Reducing agents of drone brood products supplemented by royal jelly, propolis and chitosan derivatives

D V Mitrofanov, E A Vakhonina and N V Budnikova

Chemical and biological research of bee products, Federal Scientific Center for Beekeeping, 22, Pochtovaya str., Rybnoe, Ryazan region, 391110, Russia

E-mail: dima-mitrofanoff2012@yandex.ru

Abstract: Violation of the ratio of nutrients causes diseases. Antioxidants occupy a special place among micronutrients, which can slow down aging and prevent the development of tumors. Bee products, especially drone brood, propolis, royal jelly, and chitin-chitosan-melanin complex, are rich in antioxidants. This requires the development of new combined products that have a complex effect on the human body. As an indicator of the content of unsaturated compounds, the iodine number of the drone brood adsorbed by lactose-glucose adsorbents, as well as supplemented by the chitin-chitosan-melanin complex, propolis extract and royal jelly, was studied. The results showed that new products have a higher iodine number compared to drone brood on lactose-glucose adsorbents. This is promising for the widespread use of new products in human nutrition. The iodine number can be a reliable indicator of quality.

1. Introduction

One of the main causes of oncological, metabolic, endocrine, digestive and other diseases is a change in the diet. At the same time, antioxidants, which prevent or reduce severity of oxidative stress, play an important role in maintaining the health and resistance of the body to adverse environmental factors. The development of new beekeeping products based on the drone brood of honey bees (DB) supplemented by antioxidant components is relevant. Drone brood is a rich source of antioxidants [1]. Since these substances are easily destroyed, drone brood needs stabilization and storage conditions. Stabilized by honey, alcohol, adsorption or lyophilization, the drone brood is less sensitive to external conditions.

Drone brood antioxidants are represented by unsaturated fatty acids in free and bound forms, including unique decenic acids, substances having sulphhydryl groups, flavonoid and other phenolic compounds [1]. The content of sulphhydryl groups is 2–3 times higher than in the royal jelly [2, 3]. The quantitative content of sulphhydryl groups can be determined either by their reaction with Ellman's reagent forming a bright yellow color, which is measured spectrophotometrically [4], or by the iodometric method [2]. The brood brood is rich in unsaturated fatty acids; it contains 28 % of mono- and 10 % polyunsaturated fatty acids [5]. The ability of DBs to reduce oxidative stress and prevent cardiovascular diseases has been shown [6].

The chitin-chitosan-melanin complex (CMC) is an inexpensive product that has antioxidant, sorption, photoprotective and other properties [7]. Flavonoid and other phenolic compounds are an important component of the drone brood with an antioxidant activity. The mass fraction of flavonoid and other phenolic compounds in bee products is determined by the spectrophotometric method. With a single irradiation of mice with gamma radiation at a dose of 6.5–7.5 Gy, the survival rate of animals...
Propolis is the richest source of flavonoid and other phenolic compounds. According to GOST 28886-90, their content should be at least 25%, but in individual samples their content exceeds 70% [9]. Propolis aqueous and alcoholic extracts are antioxidant substances. The concentrated propolis extract has a better indicator than natural propolis [10]. This determines the choice of concentrated extract for the preparation of a composition with drone brood. Unlike liquid extracts, the concentrated one does not contain significant amounts of alcohol, which leads to the denaturation of brood proteins or water, which complicates the drying process. Propolis can help prevent chronic cardiovascular disorders [11]. Polymer nanoparticles containing the extract of Brazilian red propolis exhibit high antioxidant properties [12].

Royal jelly (RJ) contains 10-hydroxydecanoic acid, while it was not found in DB [13]. Royal jelly increases the overall performance of rats by normalizing such indicators of oxidative stress as diene and triene conjugates, malondialdehyde, Schiff bases, and a catalase activity [14]. Royal jelly enhances oxygen-dependent metabolism of phagocytes, reducing the increased level of lipid peroxidation [15]. Royal jelly increases the stamina of young athletes, reduces fatigue, and prevents lipid peroxidation [16]. In experimental rats, royal jelly reduces the level of corticosterone and enhances the antioxidant defense of the brain during cold stress [17].

In experimental diquat-induced cataracts in rabbits, the apicomposition consisting of native royal jelly, honey and propolis showed an activity similar to the synthetic antioxidant ionol in the amount of biochemical properties [18]. Flavonoids, phenolic compounds and terpenoids of beekeeping products, such as pollen, royal jelly and propolis, can be used for neurodegenerative, oncological diseases, diabetes, atherosclerosis, side effects of drugs [19].

2. Materials and methods

The research material was samples of dry adsorbed DB based on lactose-glucose adsorbents, as well as ones supplemented by with the addition of 2, 5, 10 % CMC, 1, 2, 3 % of propolis extract, royal jelly in the amount of half of DB. Adsorption followed by vacuum drying at a temperature of + 34 °C is a simple and effective way to stabilize the drone brood. To obtain products, the drone brood or its mixture with royal jelly is thoroughly ground with the required amount of adsorbent. If it is necessary to manufacture adsorbents containing CMC, the required amount was pre-mixed with a lactose-glucose mixture. Propolis extract is introduced into the product after grinding DB with an adsorbent and mixed until a homogeneous mass. After granulation, the mass is dried.

