes the development of theoretical foundations, manufacturing, sale and consumption of the functional foodstuffs (FFS). In the developed countries, healthy food is elevated to
the level of public policy. It is not accidental. It has been proven that proper nutrition ensures the growth and development of children, contributes to the prevention of diseases, increases the capacity for work and prolongs the life of people, whereas unbalanced, on the contrary, leads to many health problems. Modern society faces a global problem of food shortages that is largely due to the growth of the population of the Earth and the diversion of a significant share of food resources for technical purposes. Along with the shortage of food raw materials, the most important issue is that the contemporary mass food industry, playing the role of a supplier of basic food substances (proteins, fats, and carbohydrates) to the population, offers modern man not only refined food deprived of a number of useful substances, but also containing substances (coloring materials, preservatives, flavors, etc.), toxic to the body. Analysis of the actual nutrition of the population in various regions of Russia indicates that it is deficient in terms of vitamins, dietary fiber (pectin and fiber), and macro- and microelements. Therefore, it is very important to enrich food products with biologically active components that can improve many physiological processes in the human body, reducing the risk of development of the nutritional-dependent diseases, that is, diseases depending on nutrition factors (allergic diseases, anemia, atherosclerosis, diseases of the digestive system, thyroid disease, hypertension, gout, obesity, osteoporosis, diabetes mellitus, some pathologies of pregnancy, etc.).

One of the ways to solve these issues is to involve environmentally friendly non-traditional raw materials into economic circulation, the use of which, in its pure form and in the production of food products, will enrich them with vital nutrients that satisfy the energy, regulatory, protective and other needs of the organism to the level, corresponding to the physiological needs of man.

According to the data of The Micronutrient Initiative (USA), the enrichment of food with biologically active substances makes it possible to prevent four out of ten child deaths, reduce maternal mortality by more than a third, increase work capacity by 40%, increase the IQ of the population by 10-15 points, increase the country's gross product by 5%. This is the direction of food biotechnology and preventive medicine, which in the 21st century will create real prerequisites for an increase in the average life expectancy, long-term preservation of physical and spiritual health, social and moral satisfaction, active life for the elderly and the birth of a healthy generation.

According to Japanese and American scientists, it is the development of the market of fortified foodstuffs that will change the general structure of nutrition for all people on the Earth in the near future, and in 25-30 years the products of this category will half-oust the existing market of medicines in the world.

Currently, in connection with the popularization of the role of nutrition among the population in the prevention of alimentary diseases, there is a steady tendency to increase the volume and expand the range of foods enriched with biologically active substances as one of the tools to increase the competitiveness of products. So far, the enriched food products account for no more than 3% of all known foodstuffs. However, judging by the forecasts of the world's leading experts in nutrition and medicine, in the next 15 to 20 years their share will reach 30% of the total food market. The need to expand the range and increase the volume of enriched products production is stipulated by the main directions of the National Concept “Healthy Nutrition Policy in Russia”, approved by the Government of the Russian Federation [1].

The Russian market of ingredients offered for the enrichment of food products is represented by a large variety of substances of various origins and physicochemical and physiological effects. At present, natural functional ingredients are of special interest for both consumers and manufacturers. The life products of honey bees (Apis mellifera), which have special properties, are the source of them along with the traditional ones, such as vegetables, fruits, berries, medicinal and spicy-aromatic plant raw materials. Their uniqueness is in the fact that specific polyunsaturated fatty acids, which are produced by the bee's organism that cannot be found in nature in pure form and have special functional properties, are added to plant biologically active substances (phenolic compounds, carotenoids, vitamins, etc.).

By now, the properties of such common products of beekeeping as honey, flower pollen, and royal jelly have been thoroughly studied. However, there is practically no data on the promising new
product of beekeeping - the larvae of open bee brood, which can be used as natural biologically active raw materials in various fields of activity, including the food industry.

