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Review Article

Physico-chemical properties of Ethiopian *Apis mellifera* Honey: Review

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Abstract

The aim of this review is focused on the physical, chemical, and antioxidant properties of Ethiopian honey such as moisture contents, reducing sugars (glucose and fructose), free acidity, pH, hydroxymethylfurfural, (HMF), phenolic compounds, minerals, and water-insoluble solid and enzymatic activity of honey. Generally, the average values of the parameter were within the acceptable ranges of National, EU, and FAO/WHO which was set as permission limit requirement for general blossom honey quality. Accordingly, HMF (9.46 ± 7.11 mg/kg), moisture contents ($18.93 \pm 1.92\%$), free acidity (23.2 ± 10 meq/kg), pH (3.94 ± 0.14), ash content ($0.32 \pm 0.13\%$), electrical Conductivity (0.41 ± 0.16 mS/cm), water-insoluble solids ($0.20 \pm 0.07\%$), reducing Sugar ($70.46 \pm 3.50\%$), and Sucrose ($2.75 \pm 1.1\%$) of the honey was found to be low, this value suggesting that Ethiopian honey were of good quality. The total phenolic contents of honey were high and strongly correlated with the antioxidant activity/radical scavenging capacity. A large portion of research findings are not focused on medicinal value therefore, more research would be important to focus on honey from medicinal plants and to build up the possible relations between the bioactive substances in plant parts and their nectars.

Introduction

Honey is a natural substance delivered by honeybees from the nectar of blossom which is gathered from various plants and popular world widely due to its high healthful and therapeutic qualities [1]. The chemical, physical, antioxidant, and healthful composition of honey varies depending upon flower source, soil type, geological root, and climatic condition CACS (2001). Both old and present-day civilizations utilize honey as a remedy for different illnesses. It is also delectable food, for the most part, made out of sugars and different constituents like proteins, organic acids, amino acids, nutrients, minerals, carotenoids, and aromatic substances. It is wealthy in flavonoids and phenolic acids that display a wide scope of biological impacts and act as natural antioxidants arabagias, et al. 2014) [2].

Honey is composed of nutritive polyphenols [3]. Polyphenols are primary identifying markers for the botanical origin of honey [4], and they display high therapeutic and

dietary value [5]. The major polyphenol compounds in honey are flavonoids and phenolic acid [6]. Flavonoids and phenolic acid are responsible for inhibiting oxidation and destroying free radicals [7].

The quality parameter and uniqueness of honey are examined by different researchers. The quality and validity of food play out a significant role for the two, buyers and producers. A significant concern of honey quality is to guarantee that honey is authentic in regard to the legislative necessities. Authenticity is identified with the judgments of topographical and floral origins and the discovery of unapproved substances [8,9].

Ethiopia and Egypt are some of the main countries in working honey beekeeping (Abera, et al. 2013). The world production of honey was around 1,800,000 tonnes; Ethiopia is the primary honey maker in Africa, and one of the ten biggest honey-producing nations in the world. The total number

of beehives in Ethiopia is 5,207,300 of which 95.96% are traditional and 2.98% are frame hives [10]. The most widely known honey plants, which are used as a source of nectar and pollen, are *Guizotia scabra* and *Guizotia abyssinica*, *Eucalyptus globulus*, *Sheffleria abyssinica*, *Vernonia* species, *Syzygium guineense*, *Acacia* species, *Croton machrostachyus*, and *Erica arborea* [11,12].

Since physicochemical parameters are very important for the honey industry. These are minerals, moisture content, reducing sugars, electrical conductivity, free acidity, sucrose content, and Hydroxymethylfurfural (HMF), which have an impact on the quality of nutrition, granulation, and quality of storage, flavor, and texture of the honey. These components are also responsible for the medicinal value of honey. The ultimate goal of characterizing the physicochemical and antioxidant properties of honey is used to verify the authenticity of the product, to reveal the possible presence of artificial components or adulterants and their contribution to the human health benefits [8,13].

The antioxidant properties of honey are believed to be at the heart of their polyphenolic compounds. Ethiopian natural honey and propolis are thought to be of different varieties due to the unique and highly diverse flora of the country because of its rich variety of environmental features ranging from semi-desert to mountain forests and its wide range of ecological, edaphic, and climatic conditions [11].

