UDC 608.2:638.135 https://doi.org/10.31548/animal2021.03.007

# DEVELOPMENT OF A PROPOLIS COLLECTING DEVICE

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***Abstract.*** *Propolis is a sticky resinous substance collected from buds, leaves, stems of wild plants and processed by bees, which has bactericidal properties and which they use to seal cracks in the hive, polish the walls of wax cells, embalm the corpses of enemies. The analysis of research and publications gives grounds to conclude that Ukraine has not yet paid sufficient attention to the conditions of propolis production. There are no devices and equipment to improve the process of production of safe and high-quality propolis, which will meet the high requirements of regulatory acts on the quality and safety of food products and raw materials. Currently, apiaries use methods of collecting propolis, which require considerable human labor, are not economically efficient, and the resulting product does not meet the quality requirements of market operators. Therefore, there is a need to improve existing technologies for obtaining propolis, to improve sanitary-hygienic conditions of production, to increase productivity and economic efficiency, mechanization, and automation of the production process. The goal of our work was to develop a new propolis collecting device. The work was carried out as a part of the dissertation research at the Department of Standardization and Certification of Agricultural Products of the National University of Life and Environmental Sciences of Ukraine during 2020–2021. A new propolis collecting device has been designed and manufactured. The design of the device shafts and the principle of mechanical cleaning of the grids from the propolis, laid down during its development, can be used to develop highly automated lines for cleaning the grids. The use of the device in industrial apiaries in countries with tropical and subtropical climates is possible by placing the device in honeycomb storage, if available, or in a manufacturing area equipped with air conditioning. For a good cleaning of the grids with propolis using the device, it is sufficient to cool the grids at a temperature of +5 °C for 60–90 minutes, depending on the type of propolis. The device can be used at apiaries in Ukraine and other countries where the production of propolis from bee colonies is carried out using elastic grids. The use of the device ensures the production of pure propolis without mechanical impurities, which meets the requirements of current legislation. The developed device is patented, a patent № 139736 "Propolis collecting device".*

***Keywords:*** *propolis, grid cleaning process, device, quality*

## *Introduction.*

Production in the field of beekeeping is aimed at reducing human labor costs in the technological process and thus increasing profitability. At the same time, minimization of the presence of human labor and human contact with raw materials and products minimizes the risks associated with deterioration of sanitary-hygienic conditions of production. The number of bee colonies kept in the apiaries affects the number of employees involved, the time spent on servicing one bee colony, the time devoted to proper sanitary-hygienic conditions of production, the rate of return in production. Today, according to the Register of apiaries in Ukraine (https://dpss.gov.ua/diyalnist/reyestrividkritidani), 8% of apiaries keep up to 10 bee colonies, 39% – up to 30, 24% – up to 50, 20% – up to 100, 7% – up to 200, 2% more than 200. The apiaries with the number of bee colonies from 100 can be attributed to industrial apiaries, which is 29% of the total number of registered apiaries in Ukraine. Therefore, there is a need to develop, research, and implement in production of industrial and automated equipment for the production and obtaining of beekeeping products and propolis. The analysis of research and publications gives grounds to conclude that in Ukraine today not enough attention has been paid to the conditions of propolis production. There are no devices and equipment to improve the process of production of safe and high-quality propolis, which will meet the high requirements of regulatory acts on the quality and safety of food products and raw materials.

## *Analysis of recent researches and publications.*

Propolis is a sticky resinous substance collected from buds, leaves, stems of wild plants and processed by bees, which has bactericidal properties and which they use to seal cracks in the hive, polish the walls of wax cells, embalm the corpses of enemies (mice, reptiles, etc.) (DSTU 4662:2006). Propolis as a raw material is used in the food, pharmaceutical, and other industries (Karabaş et al., 2020; Özer, 2020; Safaei & Azad, 2020; Sahlan et al., 2020;). In the temperate climate zone in which Ukraine is located, honeybees collect plant resins mainly from *Populus nigra* L., *Populus tremula* L., *Betula pubescens* L., which determines their chemical and physical properties. Subsequently, bees transfer plant resins into the nest and use them for sealing cracks or as a building material (Denis et al., 2011; de Groot, 2013; Isidorov et al., 2016; El-Guendouz et al., 2019). The chemical composition of propolis, specifically 344 chemicals are identified to date in samples collected by bees from *Populus* spp. and they determine its value as raw material and the use of this product by humans (de Groot et al., 2014).