Apiproduts of the larval origin have much in common with royal jelly; they have a therapeutic and prophylactic effect (especially antioxidant, immune-modulating, antitumor, actoprotective, etc. effects). The studies conducted by Professor I.A. Prokhoda have shown that there is much more decenoic acids and sulfhydryl compounds in the drone larvae than in royal jelly. The amount of protein reaches 51%, and it contains all essential amino acids, and for lysine, tryptophan and histidine the level of ideal protein on the FAO/WHO scale is exceeded almost twice. In addition, up to 5% of fats are present in the larvae, of which 10% are low molecular weight fatty acids (essential), 28% are mono-saturated, and 45% are saturated, that is, the fat content practically corresponds to the formula of rational and balanced nutrition that increases the biological value considered in the projects of apiproduts from the drone larvae [2, 8].

The foregoing allows us concluding that it is necessary and promising to carry out the claimed R&D work on the small innovative enterprise Apiprodut Ltd.

We have developed recipes for new functional bakery, confectionery and honey prod- ucts and demonstrated the possibility of their manufacturing at the small innovative enterprise Apiprodut Ltd., the first Russian enterprise that manages the quality of innovative apiprodut from the drones larvae and its introduction into the food industry for the enrichment of products of mass consumption with a high-grade protein, biologically active high-functional substances and complexes.

2. Problem Statement

The problem of production of protein-containing food products, especially from natural raw materials, is acute in the world. In modern environmental conditions, there is a significant decrease in immunity, which is manifested in an increase in the number of people infected with dangerous diseases, for example, tuberculosis. Nutrition plays the main role in the correction of immunity. One of the ways to solve the above issues is a significant increase in the diet the proportion of foods with a high content of natural protein and biologically active substances (BAS) with immune-modulating action in the form of powders, pastes, etc.

Also, manufacturers face a huge problem of search of alternative sources of natural raw materials that can be used as mineral processing products of mass consumption and giving them highly functional properties. In modern literature, many scientists have shown that bee products such as royal jelly, honey, pollen, propolis, etc. have a medical and nutritional properties, thanks to their composition of the full-fledge proteins, phenolic compounds, biopolymers, unsaturated substances, such as decenoic acid and sulfhydryl compounds that are able to bind reactive oxygen species, oxidative free radicals and to create insoluble complexes with ions of heavy metals.

However, there is no systematic scientific information on the functional properties of the unconventional product of beekeeping of the larval origin, namely, the drone larvae. Moreover, larvae are not a traditional product of the Russian cuisine, and their use in the production of functional foods is also hampered by the emotional discomfort when used. We have previously established a high therapeutic activity of the use of the drone larvae: this nontraditional apiprodut is recognized to be more effective in comparison with the synthesized preparations of traditional medicine [2], [3], and [4].

However, our studies allow us stating that:

2.1. To date, the scientific idea of using high-functional apiproduts of the larval origin in food production has not been formed. In the Russian Federation, products of the larval origin cause emotional discomfort when consumed, and are not used for food. However, in many countries of the world, larvae are used as a food product, since they contain a rich full-fledged protein. Therefore, the solution of the issue of searching for alternative raw materials from natural food ingredients is very relevant and timely.
2.2. The recipes for new bakery, confectionery and honey products have not been developed, the technologies for their production have not been developed as well, their commodity characteristics and consumer properties of new final food products have not been given.

This work is devoted to solving the actual scientific problem – to the scientific substantiation and creation of the functional food products from the larval raw materials that is an unconventional product of beekeeping, specifically, the apiproduct from the drone larvae.

3. Research Questions

3.1. The analysis of literature and the development of recipes of the “Bilar-api” bread, using apiproduct from the drone larvae as an enriching agent.

3.2. The development of recipes and technologies for the production of confectionery products – the api-dragée “Pchelka”.

3.3. The development of recipes and technologies for the production of confectionery products – “Bilar” api-honney, “Bilar” api-honney with propolis, enriched with apiproduct from the drone larvae, and the formation of their consumer properties.

4. Purpose of the Study

The purpose of the study is a scientific justification of the following:

a. The possibility of using apyproduct of the larval origin for the creation of functional food products;

b. The development of “Bilar-api” bread, “Pchelka” api-dragée, “Bilar” api-honney, “Bilar” api-honney with propolis, enriched with apiproduct from the drone larvae;

c. Formation of consumer properties of the new functional food products.