However, the physicochemical and antioxidant properties of natural honey are various due to botanical, bee species, climate, agricultural practices, geographical origin, seasonal conditions and environmental factors [13]. As a result, the present review was focused on parameters for honey quality: moisture contents, reducing sugars (glucose and fructose), Hydroxymethylfurfural (HMF), free acidity, phenolic compound, enzymatic activity, pH, ash content, minerals, and water-insoluble solid of honey in Ethiopia. Today the event of antibiotic-resistant pathogens poses a serious risk to public health, thus a high demand for an alternative to antibiotics and conventional therapies is increasing more than ever [14]. This generally shows the importance of screening of different floral origin honey and identifies the one with more antimicrobial potencies.

Method of review

For information assortment, Google Scholar, PubMed, and Science Direct were freely looked. The entirety of the accessible reports on the physicochemical properties of honey which made in Ethiopia a writing search was finished by utilizing the Scopus information base with the mix of the accompanying arrangements of two keywords; Honey with a combination of physical, chemical, or physicochemical properties. Consideration was made on physicochemical properties, for example, moisture content, electrical conductivity, sugars profile, enzyme activity, pH, and main antioxidant of Ethiopian honey.

Information was analyzed and summarized using SPSS version: 20. Different researcher utilizes different values for

reporting data; to decrease prejudice average mean value was taken. The outcome compared with National, FAO/WHO, and EU which set as consent limited by Codex Alimentarius (2001) and the Council of the European Union [15] for honey quality.

Physicochemical properties

The physicochemical properties of honey informed essentially vary by every researcher and two indistinguishable honeys never have similar properties due to differentiation in species, variety of greenery, and different geographical origin and climatic condition. Regardless of whether the physicochemical boundaries chosen by every specialist differ somewhat, however, some shared conviction was obvious.

Moisture

The moisture content of honey relies upon the production season and type of weather, which directly impact the preparation, viscosity, and crystallization of honey [16]. Measuring the refractive index of honey with fixing the temperature at 20°C is used to decide the moisture content of honey which gives data about the stability and opposition of honey to fermentation. If the moisture content of honey is > 19%, it shows undesirable honey fermentation. Thus, the low moisture content is a good sign for a more excellent and longer time span of usability of honey [13].

In Ethiopia, distinctive explorations depending on the geographical region of the nation are conducted. As indicated by Abera, et al. [12]; Meseret, et al. [17]; Birhanu[18] from Bale, West Shoa, and Guji zone of Oromia report 17.89±1.02, 16.54±1.68, and 14.4%±1.5%, respectively. From the northern part of the country Mekuanint and Meareg, (2019) report from the Amhara and Tigray region with an average moisture content of 18.09±1.23%. Likewise, Gebru, et al. 2015 [19]; Getu and Birhan, 2014 [20] from Debre-Nazret of Tigray region and Northern Gonder inform 19.97% and 18.5% which are in agreement with USDA [21] (16-18.6%). Getachew, et al. [22]; Tigistu, et al. [23], from south Ethiopia report values with a range from 20.4% - 24.8% and report the highest (20.54 ±1.28) and the lowest moisture value (14.14±0.19).

Accordingly, investigations done in Ethiopia are summed up in Table 1 which was in good agreement with EU, FAO/WHO, and Ethiopian standards. The moisture content reported goes from as low as 16.54g to as high as 19.97g/100g with a mean of 18.93g±1.92g. The entirety of the investigations was in concurrences with the discoveries of honey produced in the European Atlantic region [24] and Greek honey [2].

Free acidity

Different authors' reports all honey are somewhat acidic, this is because of the existence of organic acids [2]. Free acidity results from the fermentation of sugars to organic acids by enzymes secreted by honeybees.

The content of organic acid in honey is utilized to state the freshness of honey and separate honey as per their botanical and geographical source [26].



Table 1: The average value of moisture content, free acidity, and pH honey from Ethiopia is in contrast with a bunch of national, EU, and worldwide guidelines (FAO/WHO). Std = Standard deviation.