Obtaining propolis from bee colonies is carried out today in two known ways: a) by cleaning the elements of the hive (frames, bee entrance, and inner covers); b) the use of special tools (grids, gratings, and collectors) for the accumulation of propolis, considering the known biological instincts of bees (Osipitan et al., 2012; Lima et al., 2015, Okhale et al., 2021). Cleaning the elements of the hive is carried out with a hive tool and in our opinion is an inefficient and expensive way to collect propolis. Because during cleaning, propolis gets mechanical impurities: parts of bees' exoskeleton, wooden fragments of hive elements, wax.

In countries with tropical climates, the production of propolis is carried out using collectors of different designs (de Ayala et al., 2019). The collectors are based on the instinct of bees to seal holes and cracks to prevent pests and enemies from entering the nest and restore the microclimate of the bee nest. Collectors Intelligent Collector of Propolis (CPI), Pirassununga, Marco Propolizador, Cuadro Propolizador are made in the form of a frame (cover) with openings of different sizes and a way to increase these openings as they are filled with propolis. The productivity of propolis collection using collectors depends on many factors and averages 600–1000 g of propolis per month (Jonathan, 2015; de Ayala et al., 2019). Cleaning of collectors from propolis is carried out manually with a knife, dismantling or without dismantling. From non-demountable collectors (frames), workers cut propolis in specially designated areas without automation and mechanization of the collector cleaning process (Breyer et al., 2016).

The Campechano (Mexico) method of propolis collection or the Sarrafo method (Brazil) involve the placement of bars measuring 2 x 3 cm and a length of 45 cm on both sides of the upper body of the hive. Propolis productivity is determined to be 960 g per year with the cleaning of collectors every week with a stainless steel knife (Lima et al, 2015; de Ayala et al., 2019).

Ra'ed et al. (2008) proposed and investigated a modification of the hives of the Langstroth system placing in the side and rear wall metal sheets with slots of 4 mm with a distance between them of 10 mm. According to the results of the study, propolis productivity was highest in the sheets located in the side part of the hive and averaged from 91.92 to 96.60 g.

De Ayala et al. (2019) note several disadvantages in the use of collectors. In our opinion, among the main obstacles to the adaptation of the collector use in temperate climate zone are the formation of gaps with significant size, which cannot be used in countries with temperate climate due to cooling the honeybees' nest; the use of external collectors is accompanied by contamination of the product with mechanical impurities carried by wind gusts; the accumulation of propolis in the temperate climate zone by honey bees occurs in the second half of the beekeeping season, which coincides with the preparation of bee colonies for the winter and is accompanied by increased aggressiveness of bees; the formation of holes in the constructions of hives will intensify the attack of bees and may lead to the death of bee colonies.

The selection of propolis from bee colonies in Ukraine and many countries is also carried out using plastic gratings, grids, and canvases. These tools are placed above the nest of honeybees so that the bees have access to them to deposit propolis. Gratings and grids contain holes usually 1.6 mm wide. The grids and gratings are frozen for cleaning and subsequently, the propolis is knocked out or scraped (Tsagkarakis et al., 2017; Bankova et al., 2019; Mountford-McAuley et al., 2021). Water is used to purify propolis from wax and other mechanical impurities. Propolis is frozen and crushed and then mixed with water. Wax that has risen above the water's surface is removed, and propolis is dried on metal sieves (Bankovskiy et al., 2009). Solvent-based grid cleaning is not used because the water solubility of propolis at various temperatures ranges from 7% to 11% in ethyl alcohol from 50% to 70%, respectively, which affects the quality of the raw material and excludes certain uses (da Silva et al., 2011; Sukhanova et al., 2014).

Sadovnik (1982) proposed a line for obtaining propolis by cleaning canvases. The line consists of the SIP-55 brand machine, the SIP-up machine, the manual toothed roller, the Veterok-3 vacuum cleaner, the TsKL-1 centrifuge, the

OKS-030 hydro-press. This equipment is not manufactured or sold on the market, and fabric canvases are not used in modern apiaries in Ukraine.

