



A Review: Honey and Its Nutritional Composition

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Authors' contributions

This work was carried out in collaboration among all authors. Author SH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author DQ managed the analyses of the study. Author MA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Honey is one of the historical natural products produced by honey bees. Humans used it as medicine and protection against some infectious diseases, a honey quale is dependent in its classification of the honey bee. The most famous accomplished honey bees in the world are Africanized honey bee (*Apis mellifera .l*), Western honey bee or European honey bee (*Apis mellifera*), Eastern honey bee (*Apis cerana*), Philippine honey bee (*Apis nigrocincta*), Koschevnikovs honey bee (*A. koschevnikovi*), Giant Honeybees (*Apis dorsata*), Dwarf Honeybees (*Apis andreniformis*). This study collected the health effect, quality and usage of honey in several industries; also argue about the nutritious value of honey that the most important parts are protein, carbohydrates, vitamin, and minerals.

Honey is not only a nutrient it also plays a major role in many other products, uses of honey in cosmetics as a protective and softener of skin, it is used up to 22% in paste masks and mud packs (which are considered rinse-off formulations). Uses of honey in Ayurveda for prevention of irritation, cough, healthy teeth, gums, and boons.

Production of honey has been compared in 2013 to 2018, in 2013 the world production of honey was 1,664 thousand tones with an increase of 1/3 in just two decades. China, where manufacturing

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amounted to 466.3 thousand tons, i.e. approximately 29% of the global volume of output, these are showing that China was the biggest producer of honey in the world but it gets a decrease in 2018 as well as Brazil, America, Russia, Ethiopia, and Iran. And it increases in Turkey, Argentina, India, Mexico, and Poland.

Keywords: Type of honey bees; nutrition value of honey; usage and production.

1. INTRODUCTION

Honey is one of humankind's oldest natural sweet food products in the world. A number of substances of nutritional importance in honey which support good health and customer recovery [1]. FSSAI in 2018 has to define regulatory honey as the natural sweet substance produced by honey bees from the nectar of blossoms or from secretions of plants, which honey bees collect, transform and store in honeycombs for ripening. The main composition of honey is carbohydrates, lesser amounts of water, and a great number of minor components. Water content, Fructose, Glucose, Sucrose, Other disaccharides, Melezitose Amino acids, proteins, Acids, pH [2].

Health effect and quality of honey is dependent on bees that classified on Geographical and Botanical discrimination [3][4]. Even honey has been used for the treatment of most chronic diseases as urinary diseases, respiratory diseases, skin ulcers, wounds, eczema, psoriasis, gastrointestinal diseases, and dandruff also honey has an inhibitory effect on aerobic and anaerobic bacteria, yeast, fungi, and viruses, honey inhibited growth of *Pseudomonas aeruginosa*, *Helicobacter pylori*, *Bacteroides* spp., and enteropathogens [5]. Pure honey inhibited fungal growth and diluted honey appeared able to inhibit the production of toxins. Honey has also been reported to exhibit in vitro antileishmanial effects as well as the development of the antirubella virus. Honey can improve antibody development during primary and secondary immune responses against thymus-dependent and thymus-independent antigens [6]. Honey induced cell culture proliferation of B and T lymphocytes and stimulated the release of cytokines by monocytes, which triggered immune responses. In addition, honey had antitumor and antimetastasis activity and potentiated the cytotoxic drug antitumor effects [7]. The challenge for honey production is adulteration or the addition of similar artificial compounds that are known as economically-motivated adulteration (EMA) which honey is adulterated for

the purpose of financial advantage. Due to the strong economic incentives, the high value of honey puts it at risk for EMA. The honey market is a truly global market, with more than 60% of the honey used in the United States coming from imports [8]. Company and beekeeper both can be the response for honey adulteration because honey adulteration has two types' processes, direct and indirect. Direct adulteration has defined as a process by direct addition of substances in honey. Indirect adulteration happens when the adulterating compounds are fed to honeybees. Based on their carbon metabolism, plants which are sources of substances used for honey adulteration can be graded as C3 or C4 plants [9].