	Moisture Content in %		Free acidity (meq/kg)		pH		Authors
	Mean±Std	Range	Mean±Std	Range	Mean±Std	Range	
	18.93±1.92	16.54-19.97	28.67±3.32	34.57-24.39	3.94±0.14	4.2-3.8	Abera, et al. [12], Meseret, et al. [17], Tigistu, et al. [23], Gebru, et al. [19], Getachew, et al. [22], Mekuanint and Meareg (2019), Addis & Malede [25], Alemayehu (2011).
Ethiopia standard	-		<40		-		Quality Standard Authority of Ethiopia (QSAE) (2005).
FAO/WHO	21-23		40		-		FAO (2010).
EU	21		40		-		The Council of the European Union (2002) [15]

The free acidity of Ethiopian honey revealed by the various author with a mean estimation of 29.74±2.20 Mekuanint and Meareg, (2019), 34.57±4.80 Abera, et al. [12], 27.0±3.07, Adgaba, et al. [11], 29.66±6.13 meq/kg, Meseret, et al. [17] and Gebru, et al. [19] from Tigray region report 25.95meq/kg. Thus, the average value is 28.67±3.32meq/kg. The entirety of the report is inside the perceived national (< 40 meq/kg) Wedmore [27], international CSA, (2012) (5-54meq/kg), and WHO/FAO (< 40meq/kg) Estevinho, et al. [28] guidelines of honey quality. Adgaba, et al. [11] report a smaller value (27.0meq/kg), and the higher value (34.57meq/kg) is reported by [12] with a mean estimation of 18.93 meq/kg.

All of the research achieved in Ethiopia for organic acid were within the acceptable range of National, EU, FAO/WHO set as the limit of <50 meq/kg which is a prerequisite for blossom honey [15]. The total solids of honey organic acids are much less than 0.5%, however, it's very useful for aroma, honey taste, color, and honey renovation and permits micro-organisms to be complex to grow. These organic acids are directly obtained from nectar (citric oxalic and malic) and some of them are derived from sugar by enzyme secreted by honeydew sugars by the action of enzymes (oxalic and others) [29,30].

Ash content

Estimating ash content honey is directly related to assessing the mineral substance present in honey [2].

The mineral substance of honey relies upon soil nature, kinds of plants, ecological condition, and origin of the floral plant, which is an immediate pointer of contamination of climate and geological source. Bogdanov, [31]; affirmed pollen gathered by the honey bees during scrounging on the plants is the principal factor that influences the ash (mineral) content of honey, which fluctuates from 0.02 to marginally more than 1% for flower honey.

In Ethiopia, there was a huge contrast in the ash content of honey in the region. Mean value 0.34±0.05 (from Gambella), 0.39±0.04 (from Bale), and 0.21±0.01 (from Amhara and Tigray

Regions) reported by Berhe, et al. 2018 [32]; Abera, et al. 2017 [12]; Mekuanint and Meareg, (2019) which summarized in Table 2. The average ash content of Ethiopian honey is 0.317±0.133 with a range of 0.14-0.47%. Information on the ash content of honey is utilized as a boundary to assess the dietary benefit of honey. This affirmation was demonstrated by analyzing honey samples from various regions of Ethiopia, whose values were certified with other writing information. Typically, potassium is a major contributor to mineral content, as reported by a different author, and from the ash content, the average value of Ethiopian honey is acceptable by FAO/WHO.

Hydroxymethylfurfural (HMF)

Hydroxymethylfurfural (HMF) is broadly recognized as a boundary of honey deterioration. Honey put away for a long time has high HMF content which is formed by the breakdown of monosaccharides, particularly fructose. Honey bee species, season, pH of honey, stockpiling condition, and heating are the factor that influences the HMF substance of Honey [19,33,34] report higher value (14.99mg/kg) from Tigray, Berhe, et al. [32] from Gambella report 9.91±2.64mg/kg. Engidaw, et al. [35], work impact of season on the HMF of honey and report season also one factor which influences HMF content of honey. Hence the average HMF of Ethiopian Honey is 9.44mg/kg ±7.11 and research done in HMF in Ethiopia is summarized in Table 2. Appropriately, the mean HMF value of honey as far as production seasons in a year changed from 16.1-20.3mg/kg. The entirety of the honey falls on national and FAO/WHO acceptable range.