5. Research Methods

Theoretical basis of this study is the scientific literature on the topic of the research, the works of domestic and foreign scientists. Also, the material-technical and laboratory base of the Apiproduct Ltd. enterprise and Internet materials have been used in the process of writing this paper.

Research methods include generic scientific methods, such as the experimental method, the analog method, as well as the organoleptic, physicochemical, microbiological and other methods.

The object of the research is the “Bilar-api” bread, “Pchelka” api-dragée, “Bilar” api-honney, “Bilar” api-honney with propolis, enriched with apiproduct from the drone larvae to give final products functional properties.

The subject of the research is the development of recipes and the creation of functional products for the mass consumption, such as the “Bilar-api” bread, “Pchelka” api-dragée, “Bilar” api-honney, “Bilar” api-honney with bee glue, enriched with apiproduct from the drone larvae, and the formation of their consumer properties.

6. Findings

6.1. In the course of the research, recipes and technologies for the production of new products – “Bilar-api” bread have been developed, its commodity quality assessment has been given that allows expanding the production range, increasing nutritional value, and improving the organoleptic, physicochemical indicators of the finished product.

In the development of recipes and the selection of the chemical composition of the new products, we followed the recommendations of the Institute of Nutrition of the Academy of Medical Sciences of Russia on the nutrition of people living in areas with increased radiation, as well as on the nutrition of
the population for the prevention of cancer, according to which the daily requirement for β-carotene should be 8-10 mg, and vitamin C - 70-150 mg.

To make the products immune-modulating and provide it with functional effects, powdered apiproduct “Bilar”, and propolis in the form of an extract with a high content of SH-groups, decenoic acids, phenolic compounds, tannins, vitamins, as well as honey and flower pollen have been used. Preference for these substances has been given because phenolic compounds with P-vitamin activity, unsaturated compounds of isoprene nature and tannins, which are part of propolis, possess antioxidant, bactericidal and fungicidal activity. They are manifested in their ability to protect the body from the destructive effect of various damaging factors (ionizing radiation, free oxidation radicals, reactive oxygen species, etc.).

The “Bilar” powder has a high content of high-grade protein (50-51%), which contains all essential amino acids, and on the lysine, tryptophan and histidine exceeds the level of ideal protein on the FAO/WHO scale by almost twice, on the fatty acid composition practically correspond to the formula of balanced nutrition, vitamins, decenoic acids (7.9%), and the same is for sulfhydryl compounds (1160.1 mg/%). Decenoic acid has pronounced antibiotic properties and antitumor effect, having an inhibitory effect on malignant neoplasms [2].

The “Bilar-api” bread has been produced according to the traditional technology of bakery products by a sputtered method using sparing technological production modes. The recipe for the production of the “Bilar-api” bread is characterized by the use of apiproducts (Bilar powder and flower pollen) as a biologically active additive for giving bread prophylactic and functional properties (Table 1).

| Name of raw materials and process indicators | Opar | Dough |
|---------------------------------------------|------|-------|
| Wheat flour, high quality, kg               | 43   | 52    |
| “Bilar” powder, kg                          | -    | 2     |
| Pollen                                      | -    | 3     |
| Opar, kg                                    | -    | all   |
| Water, l                                    | 36   | All quantities are calculated |
| Yeast, compressed, kg                       | 1    | 0.5   |
| Food salt, kg                               | -    | 1.5   |
| Sunflower-seed oil, kg                      | -    | 2.5   |
| Sugar, kg                                   | -    | 3     |

Powdered apiproduct “Bilar” was introduced in an amount of 2%, flower pollen - 3% of the total amount of flour. The flower pollen is recommended to grind or dissolve in a small amount of water immediately before mixing the dough.

