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BEE HONEY: HISTORY, CHARACTERISTICS, PROPERTIES, BENEFITS AND ADULTERATION IN THE BEEKEEPING SECTOR

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Abstract. This review aims to share the history of bees and the use of honey as the only natural sweetener available to mankind for more than 40,000 years. At the same time, the characteristic of the beekeeping sector is presented, highlighting the top honey producers worldwide. The botanical origin of honey is the basis for the characterization of the 14 types of honey presented. Honey standards were analyzed to provide an overview of quality and physico-chemical indices. The data indicated in the national and regional honey standard are identical to the data for the international Codex Alimentarius standard. After the comparative analysis of these 3 sources, no significant deviations were identified. The tendencies of using honey from ancient times as a nutritious food product, as a preservative, as a medicine for treating various diseases and for performing certain rituals, etc. were highlighted. At the same time, the population must be encouraged to consume this incomparable bee product.

Keywords: *honey, beekeeping, characteristics, properties, benefits, adulteration.*

Rezumat. Acest articol își propune să împărtășească istoria albinelor și utilizarea mierii ca singurul îndulcitor natural disponibil omenirii de mai mult de 40 de mii de ani. În același timp, este prezentată caracteristica sectorului apicol, scoțând în evidență producătorii de top de miere la nivel mondial. Originea botanică a mierii stă la baza caracterizării celor 14 tipuri de miere prezentate. Au fost analizate standardele pentru miere, pentru a oferi o imagine de ansamblu asupra indicilor de calitate și fizico-chimici. Datele indicate în standardul național și regional pentru miere sunt identice cu datele pentru standardul internațional Codex Alimentarius. După analiza comparativă a acestor 3 surse, nu au fost identificate abateri semnificative. Au fost scoase în evidență tendințele utilizării mierii din cele mai vechi timpuri ca produs alimentar nutritiv, conservant și medicament pentru tratarea diferitelor boli și pentru efectuarea anumitor ritualuri etc. Totodată populația trebuie încurajată să consume acest produs apicol incomparabil.

Cuvinte-cheie: *miere, sectorul apicol, caracteristici, proprietăți, beneficii, adulterare.*

Introduction

Beekeeping plays a very important role in the production of valuable products such as: honey, wax, pollen, propolis, royal jelly and others. This branch of agriculture ensures the pollination of crops and influences the considerable increase in the quantity and quality of some products, especially seeds and fruits [1]. In the wild, the western bee Apis Mellifera Linnaeus is found in Europe, the Middle East and Africa. This species has been subdivided into at least 20 recognized breeds that are widely distributed beyond its natural range, due to the economic benefits of pollination and honey production. Currently, European honey bees are naturalized on all continents except Antarctica [3, 4]. Bee honey is considered the most consumed bee product. It is defined by the Codex Alimentarius as a "sweet substance, produced by Apis Mellifera bees from the nectar of flowers or secretions of living plants, which bees collect, transform by combining with their specific substances and stored in honeycombs for ripening and maturation" [5].

1. The bee in history

As the only available sweetener, honey has been an important food for Homo Sapiens since its inception [6,7], and the relationship between bees and Homo Sapiens began in the Stone Age. Bees are 10-20 million years old and are one of the oldest forms of animal life to date [8].

According to scientists, bees have been producing honey for almost 40 million years. Ancient civilizations prized honey primarily for its sweetness and also used it as a commercial product [9].

- 50,000 BC - hominids were able to collect honey and like modern monkeys. They used sticks to extract honey.
- Neolithic Age - primitive people also ate honey from wild beehives. A rock painting preserved in Valencia, Spain, depicts people mining honey.

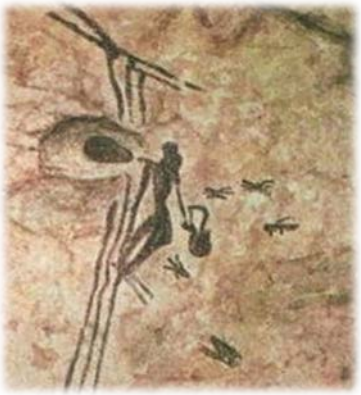

Figure 1. Cave painting, people are looking for honey [10].