Polezhaikin et al. (2005) developed a propolis collecting device from propolized fabric canvases. According to their technology, propolis canvases covered by bees are selected, sewn into a solid strip, wound on the reel of the device and in the process of cleaning cooled to -10 °C using a liquid cooling agent. Tuktarov et al. (2017) proposed a device for cleaning linen canvases from propolis. The device is made in the form of a mouthpiece for household power tools, which involves cleaning the canvases with knives mounted in it.

The disadvantages of these devices are that the propolis contains mechanical impurities of the canvas particles. This affects the quality of the product and requires additional time to clean it.

Thus, now, the apiaries are using methods of collecting propolis, which require considerable human labor, are not economically efficient, and the resulting product does not meet the quality requirements of market operators. Therefore, there is a need to improve existing technologies for obtaining propolis, to improve sanitary-hygienic conditions of production, to increase productivity and economic efficiency, mechanization, and automation of the production process.

The goal of our work was to develop a new propolis collecting device. In order to achieve the goal, the following tasks were set: a) to carry out research on scientific publications, to perform patent searches, to review catalogs of leading manufacturers of equipment, existing technologies and propolis collecting devices; b) to develop an experimental 3d model of the device; c) to make a prototype of the device for the preliminary laboratory test; d) according to the results of laboratory tests, if necessary, to refine the 3d model with the subsequent adjustment of the prototype of the device (re-production).

## *Materials and methods.*

The work was carried out as part of dissertation research on “Scientific and technical support of the process and equipment of propolis production” at the Department of Standardization and Certification of Agricultural Products of the National University of Life and Environmental Sciences of Ukraine during 2020–2021.

The analysis and synthesis of scientific information were performed using the Torraco (2005) method using the Springer scientific metric base and the Google Scholar search tool. The patent search was performed at our request by the patent-legal firm PRIMA VERITAS (https://prima-veritas.ua). Catalogs of beekeeping equipment manufacturers have been processed: Thomas Apiculture, Lyson, Melissa-93, ABB-100, PVIK Pavik, Civan, Park Plus, ICKO, Bienen-Voigt & Warnholz, Giordan Srl, Logar, Prestige Stainless, Boutelje Products, Dadant, Maxant.

The *focal object method* was used to develop an experimental device (version 1.1). The essence of the method is to transfer the features of randomly selected objects to the object being improved (Krupa & Lytvyn, 2016). The focal object in the development of the device was a machine for cleaning the painted canvases proposed by Sadovnikov (1982) – SIP-up.

The *device was modeled* using the COMPAS-3D v19.0.16 software by solid modeling method (Requicha, 1980; Requicha & Voelcker, 1982) with subsequent preservation of the device modeling results into files for 3d printing (format: *.stl) and laser cutting of metal (format: *.sdr).

*Making an experimental model of the device*. The framework of the device was made of profiled square metal pipe measuring 15 x 15 x 1.8 mm. The pipes were connected by manual arc welding using a Paton VDI-MINI 150 DC welding inverter. Subsequently, the framework was covered with metal sheets 0.45 mm thick and painted. The sheet metal was attached with aluminum rivets. A set of gear trains, a motor, and shafts were mounted and installed on a preparatory frame. The moving machinery, shafts, and motor were covered with a metal casing made of sheet metal.

*Making an experimental model of the device*. The framework and other elements of the device (version 1.2) are made using additive technologies (3D printing) (Lazebnyi et al., 2020). A strong ABS pro polymer was applied to make the framework. The protective chamber that comes in contact with the product is made from environmentally safe PLA plastic. The elements of the built-up shafts of the device were made of stainless steel in accordance with the developed drawings with the use of laser cutting of metal. The metal framework of the device is made of steel with holes for mounting a set of gear trains, 2 electric motors, two pairs of built-up shafts, a protective chamber, and the device body and a handle.

The *device was tested* at the Department of Standardization and Certification of Agricultural Products of the National University of Life and Environmental Sciences of Ukraine. Grids covered with propolis and collected from the authors' apiary in Kyiv Oblast, Ukraine were used to test the device (version 1.1). Subsequently, 75 grids covered with different types of propolis from Ukrainian apiaries in a total of 24 oblasts of Ukraine were obtained for testing the device (version 1.2).

## *Results of the research and their discussion.*

A review of the scientific literature concluded that no industrial equipment was produced for propolis production. The catalog 2021 of BIENEN-VOIGT & WARNHOLZ contains a proposal for the implementation of new development (device) for purifying plastic gratings from propolis. The device offered by the company is a plastic manual propolis stamp (Propolis Stamp) from the grating. The patent search conducted by the patent-legal firm "PRIMA VERITAS" testifies that there are no useful models and industrial prototypes of use in Ukraine that would allow receiving propolis.