“Bilar” is used in the form of a powder without additional treatment. These doses were introduced according to the recommendations of dieticians when using royal jelly for enriching food products, including bakery products and they are allowed by the Ministry of Health (MOH) of Russia. The doses are selected based on the organoleptic evaluation of the final product and economic feasibility. It was found that the addition of additives in these dosages slows the process of staling, since an increase in the amount of hydrophilic components contributes to stabilization of the forms of moisture binding in the crumb, an increase in the share of capillary and adsorption-bound moisture.

The products with api- supplements are characterized by high organoleptic indicators: the crumb gets a uniform thin-walled porous structure without voids and has a light yellow color, and a peculiar tar floral smell and floral odor. Flower pollen, which contains natural coloring pigments, phenolic compounds and carotenes, imparts the yellowish color and floral aroma to the “Bilar-api” bread.
Based on the results of the comprehensive study, an increase in the qualitative and quantitative indices of the “Bilar-api” bread was established in comparison with the control (“Rozhdestvensky” bread, enriched with bran and produced according to a similar recipe). The biological value of the new “Bilar-api” bread increased at a constant humidity of 44.0%, acidity of 3.9° and fat and carbohydrate content; protein content was 11.5%; the bread is enriched with vitamins.

Technical documentation has been developed for the new “Bilar-api” bread with the use of the “Bilar” powder and pollen. Recipes and technologies of the enriched products are approved and introduced on “The Komarichsky Bakery”.

6.2. The recipes and technologies for the production of confectionery products – the api-dragee – have been developed. As raw materials, in the preparation of the api-dragee have been used sugar, molasses, nuts, honey, fats, food acids, dyes, essences, vegetable oils, etc. Starch has been used as a forming material. Paraffin and beeswax have been used to gloss the surface. The preparation of raw materials for production and the manufacturing technology is the same as in the production of other types of confectionery products, except that apiproducts have been introduced in the process of coating. From traditional production technologies, the api-dragee differs in using apiproducts. To strengthen the protective effect, ascorbic acid has been added, which is not only an antioxidant, but also a synergist. Flower pollen and honey have been injected into the formulations in an amount of 4.5-5%. The dose is selected based on the organoleptic evaluation of the final product and economic feasibility. Apiproduct Bilar was used in an amount of 0.1%. This dose is used for the preparation of food products and their enrichment with royal jelly and is authorized by the MOH of Russia. The api-addition from propolis was added in an amount of 0.06% per dry matter, by analogy with the use of natural preservatives. The introduction of apiproducts provides a high level of P-active substances in the finished products that have the ability to accept free radicals and thus reduce the intensity of oxidative processes that initiate a decrease in human immunity.

The study of the quality of the api-dragee showed that they have a pleasant taste and a peculiar tar honey aroma with a shiny surface, round or oval in their organoleptic characteristics. Humidity of the api-dragee ranges from 2.5-6.5%. Studies of the content of BAS in the api-dragee showed that the mass fraction of β-carotene was 1.1-1.5 mg per 100 g, and they are characterized by a high content of ascorbic acid (315-321 mg per 100 g). The recommended preventive dose of api-dragee is 25 g, and it contains 78.7-80.3 mg of vitamin C that corresponds to the daily requirement of a person in vitamin C. It is also shown that the new api-dragee have a high content of phenolic compounds, such as chlorogenic acid - 843-898 mg per 100 g, flavonol glycosides - 215-221 mg per 100 g, free catechins - 104-112 mg per 100 grams, and tannins - 348-375 mg per 100 g.

Studies of the microbiological parameters of the new api-dragee showed that the total number of mesophilic aerobic and facultative anaerobic microorganisms was 2.8-3.5 x 10^3 units per gram that does not exceed the parameters provided by the state standards (GOST). It is shown that the quality of api-dragee “Pchelka” is practically unchanged for 6 months: the mass fraction of β-carotene decreased by 13-18%. Medico-biological studies of the api-dragee carried out at Kharkov National Pharmaceutical University have shown that they possess therapeutic and prophylactic properties and are recommended for regular use.

6.3. “Bilar” api-honney is a mixture of natural honey with a powdery apiproduct “Bilar” (100:1), “Bilar” api-honney with propolis is a mixture of the same components with the addition of the propolis api additives in the form of water-alcohol extract (100:1:2).