- Bronze Age - people began to prepare a mixture of honey and water, a drink that can also contain alcohol if left to ferment [11]. Beeswax becomes a very expensive product. It began to be used in various religious rituals: birth, marriage, purification and death; embalming, sealing the coffin and mummification, as well as for candle production.3000 - 4000 BC - in this period mankind begins to keep bees.
- 2700 BC - honey, beeswax and propolis have become widely used in medicine as a medicine for the treatment of wounds.

- 2600 and 2200 BC - honey became the most popular ancient medicine in Egypt, due to its antibacterial properties it was used as an ointment to help heal infected wounds. All medicines contained honey with wine and milk [12].
- 2000 - 1000 BC - The ancient Greeks consumed a drink called Oenomel which was made from honey and unfermented grape juice [13]. Hippocrates recommends several products obtained from honey. Thus a diet based on the consumption of fruit vinegar and honey was considered very effective. The water-based drink with bee honey was recommended for soothing and a quality and deep sleep [14]. He used honey for wound healing, baldness, contraception, cough, laxative action and sore throat, topical antisepsis, eye disease, prevention and treatment of scars.

Figure 2. Ancient coin from Crete - Bees and Persephone 300 BC [15].

- 600 - 1000 AD - in Islamic medicine, honey was used as a healthy drink.
- Medieval times - the currency was used beeswax, imposed as a tribute by conquered peoples, and was used in writing, painting, sculpture and for lighting, as well as in protecting works of art.
- 1622 AD - European honey bee *Apis mellifera L*., is considered more productive, because of this, pilgrims in the 1600s brought the first bees to North America.
- 1850 - bees have already spread throughout the continent. People used traps to catch the bees and then released them and followed the bees to their hive.1852 - L. L. Langstroth, invents and patents a hive with movable frames which is still used today, causing an increase in the production of honey. The innovative key to the Langstroth beehive design was the discovery of a bee space (6-9mm), in which the bees do not build combs and do not close it with propolis [16].

Figure 3. Three Langstroth hives adjacent to a water source.

Today, honey is one of the last untreated natural foods [17], and in order to feed itself, a bee can button

an average radius of 1 to 3 km around its hive, in extreme famine situations. - up to 10 km. About 120,000 bees produce about 1 kg of honey, and in its lifetime one bee produces only a tablespoon of honey [18].

2. Characteristic of the beekeeping sector worldwide

Currently, the annual world honey production is less than 1% of the total sugar production, which is about 1.2 million tons per year.

The largest honey producing countries are China, the United States and Argentina. Some East African countries are also important players in the international market, but the African continent as a whole is under-represented globally (figures 4 and 5) [19].

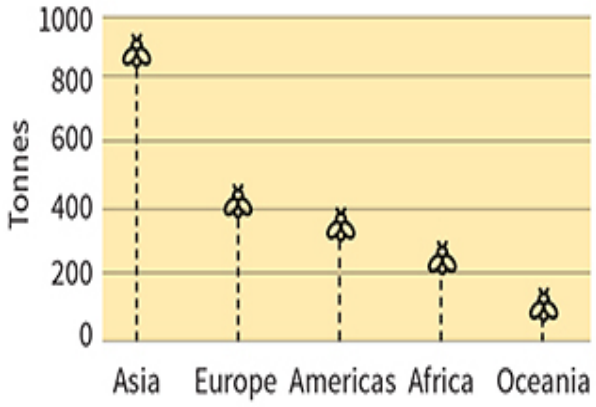

Figure 4. Top honey producers distributed by geographic areas [20].

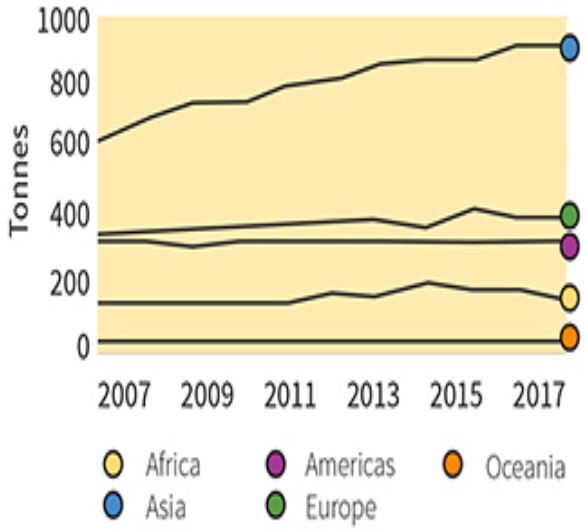

Figure 5. Honey production in the last decade [20].