The general form and principle of shaft operation of the machine were transferred to the selected focal object to produce a wave-shaped metal profile, the dimensions of which were adapted to the given tasks. The following criteria are met, which must have the experimental model of the device: a) will allow for the rapid cleaning of propolis from the grids without further preparation; b) it will not contain rapidly worn elements requiring additional financial costs for the maintenance of the device; c) be mobile with the possibility of use in different production conditions; d) can be used at industrial and recreational apiaries; e) excludes manual work on the cleaning of propolis; f) is made of materials which do not affect the chemical, physical, and mechanical properties of propolis; g) enables reuse of the same grids in subsequent production cycles; h) maintainable.

We did not consider the solvent-based cleaning of the grids because it affects the quality of the product. The base was a mechanical bend of elastic propolis grids with pre-cooling.

*Device modeling*. Propolis has increased adhesion (gluing), which depends on temperature, a contact area of propolis with the surface, pressure force and time. The average value of the adhesion of propolis in contact with steel is 2.29 J/m², while with glass – 2.96 J/m². The tests were carried out at room temperature of 24 °C with a specified load of 5 mN and without delay between contact time and take-off time. The work of propolis adhesion on contact with glass (reference standard) and the increase of the contact time to 60 s at a temperature of 24 °C and a specified load of 5 mN increases from 2.96 J/m² to 6.72 J/m². The radius of contact at maximum load was 36.06 ± 17.14 μm (Saccardi et al., 2021). These physico-chemical characteristics of propolis were considered in the design of shafts (Nekrashevich, 2005; Chursinov, 2006; Matin et al., 2016). The contact time of propolis is directly proportional to the work of propolis adhesion, which was considered in the design of a set of gear trains that transmit torque from engines to the shafts.

An experimental model of the device (Fig. 1), consisting of a metal framing on which one pair of shafts was placed, has been developed. The shafts are made in such a way that the protrusions on one of them enter the gaps between the protrusions of the other shaft, and the grid passing between them is mechanically bent in a wave-like form. The torque from the electric motor is transmitted to the shafts through a set of gear trains. The shafts rotate opposite each other and intake the grid with propolis without the need for additional supply thereof. The intake of a grid by shafts is caused by a design of shafts sheets proposed by the authors. The motor, a set of gear trains, and shafts are mounted in the metal framing of the device and placed on a stand made of metal quadrilaterals. The tray for grids is inserted into the framing of the device by horizontal movement.

As a result of modeling, an experimental model of the device was designed and subsequently manufactured (Fig. 1 (A)).

*The principle of device operation* (Fig. 1). The device works as follows: propolized grids removed from the honeybee nest are cooled at +5 °C for 60–90 min in a cooling chamber and are removed. The operator places the tray in the tray

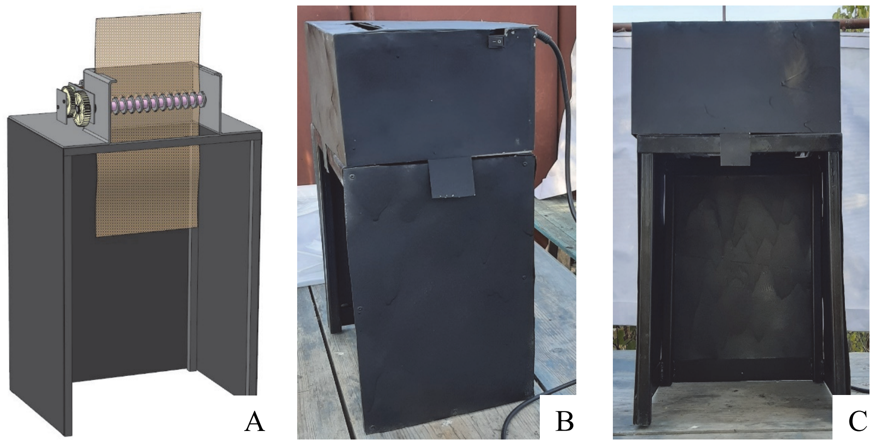


**Fig. 1. Experimental Model of Propolis Collecting Device (version 1.1): A – cut-away 3d Model of Propolis Collecting Device; B – lateral view of the manufactured device; C – profile view image of the device.**

compartment and turns on the device. The cooled grids are alternately inserted by the operator into an opening located at the top of the device. The rotating shafts bend the grids in a wave-like form, so the propolis is separated from the grids and crumbled in the tray. The grids pass through the device and fall into the tray. The tray is in the lower part of the device.