Preparation of api-honney was made with the help of a mixer according to the generally accepted technology. When using crystallized honey, it was previously “dissolved” in a heated water bath at a temperature of plus 40°C to evenly mix the components. Packing of the api-honney “Bilar” was carried out in glass jars, with a volume of no more than 0.5 dm³, covered with sterile metal lacquer lids. In the room where the packing process was taking place, the relative humidity of the air should not be more than 75%, and the temperature not higher than 25°C.

According to the organoleptic indicators, api-honney “Bilar” has a sweet taste with a peculiar floral aroma, and api-honney “Bilar” with propolis has a pleasant sweet taste and a peculiar tar floral aroma.
peculiar to propolis. The addition of apiproducts did not affect the appearance of the api-honney - a thick syrupy mass; the color is rich yellow due to propolis, which contains phenolic compounds that impart an additional intensity to the staling. The addition of lipid additives to honey made it possible to enrich its BAS and was directed to form a quality: the mass fraction of vitamin C was 12.2-12.5 mg per 100 g, phenolic compounds, such as chlorogenic acid, 185-198 mg, flanollol glycosides 42.0-50.0 mg per 100 grams, free catechins 10.0-12.0 mg per 100 grams, tannins 380-420 mg per 100 grams. The main component of honey is carbohydrates (95%), so api-honney “Bilar” and “Bilar” with propolis are enriched with biologically active substances, which give them enhanced immune-modulatory and functional qualities in comparison with natural honey.

The study of the microbiological indices of the api-honney “Bilar” showed that the total amount of mesophilic aerobic and facultative anaerobic microorganisms was 2.0x100 units per gram that does not exceed the standard specified in the GOST for natural honey.

The results of the conducted tastings showed that the developed products have high organoleptic and structural and mechanical characteristics and enriched chemical composition compared to traditional ones, due to the introduction of apiproduct from the drone larvae and other apiproducts.

According to clinical trials, apiproduct from the drone larvae has a multifaceted biological effect: its use is recommended for stabilization of the immune and nervous (with vegetative-vascular dystonia, cerebral blood flow disorders, etc.) systems, hematopoietic system of children with anemia; it normalizes appetite, increases the body's resistance to infections, and is the source of essential amino acids, vitamins, macro- and microelements and other essential biologically active complexes. Apiproduct promotes increased growth, normalization of the hormonal background, especially during puberty and the adverse effects of menopause, and in the treatment of sexual infertility. It is recommended in physical exhaustion and during the reconvalescence of patients, for improving memory and vision, mental and physical performance, and for rejuvenating the body.

In 2013, the technical standards TU 9882-001-30327738-2013 “Powders from open bee brood “Bilar” was developed, together with pharmacists, physicians and technologists and entered into operation on the Apiproduct Ltd. [6].

7. Conclusion
Possibility of using apiproducts of the larval origin from the drone larvae for the creation of functional foodstuffs - bakery, confectionery and honey products enriched with high-grade protein, biologically active high-functional substances and complexes, and giving them therapeutic-prophylactic and immune-modulating properties is scientifically substantiated.

The recipes for the “Bilar-api” bread, api-dragee “Pchelka”, api-honney “Bilar” and api-honney “Bilar” with propolis, enriched with apiproduct from the drone larvae, has been developed.

The “Bilar-api” bread has been produced according to the traditional technology of bakery products using sparing technological production modes.

The “Bilar-api” bread is characterized by high organoleptic characteristics: the crumb acquires a uniform thin-walled porous structure without voids and has a light yellow color, a peculiar tar floral smell and floral scent. The yellowish color and floral aroma are imparted to the “Bilar-api” bread by flower pollen, which contains natural coloring pigments, phenolic compounds and carotenes.

Based on the results of the comprehensive study, an increase in the qualitative and quantitative indices of the “Bilar-api” bread has been established in comparison with the control (“Rozhdestvensky” bread, enriched with bran and produced according to a similar recipe). The biological value of the new “Bilar-api” bread increased at a constant humidity of 44.0%, acidity 3.9º and fat and carbohydrate content; protein content was 11.5% and bread is enriched with vitamins.