There was mentioned the same awareness about honey usage it should not be given to infants especially younger than 12 months old. Major pediatric and public health organizations, as well as honey manufacturers in the United States, support this recommendation [10]. Still, many parents, do not realize the potential hazard of honey and administer it to their infants. Honey can be a reservoir for *Clostridium botulinum* spores, which have been related to infant botulism growth. Clinicians should be familiar with the risks of honey and should not recommend additives containing honey or the use of honey as a flavoring agent for children [11]. Honey and other bee products are polluted by bacteria, pesticides, heavy metals, and radioactive materials. Residues of pesticides cause genetic mutations and cellular degradation, and the presence of antibiotics may increase the pathogens of resistant humans or animals. Many cases of infant botulisms have been attributed to contaminated honey. Honey might be very toxic when produced from certain plants. Ingestion of honey without information about its source and safety can be problematic. Honey should be labeled to investigate its origin, composition, and clear statement that it is contaminant-free. Honey not being analyzed and sterilized shouldn't give for infants and should not be used for wounds or medicinal purposes [12].

2. HISTORY OF HONEY

Honey was valued greatly in the Middle East [13]. As natural food and medicine by mankind has been in essence from time immemorial [14]. It was mentioned in the Holy Quran 1400 years ago [13]. In fact, there are some records that show raw honey is the most ancient sweetener, and it was noted to have been the use of honey in throughout the world several million years ago [14]. Production of honey by the non-timber forest technique is prevalent in any country of the world that provides income for smallholders. Some of these beekeepers supply their honey under contract to a company that markets their organic honey internationally allowing them to access insurance markets [15]. Transshipment relates to the shipping of honey through foreign countries and eventual relabeling to hide the true country of origin, a practice often known as "honey smuggling." A major honey laundering scheme in the U.S. culminated in 11 people and six firms being indicted on U.S. federal charges charging a global conspiracy to unlawfully manufacture Chinese honey [8]. For honey production, there is some origin a country which provide honey, some other country which imports raw honey and leads to companies and marketed such around 606 shipments of Chinese-origin honey entered the United States between March 2002 and April 2008, though declarations incorrectly stated that the honey originated in Russia, India, Mongolia, Philippines, Malaysia, South Korea, Taiwan, Indonesia, and Thailand [16]. Indeed, Genus *Apis* including three subgeneruses' *Megapis*, *Micrapis* and *Apis* that are originated in Asian, Africa, Middle East and European respectively [17]. The stingless bee genus *Melipona* contains at least 50 species of medium-sized (8–15 mm), robust, and often hirsute bees inhabiting forests of tropical America, from Mexico to Argentina and Amazon Basin [18].

3. NUTRITION VALUE OF HONEY

3.1 Carbohydrates

Frist research was conducted in 1960s to determine the sugar profiles of honey by using thin-layer chromatography (TLC) [19]. There are many types of carbohydrates present in honey such as Monosaccharide's (fructose, glucose) Disaccharides (sucrose) Trisaccharides (melezitose, erlose), oligosaccharides, and other carbohydrates undetermined that total sugars content is 79.7 g/100g [20]. In addition, about 25

different oligosaccharides have been detected in honey [21]. Each of these carbohydrates has its own function in our body [20]. The major role of carbohydrates in humane body is the production of energy. But some non-energy related effects of carbohydrates depend on short-chain fatty acid production and bacterial fermentation in the colon also responsible for this purpose. The complex carbohydrates reduce glycemic index and insulin production, therefore reported less profound effect on the modification of lipid metabolism [22]. All available data have shown that consumption of high total carbohydrates does not adversely affect insulin sensitivity as compared to high fat consumption. There are some animal data that also suggest that simple sugar, especially fructose, have an adverse effect on insulin, but these adverse effects have not been proved on humans. More intake of dietary fiber appears improvement of insulin action and it prevents diabetes [23]. High dietary sucrose may increase blood pressure and concentrations of circulating insulin. Control of diet is a big challenge for all types of meals. A diet high in sucrose with 20% of energy elevated the levels of plasma triglycerides (TG). Fructose is the primary nutrient mediator of sucrose-induced insulin resistance and glucose intolerance. Because potentiation of postprandial lipidemia by fructose is seen in both diabetic and nondiabetic humans [24].