Preliminary laboratory tests of the device (version 1.1) were performed by cleaning the elastic grids from propolis with pre-cooling. We have identified several disadvantages of the experimental device (version 1.1). When modeling and manufacturing the device, the need to provide a protective chamber of the shafts was not considered, which led to the ingress of propolis into the mechanisms of the device. The peculiarities of propolization of grids by honeybees are that the grid with propolis has a front and back side. The bending of the grid by a wave-shaped pair of the built-up shafts of the device causes one side of the grid to bend outwards and, at a certain distance, the same side inwards. This wave-like bending results in incomplete purification of the grid from the propolis during a cycle of passing a grid through the set of device shafts. To completely purify the grid from propolis using the experimental device model (version 1.1), the grid should be passed through the device 2–3 times.

Based on the results of the laboratory tests of the experimental model (version 1.1), we decided to improve the device (Fig. 1). It has been determined that the device model (version 1.1) needs to be equipped with a protective shaft chamber to limit the propolis ingress into the mechanism of the device. Considering the results of laboratory tests of the device (version 1.1), it has been determined that it is necessary to design and manufacture a device with two pairs of shafts arranged one pair under the other. The elements of the second pair of built-up shafts are arranged in such a way towards the first one in order to ensure the reverse bending of the same section of the grid. Thus, the same part of the grid that passes through the upper pair of shafts and bends outwards and it bends inwards as it passes through the lower pair of shafts. In addition, we have identified the need to reduce the weight of the device so that it can be moved more easily within production if necessary.

*The main technical characteristics of the device.* Based on the modeling results, a device for further testing and evaluation of the effectiveness of design solutions was constructed (Fig. 3). The structural design of the built-up shafts of the device (Fig. 2 (2)) consists of a pair rotating oppositely to each other and retracting the grid independently, without the need to install additional mechanisms for its supplying. This approach in shaft design provides a simplified design of the device and minimizes elements that should be repaired and maintained in the future. The grid covered with propolis as it passes through the upper pair of the shafts bends in a wave-shaped form and the same section bends outwards and inwards when passing through the lower pair of the shafts. This solution provides improved cleaning of the grid, considering the bee ethology during the accumulation of propolis in the grids that we have observed. A set of gear trains and motors provide a speed of the grid of 2.5 m/min. To reduce propolis contact time with the shaft elements, rotation thereof with the aid of motors and a set of gear trains (Fig. 2 (1, 3)) is ensured at a speed of 60 m/min and this reduces the adhesion work.

To verify the effect of the shafts on the grid mechanical condition, we conducted a test with a passage of the grid through the device shafts in 100 cycles and did not detect visual mechanical damage. To avoid the accumulation of propolis on shaft elements and the possibility of cleaning the grids at room temperatures (+20–25 °C), the elements of the built-up shaft were designed so that the contact surface with propolis is 19.32% of the area of the elements in the ratio to the grid area in the shaft zone. The contact of one shaft element with the accumulated propolis in the grid is 40 mm². The inlet and outlet openings of the device (Fig. 2 (4, 5)) are designed in such a way that, if necessary, without disassembly thereof, it makes it possible to clean the device shafts from small amounts of propolis (>1 g cycle). The noise level of the device when it is idling is up to 72 dB. As a result of the replacement of some metal constructions of the device (Fig. 1) with plastic ones, we have ensured the weight of the device without basket – 8 kg, which ensures its mobility. The device is powered by a domestic network of 220–240/50 V/Hz.

The device is equipped with a protective shaft chamber to prevent the ingress of the propolis fractions which are cleaned from the grids into the mechanisms of the device (Fig. 2 (8)). Use of the device does not require additional consumables, special preparation, adjustment to start the operation. To minimize the consequences of mishandling of the device, it was possible to turn on the reverse rotation of the device shafts by turning the switch in the reverse position. The main part of the device case is arranged on a plastic basket-stand in which propolis and cleaned grids accumulate after passing through the shafts of the device (Fig. 3). The stand-basket is disconnected from the main part of the device once it is filled or when transportation is necessary.