Globally, honey consumption is very different. For example, in the countries that produce and export the largest amount of bee honey such as China and Argentina, annual consumption is quite low. At the same time, there are situations when domestic honey production does not cover the needs of the domestic market. This situation is characteristic of some developed countries (table1).

Table 1

Global trends in annual honey consumption

Country	Annual honey consumption, kg / inhabitant
Italy, France, United Kingdom	0,3 to 0,4
Australia, Austria, Germany, Greece, Hungary, Switzerland, Portugal, Canada	0,6 to 0,8
China, Argentina	0,1 to 0,2
Denmark, Portugal to the sea	1 to 1,8

3. Characteristic of some types of honey depending on the botanical origin

Most often, honey is appreciated by consumers for its taste, sweetness and aroma. These characteristics are mainly related to the botanical origin of the plants used in the production of honey [21]. The price of honey is influenced by both the geographical position of the country or region of honey collection, as well as the botanical origin of honey, that is, the purity of pollen collection. These parameters increase the value of the product and give it a specific aroma and taste, and also has special medicinal properties [22]. A distinction is made between flower honey, which can be monofloral (with specific sensory, physical and chemical characteristics) and multifloral; and honeydew honey, called forest honey [23]. In the table nr.2 below are characterized by botanical origin the types of honey.

Table 2

Characteristics of honey types by botanical origin

Nr. ord	Type of honey	Original flower / flowers	Characteristics
		Monofloral (unifloral) types of honey	
1.	**Linden honey**		Linden honey has an unmistakable fragrance and a strong aroma of lime blossom flowers of a red-yellow-orange color. It can be fluid, viscous or crystalline, depending on the time of year [28]. The best honey production is obtained from silver lime (950 - 1200 kg / ha), large-leaved lime (800-1000 kg), and pumice lime offers 450-800 kg / ha [29].
2.	**Acacia honey**		Acacia honey is light in color, the flavor is medium sweet and very smooth. Thanks to the high fructose content, this honey remains liquid for a long time [30]. It is a very nutritional honey with a strong antioxidant, immunomodulator, neurological potential [31].
3.	**Sunflower honey**		Honey has shades ranging from straw yellow to gold, with a specific, sweet smell and taste; due to the high content of glucose, it crystallizes quickly, acquiring a very compact mass [32].

Continuation Table 2

4.	**Rapeseed honey**		Rapeseed honey belongs to "white honey, containing a unique amount and combination of nutrients [33]. After pumping, there is a light amber color, almost white; after crystallization, it looks like whipped cream. The aroma is pleasant, slightly hard, the taste is pronounced, sweet, even sweet, a bit bitter, thanks to the secretion of rapeseed nectar, rich, deep and very acidic [34].
5.	**Buckwheat honey**		Buckwheat honey has a dark color, a slightly bitter and tangy taste, it is not as sweet as classic honey and a pleasant, intense smell, combining sweet and slightly bitter aromas. In the process of crystallization, which takes place rapidly, the color becomes lighter [35] .
6.	**Lavender honey**		Premium quality lavender honey with a very delicate lavender aroma, pleasant and well balanced. The color ranges from light white to very light amber. If it is dark in the presence of honeydew, it may have salty notes. Moderate to very fine crystallization. No bitterness and low tasting acidity [36].
7.	**Thyme honey**		Is a honey with a unique aroma, produced from many species of thyme (350 species) [27] - an aromatic plant, with a very strong odor. It is quite dark, amber or brown, with a fruity odor, creamy consistency that can sometimes become grainy during crystallization. Rich in carbohydrates, should be stored at room temperature in a dry and ventilated place to retain all its properties [28].