3.2 Protein

Honey contains roughly 0.5% proteins, mainly enzymes and free amino acids [20]. In fact, the composition of honey depends on its origins of geographical and botanical. Usually, proteins are reported in honey at low concentrations [25]. Honey contained major royal jelly proteins (MRJP) and its derivative such as MRJP-1, MRJP-2, MRJP-5, and MRJP-7, which detected by mass spectrometric as well as a few uncharacterized proteins from *Apis mellifera*. MRJP-1 was the most abundant protein, in Acacia samples. Honey proteins possess significant antioxidant activity as free radical scavengers and reducing agents [26]. This protein is found in the royal jelly at high concentrations, but it's present in honey in low levels [27]. RJ possess various useful activities, such as antibacterial, and antiallergic activities [28]. The role of MRJP in the human's body has been reported as the dietary protein and peptide hypocholesterolemic activity is closely linked to the bile acid-binding ability of dietary protein and bile acid metabolism. Bile acids play important roles not only in consuming dietary fat as a

detergent but also in controlling homeostasis of cholesterol by oxidation of cholesterol. Clinically, anion exchange resins, such as cholestyramine, were used as cholesterol-lowering agents. These agents bind bile acids in the intestine and reduce the enterohepatic circulation of bile acids, which results in an accelerated conversion of cholesterol to bile acids [29].

3.3 Vitamins

In the 1920s and 1930s, the value of vitamins throughout diet were originally recognized, and in the past, the presence of vitamins in honey was researched, mainly by biological assays. Chemical methods of analysis were introduced only in the 1940s, particularly for the determination of ascorbic acid, i.e. the only one—at that time—considered to be of interest due to its biochemical significance [41]. The vitamin’s content in honey is mainly water-soluble due to its aqueous nature containing a high quantity of sugars and a low percentage of lipids. Vitamin C has been especially determined in honey because of its antioxidant effect [42]. Vitamin available in honey are phylochinon (K),

Thiamin (B1), Riboflavin (B2), Pyridoxin (B6), Niacin, Panthothenic acid, Ascorbic acid (C) [20]. That water-soluble vitamins are a structurally dissimilar group of organic compounds that share the common features of being normal cellular functions, growth, and development. Vitamins play major roles in maintaining normal metabolic, differentiation, energy, and growth status of cells. Thus their deficiency has negatively affected human health [43].

3.4 Minerals

Honey also contains micro as well as macro elements (tin, calcium, phosphor, sulfur, chlorine, magnesium, iron, aluminum, manganese, sodium, chromium, zinc, sinker, arsenic, mercury, cadmium, and titan. Also, some salts such as (phosphates, chlorides, and sulfates the most) and etc [44]. Minerals have key roles in our body to do important functions – for growth of strong bones to transmitting nerve impulses - for healthy and lengthy life, some macro- and micro-elements are found in the structure of teeth (Ca, P and F) and bones (Ca, Mg, Mn, P, B, and F),

Table 1. Related to type of honey bees and origin area

| No | Common name of honey bee | Scientific name of honey bee | Favorite plant | Origin area | Transferred area | References |
|----|---|------------------------------|------------------|--|--|----------------------|
| 1 | Africanized honey bee | <i>Apis mellifera .l</i> | Sunflower | Africa | Brazil America Europe | [30] |
| 2 | Western honey bee or European honey bee | <i>Apis mellifera</i> | Alfalfa | Western Asia and Europe | America and New Zealand | [31] [32] [33] |
| 3 | Eastern honey bee | <i>Apis cerana</i> | Orchid flower | Eastern Asia | East Russia, Japan Korean Peninsula, south Philippines Malaysia, Indonesia, west to easternmost Afghanistan and Pakistan | [34] [35] [36] |
| 4 | Philippine honey bee | <i>Apis nigrocincta</i> | Flowering plants | Philippian | China, | [37] |
| 5 | Koschevnikovs honey bee | <i>A. koschevnikovi</i> | Flowering plants | Malaysia Indonesia | - | [38] |
| 6 | Giant Honeybees | <i>Apis dorsata</i> | Flowering plants | western India | island of Palawan | [38] |
| 7 | Dwarf Honeybees | <i>Apis andreniformis</i> | Flowering plants | Eastern Himalayas eastward to Indochina Philippines. | Yunnan China Thailand Malaysia Indonesia Philippines | [39] [38] [40] |