This approach ensures the compactness of the device as compared to the previous solution (Fig. 1), which had a solid body of the device. The device has a compartment for a power supply cable from the network, which can be closed for transportation purposes (Fig. 1 (9)). The device can be moved by means of a folding handle.

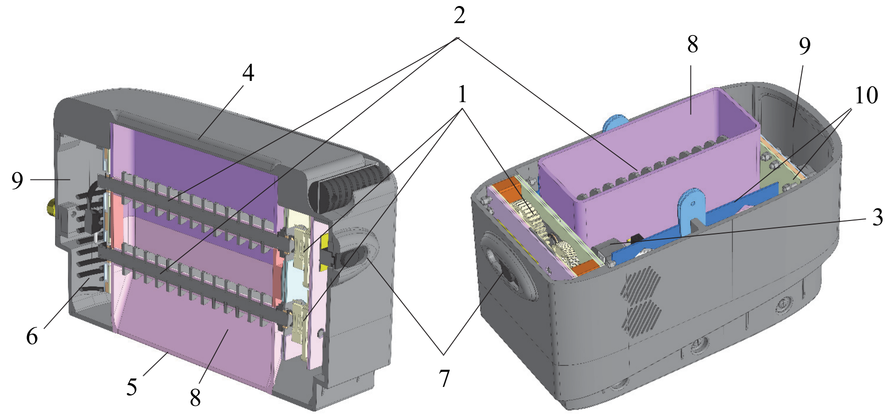


**Fig. 2. Experimental 3D Model of Propolis Collecting Device (version 1.2): 1 – a set of gear trains; 2 – lower and upper pair of shafts, the protrusions of which enter into each other; 3 – electric motor; 4 – propolis grid insert opening; 5 – outlet; 6 – electric cable; 7 – switch; 8 – protective chamber; 9 – power supply cable compartment; 10 – metal framing**

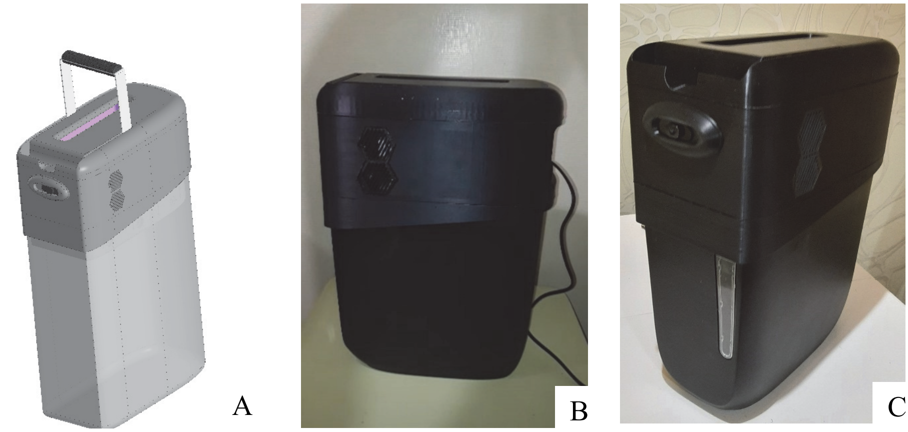


**Fig. 3. Experimental Model of Propolis Collecting Device (version 1.2): A – 3d Model of Propolis Collecting Device, general arrangement; B – profile view image of the device; C – lateral view of the manufactured device**

*The operation principle of an improved Propolis Collecting Device* (Fig. 2). For cleaning the grids, it is sufficient for the operator to place the device on a stable surface at a convenient level for laying the grids through an opening at the top of the device. After the reliable placement of the device, the operator connects the device to the domestic network. Cooled propolized grids are inserted one by one into the device. A transparent window made of plastic is built in to evaluate the filled tray. After the tray is filled, the operator switches off the device and disconnects the upper part of the device from the basket with cleaned grids and propolis using a handle. Once the tray is cleaned, the cleaning operation is repeated. In the case of propolis adhesion on shaft structure, the shafts are cleaned with a metal brush in the reverse motion of the shafts.