Technical documentation has been developed for the new the “Bilar-api” bread with the use of the Bilar powder and pollen. Recipes and technologies of the enriched products are approved and introduced on “The Komarichsky Bakery”. 
The developed recipes and technologies for the production of confectionery products, namely the api-dragee “Pchelka”. As raw materials, sugar, molasses, nuts, honey, fats, food acids, dyes, essences, vegetable oils, etc. have been used in the preparation of the api-dragee. Starch has been utilized as a forming material. The api-dragee differs from traditional production technologies with using apiproducts. Flower pollen and honey were injected into the formulations in an amount of 4.5-5%. The apiproduct Bilar was used in an amount of 0.1%, the additives from propolis – in an amount of 0.06% on a dry matter. According to the organoleptic indices, the api-dragee “Pchelka” has a pleasant taste and a peculiar tar honey aroma with a shiny surface, round or oval. Humidity of the api-dragee ranges from 2.5-6.5%. Studies of the content of BAS in the api-dragee showed that the mass fraction of β-carotene was 1.1-1.5 mg per 100 g; they are characterized by a high content of ascorbic acid (315-321 mg per 100 g). The recommended preventive dose of api-dragee 25 g per dose contains 78.7-80.3 mg of vitamin C, which corresponds to the daily requirement of a person in this vitamin. It is also shown that the new api-dragee have a high content of phenolic compounds such as chlorogenic acid - 843-898 mg per 100 g, flavonol glycosides - 215-221 mg per 100 g, free catechins - 104-112 mg per 100 grams, and tannins - 348-375 mg per 100 g.

Studies of the microbiological parameters of the new api-dragee have shown that the total number of mesophilic aerobic and facultative anaerobic microorganisms is 2.8-3.5 x 103 units per gram that does not exceed the standard provided by the GOST. It is shown that the quality of the api-dragee “Pchelka” is practically unchanged for 6 months: the mass fraction of β-carotene decreased by 13-18%. Medical and biological studies of the api-dragee “Pchelka” carried out at Kharkov National Pharmaceutical University have shown that they possess therapeutic and prophylactic properties and are recommended for regular use.

The api-honney “Bilar” is a mixture of natural honey with a powdery apiproduct “Bilar” (100:1), the api-honney “Bilar” with propolis is a mixture of the same components with the addition of propolis in the form of water-alcoholic extract (100:1:2).

On its organoleptic indicators, the api-honney “Bilar” has a sweet taste with a peculiar floral aroma; the api-honney “Bilar” with propolis has a pleasant sweet taste and a peculiar tar floral aroma peculiar to propolis. The addition of apiproducts does not affect the appearance of the api-honney - a thick syrupy mass; the color is rich yellow due to the apiproduct of propolis, which contains phenolic compounds that impart an additional intensity to the staling. The addition of lipid additives to honey made it possible to enrich its BAS and is directed to form a quality: the mass fraction of vitamin C was 12.2-12.5 mg per 100 g, phenolic compounds such as chlorogenic acid - 185-198 mg in 100 g, flanolol glycosides - 42.0 -50.0 mg per 100 grams, free catechins - 10.0-12.0 mg per 100 grams, and tannins - 380-420 mg per 100 grams. The main component of honey is carbohydrates (95%), so the api-honney “Bilar” and “Bilar” with propolis are enriched with biologically active substances, which give them enhanced immune-modulatory and functional properties in comparison with natural honey.

The study of the microbiological indices of the api-honney “Bilar” showed that the total amount of mesophilic aerobic and facultative anaerobic microorganisms is 2.0x100 units per gram that does not exceed the standard specified in the GOST for natural honey.

The results of the conducted tastings showed that the developed products have high organoleptic and structural and mechanical characteristics and enriched chemical composition compared to traditional ones, due to the introduction of apiproduct from the drone larvae and other apiproducts.

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