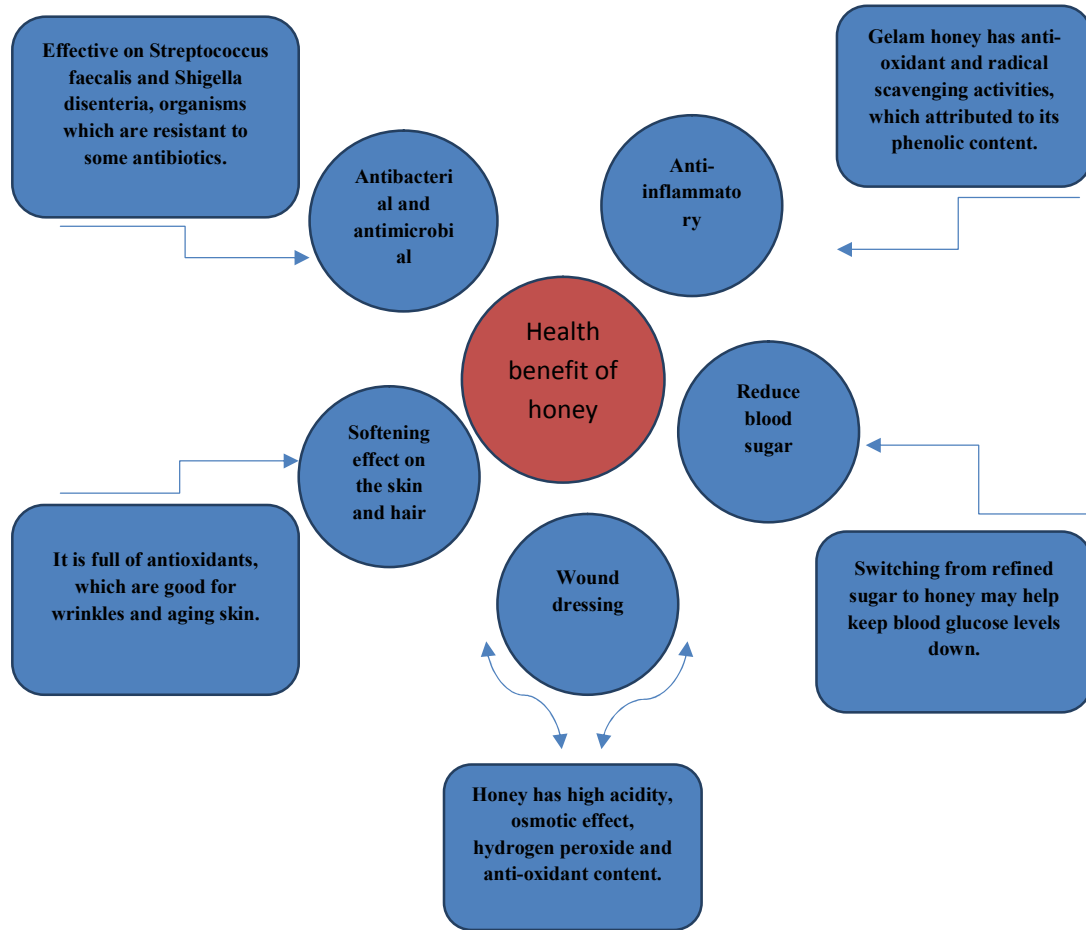


Fig. 1. Health benefit of honey with effective factors [46] [47] [48]

Table 2. Amount of phenols, flavonoids and antioxidant in the different type of honey

| Sr. No. | Name of honey | Total phenol (mg galic acid/kg) | Total flavonoid mg catechin/kg | Antioxidant activity % | References |
|---------|-----------------------|---------------------------------|--------------------------------|------------------------|--------------|
| 1 | Sourwood honey | 580.03 ± 0.38 | 156.82 ± 0.47 | 59.26 ± 3.77 | [49] |
| 2 | Strawberry tree honey | 126.83 ± 6.66 | 34.99 ± 1.55 | 447.92 ± 0.81 | [18] |
| 3 | Manuka honey | 0.00127±0.00008 | 71.90±0.03 | 0.06±0.00 | [50] [18] |
| 4 | Acacia honey | 43.66 ± 6.45 | 113.06 ± 6.18 | 111.05 ± 45.10 | [51] [49] |
| 5 | Blackthorn honey | 83.40 ± 2.75 | 8.68 ± 1.15 | 597.50 ± 0.43 | [52] |
| 6 | Rose honey | 143.17 ± 5.25 | 31.05 ± 1.18b | 428.84 ± 0.71 | [52] |

whereas most micro-elements (Cu, Fe, Mn, Mg, Se, and Zn) play a vital role as a structural part of many enzymes. Minerals also involved in immune (Ca, Mg, Cu, Se, and 54 Zn), and the brain (Cr and Mn) system [45].