Continuation Table 2

8.	**Eucalyptus honey**		Eucalyptus honey is rich in eucalyptus tree pollen grains and has specific physicochemical characteristics that set it apart from other monofloral honeys [24]. It is a medium dark color and may have a red tint. It is a honey with strong antioxidant and anticancer activity [25].
9.	**Black grass honey**		It is a rare honey, cannot be confused with any other honey, which has started to be more and more sought after nowadays. It has a strong, slightly bitter taste (preferred by diabetics) and a strong floral scent, which places this assortment in the premium category [26].
10.	**Raspberry honey**		This honey is easily recognizable by its specific whitish color. Specialists recommend this variety of honey, with an incomparable aroma, especially for women, because it regulates the activity of the ovaries and rejuvenates. It is one of the forest varieties and is 100% natural because it cannot be counterfeited [27].
	Multiflora honey (polyfloreaux)		
11.	**Multiflower honey / polyflowers**		Said wildflower honey is quite bright with amber highlights. The presence of pollen from various plants also gives this honey a rich content of vitamins and minerals. [37,38]. It has a persistent aromatic and sweet taste with slight variations depending on the flowers from which it comes. The color can range from light yellow to orange and brown, with ruby amber highlights [38,40].

Continuation Table 2

12.	**Spice flower honey**		Is a natural type of Tunisian honey, whose bees forage in fields of cumin and coriander, which gives it a unique taste is specific [41]. Honey has a dense consistency with fine particles of crystals.
13.	**Mountain honey**		Mountain honey is more full-bodied, strongly aromatic, amber in color, rich in flavor and renowned, with a herbaceous and strong taste. The bee colonies that produce this honey are located in remote mountainous regions. A diverse wild flora with nectar and honeydew gives this honey a rich and aromatic flavor [42,43].
Non-floral honey			
14.	**Manna honey**		Badly called forest honey, fir honey, comes from the sweet juices (manna) collected by bees on certain parts of plants (other than the nectar glands), resulting from the metabolism of insects (aphids, psyllids, coccidia or lecanids) which parasitize some plant species (trees and shrubs), consume sap and excrete mana [44,45,46]. There is dark brown color, specific taste, slightly caramelized, it can be consumed by people allergic to pollen [47,48].

4. Physico-chemical properties of honey according to normative documents

For the beginning, the standards for honey were analyzed, in order to give an overview of the physicochemical quality indices [49, 50]. The data indicated in the national and regional standard for honey are identical to the data for the international Codex Alimentarius standard. After the comparative analysis of these 3 sources, no significant deviations were identified, all identical to each other [51, 52].

Table 3

Honey quality indices, stipulated in International, National and Regional standards

Physico-chemical properties	**International Standard** STANDARD FOR HONEY CXS 12-1981[53]	**National Standard** Nr. HG661/2007 of 13.06.2007 [54]	**Regional Standard** COUNCIL DIRECTIVE 2001/110 / EC of 20 December 2001 on honey [55]

Continuation Table 3

Moisture, max,%	20	20 -21	20
Water insoluble matter content, max, g / 100g	0.1	0,1	0,1
Sugar content, fructose and glucose, max, g / 100g	60	60	60
Sucrose content, max, g / 100g	5	5	5
Electrical conductivity, mS / cm	0.8	0.8	0.8
Free acid, max, milliequivalents per 1000 grams	50	50	50
Diastase activity (Schade scale), min	8	8	8
Hydroxymethylfurfral (HMF), mg per 1 kg of honey, maximum	40 mg/kg	20-40 mg/kg	40 mg/kg

5. Functional properties of honey

Bee honey is a very complex food product and is found on the market in a very varied assortment. The physico-chemical and biological properties give it a multitude of both nutritional and therapeutic characteristics. [56, 57].

As already noted, most of the ancient peoples used honey both for food and for medicinal purposes. According to a biblical proverb, the wise Solomon said, "My son, eat honey, for it is good, and the honeycomb is sweet in your mouth." (Old Testament, Proverbs 24:13).

Honey has many important functional and biological properties: antibacterial, antifungal, antioxidant antiviral, anti-inflammatory, anticarcinogenic, prebiotic. These properties are largely related to potential use in medicine, including gastroenterology, and for management [58, 59].