The iodine number (IN) was determined by binding the products of free iodine in a non-aqueous medium. Then the excess iodine was titrated with sodium thiosulfate solution until discoloration (indicator – soluble starch). The iodine number is an important characteristic of antioxidant activity.

The first adsorbent is considered classic. Adsorption was carried out with a ratio of DB and adsorbent 1: 5, royal jelly – 1: 4

| No | Composition | Symbol |
|----|-------------|--------|
| 1  | lactose: glucose 96:4 +DB  | A1     |
| 2  | lactose: glucose 1:1 + DB | A2     |
| 3  | lactose: glucose:CMC 94:4:2 + DB | 2 CMC  |
| 4  | lactose: glucose: CMC 91:4:5 + DB | 5 CMC  |
| 5  | lactose: glucose: CMC 86:5:10 + DB | 10 CMC |
| 6  | lactose: glucose 96:4, DB:MM 2:1 | DB+RJ |
| 7  | lactose: glucose: propolis extract 96:4:1 + DB | 1EP    |
| 8  | lactose: glucose: propolis extract 96:4:2 + DB | 2EP    |
| 9  | lactose: glucose: propolis extract 96:4:3 + DB | 3EP    |
3. Results and discussion

Table 2 presents the average values of the IN and the error probability of error. Green and turquoise indicate colors the values, the differences between which are statistically significant.

|        | A1  | A2  | 2CMC | 5CMC | 10 CMC | 1EP  | 2EP  | 3EP  | DB+RJ |
|--------|-----|-----|------|------|--------|------|------|------|--------|
| M±m    | 1.68 ± 0.198 | 1.06 ± 0.524 | 2.53 ± 0.474 | 2.42 ± 0.114 | 3.81 ± 0.174 | 3.08 ± 0.416 | 5.05 ± 0.172 | 5.88 ± 0.119 | 2.89 ± 0.181 |
| lim    | 0.51-2.319 | 0.535-2.106 | 1.687-3.892 | 1.801-2.707  | 3.656-4.16  | 2.58-3.91  | 4.85-5.39 | 5.57-6.35 | 2.53-3.08 |

A2 0.2078

2CMC 0.0684 0.0932

5 CMC 0.0151 0.0054 0.7773

10 CMC 0.0002 0.0076 0.0785 0.0002

1EP 0.0076 0.0389 0.2805 0.0633 0.1828

2EP 0.0000 0.0019 0.4412 0.0000 0.0072 0.0120

3EP 0.0000 0.0011 0.0074 0.0000 0.0022 0.0043 0.0481

DB+RJ 0.0119 0.0298 0.5650 0.0567 0.0215 0.6906 0.0009 0.0006

p – error probability. * > 0.1; * 0.05 – 0.1; * 0.001 – 0.05; * < 0.001

Thus, the iodine number A1 is statistically inferior to all samples, with the exception of A2 and 2CMC. A2 is statistically significantly inferior to all samples except for 2CMC. 2CMC is statistically significantly inferior only to 3EP. 5CMC exceeds A1 and A2, but inferior to 10CMC, 2EP and 3EP. 10CMC in exceeds A1, A2, 5CMC and DB + RJ, but inferior to 2EP and 3EP. 1EP is significantly inferior to 2EP and 3EP, but surpasses A1, A2 and DB + RJ. 2EP is statistically significantly superior to A1, A2, 2CMC, 5CMC, 10CMC and DB + RJ, but inferior to 3EP. 3EP is statistically significantly superior to all other samples by the iodine number. DB + RJ significantly exceeds A1 and A2, but is inferior to 10CMC, 2EP and 3EP. The remaining differences do not reach statistically significant values (they are marked by yellow and red colors).
Figure 1 shows that the lowest values of the iodine number are observed in DB adsorbed on lactose-glucose adsorbents, royal jelly increases this indicator by 1.21 g/100 g relative to the product based on the classic adsorbent, 5 and 10 % CMS – by 0.89 and 2.13 g/100 g respectively. All samples have a pleasant taste and smell, with the exception of 10CMC, which gives an unpleasant sensation. Products A1, A2, 2CMC and 5CMC have a pleasant sweet taste, samples supplemented by royal jelly are characterized by a pleasant sweet and sour taste and honey aroma. When applying EP, the samples have a sweet taste with bitterness – from the barely noticeable one at 1 % EP to the pronounced one which is considered unpleasant. Samples supplemented by the propolis extract have a characteristic propolis flavor.

4. Conclusion
The use of propolis extract in the amount of 1, 2, and 3 % increases the iodine number by 1.4, 3.37, and 4.2 g/100 g, respectively.

All tested products showed a higher iodine value in comparison with the product based on the classic adsorbent. The greatest increase can be achieved by adding the propolis extract. This suggests that CMC, RJ and EP increase the biological activity of products.

The iodine number can be used as an indicator of quality of the products. Standard values for all products must be determined individually.

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