Table 2 was discussed about the mean component (phenol, flavonoid, and antioxidant activity) of different type of honey that marked in the world, which has given as per unit of mg/kg and percentage, whereas the highest phenol

content (580.03 ± 0.38) presented was in Sourwood honey, and the lowest of this compound (0.00127 ± 0.00008) was presented in the Manuka honey.

Flavonoid compound with largest content of (156.82 ± 0.47) also found in sourwood honey but the lowest flavonoid content (8.68 ± 1.15) has shown in the Blackthorn honey.

The percentage of high amount antioxidant activity (597.50 ± 0.43) was given in Blackthorn honey, and (0.06 ± 0.00) percent was given in Manuka honey.

4. HEALTH EFFECT OF HONEY

Honey is a high-carb food that contains small quantities of protein, enzymes, amino acids, minerals [20]. Its flavonoid and phenolic acid content play a key role in human health, contains strong antioxidant and anti-inflammatory properties that they exert, antimicrobial potential and anticancer activity against various tumor types that act on different molecular pathways involved in cell proliferation [18]. Scientific proof of honey's wound-healing abilities validates its effectiveness as a wound repair promoter and an antimicrobial agent [53]. High antioxidant and immunomodulatory potential of Acacia honey, which can indeed be considered a great candidate for cancer prevention and treatment [54]. Most of the conventional statements (e.g., use for diabetes, diarrhea, inflammation, gastrointestinal and cardiovascular diseases) for honey have been scientifically tested by several

researchers utilizing scientifically controlled experiments [55]. Medical grade honey is filtered; gamma irradiated to destroy Clostridium spores and generated according to exacting hygiene standards [56].

5. PRODUCTION OF HONEY IN SAME IMPORTANT COUNTRIES

5.1 Production of Honey

According to FAOSTAT, in 2013 the world production of honey was 1,664 thousand tones with an increase of 1/3 in just two decades. China, where manufacturing amounted to 466.3 thousand tons, i.e. approximately 29% of the global volume of output [57]. Honey productivity is closely correlated with the weather conditions and the honey flows available [58]. In world trade, honey is exported from countries with lower levels of economic development to countries with higher living standards where it is possible to sell products at a relatively higher price than on the domestic market [57]. In the international trade honey mainly goes to the European market (more than 53%) and mostly to the EU countries [58]. Figures two and three also mention the production of honey in some mentionable countries for recent years (2013 to 2018). These are showing that China was the biggest producer of honey in the world but it gets a decrease in 2018 as well as Brazil, America, Russia, Ethiopia, and Iran. And it increases in Turkey, Argentine, India, Mexico, and Poland.