6. The nutritional properties of honey

Honey provides 310 calories per 100 g, and 1 kg of honey is equivalent to 3 liters of milk, 30 bananas, 50 eggs or 12 kg of meat. It is a natural product without additives and preservatives and its aromatic and taste qualities could be stored for a long time.

The daily dose of honey in the amount of 20 g covers about 3% of the daily energy requirement [60].

In terms of vitamin content, honey is inferior to many food products.

Honey mainly contains water-soluble vitamins and always a mixture of pollen grains (very rich in vitamins), therefore the vitamin content of honey mainly depends on its presence, the composition and quantity of which in turn depend on the type of honey plants, timing of nectar collection, weather conditions [76].

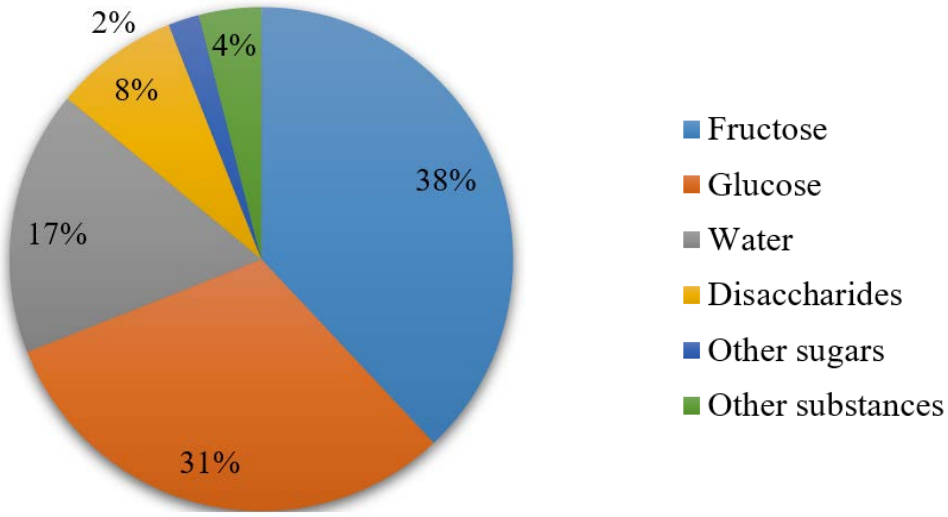

Figure 6. The nutritional value for 100g honey presented by FAO [Produced by the author].

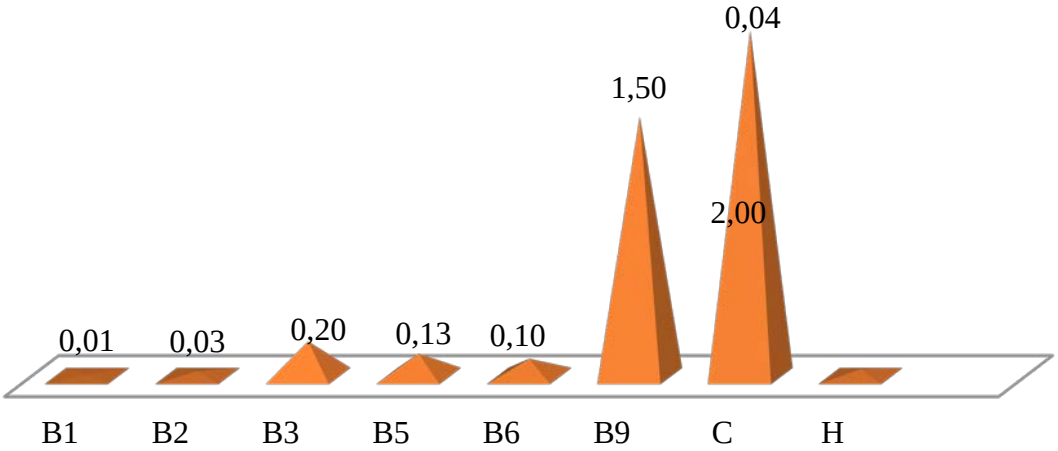

Figure 7. The vitamin content in 100g honey [Directed by the author].