Electrical conductivity

The electrical conductivity of honey is identified with its capacity to move electric flow, this is because of the mineral, salts, organic, and other components which exist in honey [11]. This parameter compliments different boundaries utilized in the assurance of honey botanical origin [14]. Chefrour, et al. [37] report electrical conductivity is linked to honey ash content and alkalinity which is widely used to differentiate between

Table 2: The average value of HMF, ash content, and electrical conductivity honey from Ethiopia in contrast with a bunch of national, EU, and worldwide guidelines (FAO/WHO).

	HMF (mg/kg)		Ash Content (%)		Electrical Conductivity (mS/cm)		Authors
	Mean±Std	Range	Mean±Std	Range	Mean±Std	Range	
	9.46±7.11	16.5-0.84	0.32±0.13	0.14-0.50	0.41±0.16	0.21-0.7	Engidaw, et al. [35], Nigussie, et al. [36], Abera, et al. [12], Meseret, et al. [17], Gebru, et al. [19], Mekuanint and Meareg (2019), Alemayehu (2011), Adgaba, et al. [11], Abera, et al. (2013), Berhe, et al. [32], Dubero, et al. (2015), Tigistu, et al. [23].
Ethiopia standard	< 40		< 0.6		-		Quality Standard Authority of Ethiopia (QSAE)(2005).
FAO/WHO	80		-		-		FAO (2010)/Codex Alimentarius (2001).
EU	40		< 0.6		< 0.8 mS/cm		The Council of the European Union [15].

Std = Standard deviation.



honeydew and blossom honey and as well for the classification of unifloral honey.

Blossom honey has electrical conductivity lower than 0.8mS/cm, yet honeydew should be higher than 0.8mS/cm as per. Electrical conductivity in all regional parts of the country report ranged from 0.21mS/cm [36] to 0.70 mS/cm (Abera, et al. 2013).

In general, the average values are 0.41 0.16 which is below the maximum limit of 0.8 mS/cm set by the Codex Alimentarius (Codex, 2001) and FAO/WHO.

pH (Power of Hydrogen)

Honey pH has been helpful in the determination of its geographical starting point and corresponded with an affirmation of adulteration of honey [38]. The pH of Honey is ranging from 3.4 to 6.4. The average pH value of Ethiopian honey was 3.94±0.14, with a most minimal worth detailed by Abera, et al. [12] (3.79) for 320 kinds of honey gathered from Ethiopia and the highest value is reported by Alemayehu (2011) (4.37) from silite zone.

Although the pH limit has not yet been described by the Regulatory Committees, a pH level between 3.2 and 4.5 and the natural acidity of the honey inhibit the growth of micro-organisms, as the optimum pH for most organisms is between 7.2 and 7.4 [8,9]. The pH of honey from Kenya and Sudan was reported with a mean of 4.1±0.3 and 3.6±0.6 Nzano, et al. [39]; Ishraga, et al. (2017) separately. Lower pH is linked with the fermentation of sugars present in the honey into organic acid. Blossom honey has a pH range from 3.5 to 4.5 yet honey with a pH over 5 to be of low quality [37]. Therefore, Ethiopian honey has delegated Blossom honey.

Sugar content

As a food service, honey has been utilized for quite a long time as a sugar and human energy source. Carbohydrates as sugars are the significant constituents of honey, from which fructose and glucose (reducing sugars) are the primary contributors [40]. Sugars contained in pollen are principally sucrose, glucose, and fructose, yet their relative proportions are usually rather variable; in any case, they are very reliable for certain botanical families [41].

Numerous investigations are led by researchers in Ethiopia for sugar compositions of honey which were inside the satisfactory scope of EU, FAO/WHO, and national set. In Tigray and Amhara, Mekuanint and Meareg, (2019) were done honey research acquired from the farmers' hives and reported

sucrose content within arrange of 1.35%–5.96% which were in acceptable concurrence with Alemu, et al. 2013 [42] (1.0%–5.2%) and Eyobel, et al. (2017) (2.28%– 5.72%) and reducing sugar with mean values of (64.93±1.53) which summarized in Table 3.