Therefore, the design of the device shafts and the principle of mechanical cleaning of the grids from propolis, incorporated in its design, can serve to develop highly automated lines for cleaning grids. The use of the device in industrial apiaries in countries with tropical and subtropical climates is possible with the placement of the device in honeycomb storages if available or in manufacturing area equipped with air-conditioning. Minimizing the transfer time of propolis grids after cooling to +5 °C from the cooling chamber to the device and cleaning contributes to the cleaning efficiency. For a high-quality cleaning of the propolis grid using the device, it is sufficient to cool the grids at +5 °C for 60–90 minutes depending on the type of propolis.

The developed device is patented, a patent № 139736 “Propolis Collection Device” and approved at 3 conferences (Dvykaliuk & Adamchuk, 2020[1], 2020[2]; Dvykaliuk & Adamchuk, 2021).

## *Conclusions.*

A new propolis collecting device has been designed and manufactured. The device can be used in Ukrainian apiaries and other countries where the propolis is obtained from bee colonies using elastic grids. The use of the device makes it possible to produce pure propolis without mechanical impurities that meet the requirements of the current legislation.

The prospects for further research are the production tests of the device and the assessment of the influence of different types (kinds) of propolis on the degree of cleaning of the grids, whether or not the shaft elements need to be periodically cleaned, wear resistance of the movable elements of the device (set of gear trains, motor), convenience of use of the device in different production conditions, and safety precautions rating of the operators when performing work with the device.

## *Acknowledgments.*

The publication was prepared with the active participation of researchers involved in the International network AgroBioNet of the Institutions and researchers for realization of research, education, and development program "Agrobiodiversity for improving nutrition, health and life quality" TRIVE (ITMS 26110230085).

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***Р. М. Двикалюк, Л. О. Адамчук (2021). РОЗРОБКА ПРИСТРОЮ ДЛЯ ЗБОРУ ПРОПОЛІСУ.*** *ANIMAL SCIENCE AND FOOD TECHNOLOGY, 12(3): 76-88. https://doi.org/10.31548/animal2021.03.007*

***Abstract.*** *Прополіс – клейка смолиста речовина, зібрана з бруньок, листя, стебел диких рослин і перероблена бджолами, яка має бактерицидні властивості та яку вони використовують для заклеювання щілин у вулику, полірування стінок воскових комірок, бальзамування трупів ворогів. Аналіз досліджень та публікацій дає підстави зробити висновки, що в Україні до сьогодні не достатньо приділяли належної увагу умовам виробництву прополісу. Відсутні пристрої та обладнання для удосконалення процесу виробництва безпечного та якісного прополісу котрий відповідатиме високим вимогам нормативно-правових актів з якості та безпечності харчових продуктів та сировини. нині у пасічницьких господарствах використовуються способи збору прополісу які вимагають значних затрат людської праці, є економічно не ефективними, а отриманий продукт не відповідає вимогам якості, які ставляться перед операторами ринку. Тому виникає потреба в удосконаленні існуючих технологій одержання прополісу, покращення санітарно-гігієнічних умов виробництва, збільшення продуктивності та економічної ефективності, механізації та автоматизації процесу виробництва. Метою нашої роботи було розробити новий пристрій для збору прополісу. Робота проводилась в рамках виконання дисертаційного дослідження при кафедрі стандартизації та сертифікації сільськогосподарської продукції Національного університету біоресурсів і природокористування України» впродовж 2020–2021 рр. Сконструйовано та виготовлено новий пристрій для збору прополісу. Конструкція валів пристрою та принцип механічної очистки сіток від прополісу, що закладені при його розробці може слугувати для розробки високо автоматизованих ліній з очистки сіток. Використання пристрою на промислових пасіках у країнах з тропічним та субтропічним кліматом можливе з розміщенням пристрою у стільникосховищах за їх наявності або у виробничих приміщеннях, що забезпечені кондиціонером. Для якісної очистки сіток з прополісом з використанням пристрою сітки достатньо охолодити при температурі +5°C протягом 60–90 хв залежно від типу прополісу. Пристрій може бути використаний на пасічницьких господарствах України та інших країн де отримання прополісу від бджолиних сімей здійснюється з використанням еластичних сіток. Використання пристрою забезпечує отримання чистого без механічних домішок прополісу, що відповідає вимогам чинного законодавства. Розроблений пристрій запатентовано патент № 139736 «Пристрій для збору прополісу».*

***Ключові слова:*** *прополіс, процес очищення сіток, пристрій, якість*