Minerals affect the taste of honey, which also reduce the acidity of honey, which slightly alters its taste. The mineral composition of honey depends on its botanical origin and the chemical composition of the soil. Thus, honeydew honey contains a greater amount of minerals than floral honey, dark honey more than light honey, and polyfloral honey more than monofloral honey [61].

8. Therapeutic properties of honey

The therapeutic properties of bee honey are different and depend on the type of honey used in different diseases. Honey is used therapeutically by topical application, orally, by electrophoresis or in the form of aerosols. The antibacterial and antioxidant activity of honey strongly depends on its botanical origin [63,64].

Because honey has strong anti-inflammatory activity, it is often used as an antibacterial agent to treat infections in various types of wounds.

Numerous studies in this field have shown that these wounds, which are difficult to heal, give good results in honey dressings, which are easily removed without damaging the regressing cells. Honey promotes rapid healing with minimal scarring, so the inflammation, swelling, and pain go away quickly and the unpleasant odors cease

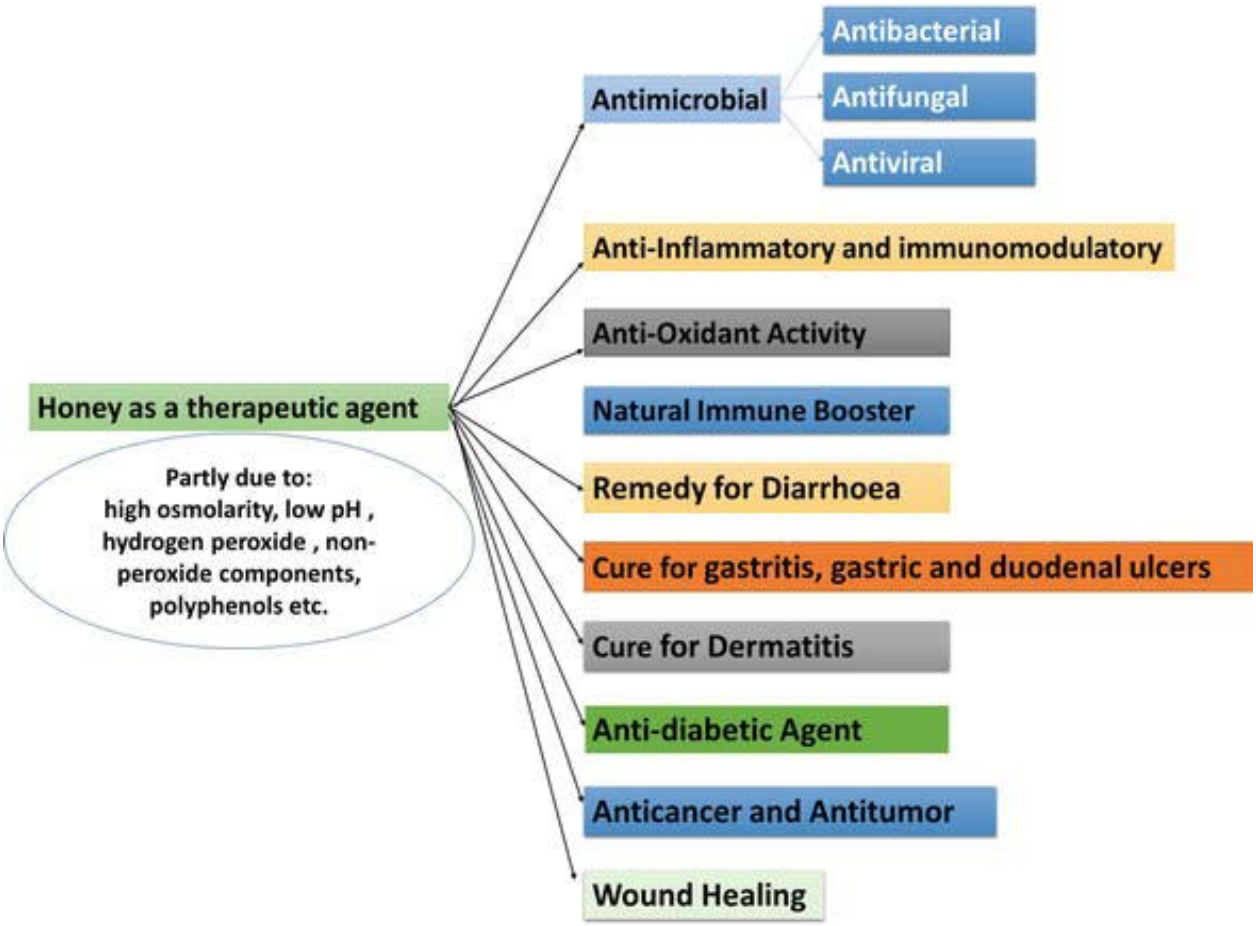

Figure 8. Schematic representation of therapeutic potentials of bee honey [64].

In vitro and in vivo studies have demonstrated the antifungal, antimicrobial, antiviral, antidiabetic and anticancer activity of honey. A protective effect of honey has also been observed under physiological conditions characterized by high levels of free radicals, such as those of athletes playing different sports. As well as, the protective effect on the nervous, cardiovascular, gastrointestinal and respiratory systems has also been proven.

9. The problem of honey adulteration in the beekeeping sector

However, beekeeping faces a number of problems that affect the quality and quantity of honey produced. One of the reasons in developing countries is the lack of qualified beekeepers, sufficient training in modern beekeeping techniques and access to appropriate equipment, which is also too expensive. In developed countries, the damage to bees is due to collapse disorder. The causes of which are unknown, although scientists are still studying several factors to determine an exact cause, they speculate that excessive use of pesticides is one. one of the possible causes [65].

Pesticides and their residues, as well as heavy metals related to particles of 10 μm and smaller - represent fine particles. They are composed of various chemical components with a toxic potential [67]. It is known that pesticides, insecticides and others come from agricultural sources. On the other hand, heavy metals appear as a result of industrial technological processes, etc. [68]. Bees can ingest contaminants orally during foraging and then carry their honey [69]. Pollutants can also reach stored foods, such as bee bread, royal jelly or propolis. In addition, pollutants can be deposited from the body insect and through the air. They can

be incorporated into even enter the insect's body, for example, through the tracheal system [70].