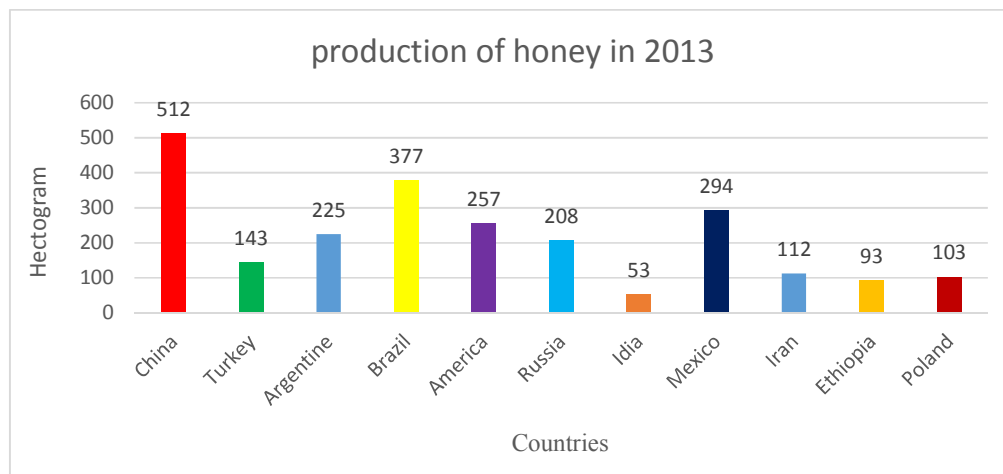


Fig. 2. FAOSTAT, production of honey in 2013

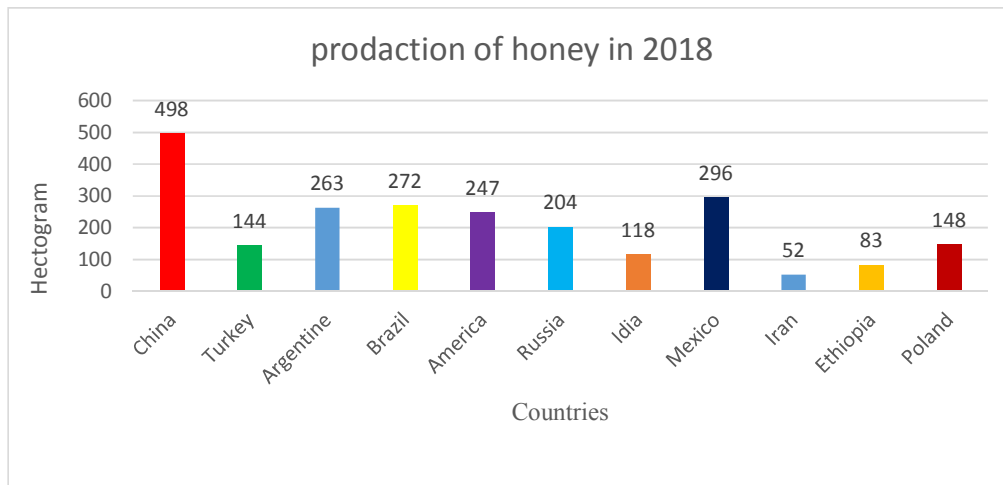


Fig. 3. FAOSTAT, production of honey in 2018

6. USES OF HONEY IN MANUFACTURING

6.1 Uses of Honey in Ayurveda

Ayurveda is one of the grand traditional medicine productions of Indian. Ayurveda products are preventing unnecessary suffering and living a healthy life. Ayurveda made up of natural elements to resolve the root cause of the disease by remake balance, as well as create a healthy life-style to intercept the recurrence of imbalance. Herbal medicines were used in ancient Chinese, Egyptian, Greek, and Indian medicine for various treatment purposes [59]. Honey is a portion of Ayurveda, that is a natural full nutrient sweet and beneficial food for human health is also a boon for those suffering from weak digestion. The use of honey is highly beneficial for the treatment of irritating cough, it most valuable to maintain healthy teeth and gums. For decades, it has been used to cure depression because it has hypnotic action. Regarding skin disorders (such as cuts and burns), chest discomfort, and palpitation, both respiratory imbalances, and anemia, conventional Ayurvedic scholars often prescribe honey. Also, Honey has a long history of using Ayurvedic to treat different eye problems [60].

6.2 Uses of Honey in Cosmetics

Cosmetics products are made up to achieve specific effects on the skin clean or change the look of the face these effects may or may not include some altering the human skin microflora. Whether it is a designed activity or a secondary consequence of cosmetic application [61]. The data collected from a 2018 concentration of use survey conducted by the Council indicate Honey

has the highest concentration of use for cosmetics; it is used up to 22% in paste masks and mud packs (which are considered rinse-off formulations). The highest concentration of use reported for leave-on products was in design containing Honey Extract at up to 7% in body and hand cosmetics products [62].

Honey is reported to be used in 13 baby products at up to 0.01%. It can use with that product that would be applied near eyes, and incidental honey used as ingestion and mucous membrane exposure products. Additionally, Honey and Honey Extract is used in cosmetic sprays and could possibly be inhaled, for example, Honey is reported to be used in colognes and toilet waters and in hair sprays at up to 0.25% and 0.1%, respectively [63].

6.3 Uses of Honey in Food Industry

Honey is a foundation of readily accessible sugars, protein, acids, nitrogen, amino acids, the minimal amount of minerals and a number of other micro quantities of modules like pigments, aroma, flavor, phenolic compounds, colloids, sugar alcohol and vitamins (Crane 1975). In peoples' perspective, the quality of the product will be the key success factor of the honey product were industries of honey maker faced challenges for making and maintaining as well as preserving of honey products [64].

7. CONCLUSION

The quality of the nutritious value of honey are depending on classification of honey bees that classified on Geographical and Botanical

discrimination, even though every essential nutrient is present in the honey compound as carbohydrates, protein, vitamins, minerals, and etc.

As per studies of different type of honey biased on phenol, flavonoid, and antioxidant activity, sourwood honey contains the high amount of phenol and flavonoid, (580.03 ± 0.38), (156.82 ± 0.47) respectively, but the antioxidant activity presents in Blackthorn honey with high percentage of (597.50 ± 0.43).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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