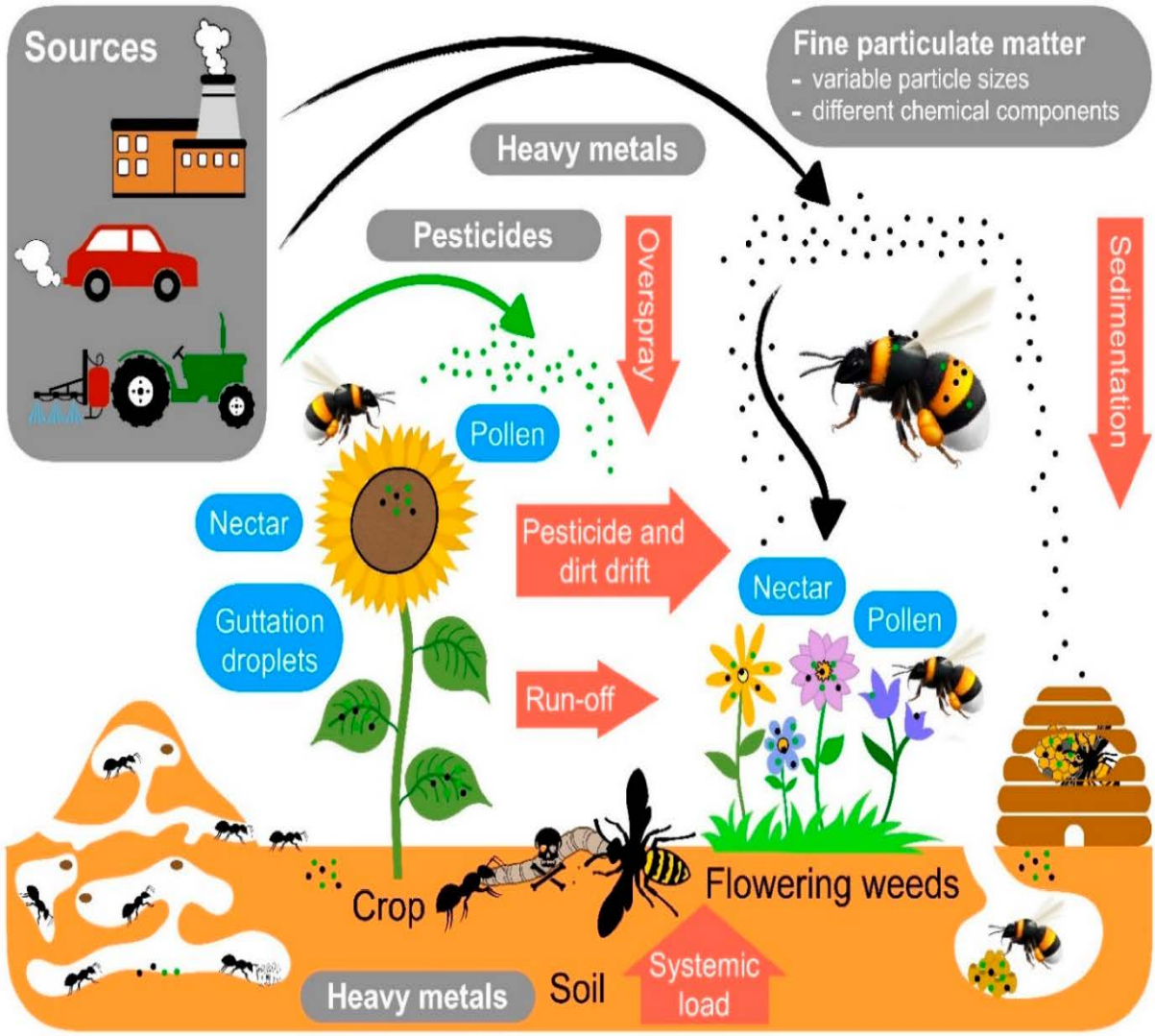

Figure 9. Sources of the environmental pollutants and exposure pathways of social insects to pollutants [66].

According to international definitions - economically motivated adultery - is "the intentional or fraudulent replacement or addition of a substance in order to increase the apparent value of the product or reduce its cost of production, ie for economic gain" [71]. Food adulteration is increasingly common on the market. Another definition equivalent to adultery is food fraud. In this context, food fraud involves the conscious marketing of food that is not produced according to standards [72]. Economically motivated adultery is not a new problem, it has very old roots. For example, in Egypt and ancient Greece, wine and other food products were counterfeited. Some laws have been passed in the United States since 1784 to punish food fraud. Foods that have a high price are most often counterfeited. Even in the production of sweeteners, maple syrup and bee honey are most often counterfeited.

One of the major problems in beekeeping is the identification of adulteration of bee honey. Because of this, some beekeepers have economic losses but also consumer confidence. For example, in Florida in the United States there is an identity standard for bee honey that is very similar to the Codex Alimentarius definition. The Wisconsin legislature is

considering a definition for honey that will meet the standard issued by the Codex Alimentarius [73, 74]. In the European Union there is an identity standard for honey, which is almost identical to that of the Codex Alimentarius [75].

Beekeeping remains a quite attractive branch for the rural area. Anyone on earth has heard about the benefits of this unique beekeeping product. Thus, honey that deserves to be promoted and recommended for its beneficial qualities [76 - 78].

Conclusions

By studying the properties of different types of honey, it has been established that they have nutritional and therapeutic properties, due to their content of proteins, carbohydrates, vitamins, tannins, and antioxidant properties due to the content of phenolic compounds. and flavonoids they contain.

Following the literature review, the benefits of consuming honey have been demonstrated, whose aroma, taste, color and flavor offered by honey are directly related to its botanical origin.

Honey has been used since ancient times as a nutritious food product, as a preservative, as a medicine to treat various diseases and to perform certain rituals, and the population must be encouraged to consume this incomparable bee product.

Fraudulent honey adulteration companies are becoming more and more common and consumers are being deceived with honey with additives that are harmful to health.

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