Then again, research led by Berhe, et al. [32] from Gambella, Abera, et al. (2013) from Bale, Meseret, et al. [17] from west Shewa Oromia, Alemayehu, (2011) from siliti woreda, Abera, et al., [11]; Adgaba, et al. [12] for honey gathered from various part of the nation detailed mean value of sucrose and reducing sugar were discovered to be 4.1 and 69.04, 2.4 and 69.48, 1.54 and 71.84, 4.1 and 69.04, 2.43 and 69.48 and 3.7 and 67.4%, independently. Mohammed [43] from Sudan and Cantarelli, et al. [44] from Argentinean reported sucrose content of 5.8–8.7% and 4.05%, individually.

Generally, as per the prerequisite set by EU/FAO/WHO for honey quality (<5g/100g sucrose) and (>65g/100g reducing sugar) the above-demonstrated honey satisfies the foreordained guideline with a mean value and standard deviation of 2.75±1.11 and 70.46±3.95. Moreover, fructose and glucose in honey are credited to predetermine phases of honey ripeness nectar sources in various geological areas, and it ascribes to decide the sugar composition of honey. In general [8], the flower utilized by the honey bee, ecological and climatic conditions are a primary contributor to the sugar composition of honey [45]. The dietary, physical, and synthetic properties of honey-like thickness, hygroscopicity, explicit turn, and energy principally rely upon the sugar structures [46].

Minerals and water insoluble solids

In *Apis mellifera* honey, the mineral content of the honey is frequently reported to relate to the dietary advantage of honey [19]. Pollen, wax, honeycomb debris, honey bees, and filth particles are water-insoluble solid constituents of honey. In Ethiopia, Abera, et al. [12] was carried out research on honey gathered from the whole part of the country and reported the Potassium level of monofloral honey ranged from 1.136±5 to 0.272±10 g/kg. Also, in Tigray, studies directed by Nigussie, et al. [36] for honey samples gathered from the known apiculture areas report Cu (13.99 mg/kg for Adigrat), Ni (2.612 mg/kg for Abiy Adi), and Fe (12.73 mg/kg for Hagereselam). The estimation of water-insoluble solids is imperative to distinguish honey pollutions that are higher than the allowed maxima.

The accessible information on water-insoluble solid revealed the lowest value of 0.12% in Hareenna forest from Oromia by Abera, et al. (2013), the greatest value reported by Alemayehu, (2011) (0.26%) and 0.21% from the Tigray region

Table 3: The average value of Reducing Sugar, Sucrose, and Water-insoluble solids from Ethiopia is in contrast with a bunch of national, EU, and worldwide guidelines (FAO/WHO).

	Reducing Sugar (%)		Sucrose (%)		Water-insoluble solids (%)		Authors
	Mean±Std	Range	Mean±Std	Range	Mean±Std	Range	
	70.46±3.50	64.9-76.4	2.75±1.1	1.22-3.7	0.20±0.07	0.12-0.21	Berhe, et al. [32], Abera, et al. [12], Meseret, et al. [17], Gebru, et al. [19], Mekuanint and Meareg, (2019), Alemayehu, (2011), Adgaba, et al. [11], Abera, et al. 2013, Tigistu, et al. [23].
Ethiopia Standard	>65		<10		< 0.1		Quality Standard Authority of Ethiopia (QSAE) (2005).
FAO/WHO	>65		5-10		-		FAO (2010).
EU	>65		5		< 0.1		The Council of the European Union [15]; Codex Alimentarius (2001).

Std = Standard deviation.

which was announced by [19]. The water-insoluble solid substance has been set to be not more than 0.1max in *Apis mellifera* honey in the national standard. The average value for the water-insoluble solid of Ethiopian honey was 0.196 ± 0.071 . This outcome was under the world limit esteem (0.26%–0.84%) but above the national standard (0.1%) this is on the grounds that the pure whiteness of honey.

Antioxidant properties

Antioxidants, as their name indicates, are chemicals that inhibit oxidation. Antioxidants are therefore required to act as radical scavengers, which transform reactive radicals to less reactive forms and prevent reactions with body cells in order to avoid cell harm (Kumar, 2014).

Phytochemicals such as polyphenols are the main contributors to the effects of antioxidants in honey, according to Khalil, et al. [47]. Polyphenols are composed of flavonoids and phenolic acids, which together with other components such as organic acids, amino acids, proteins, carotenoids, enzyme glucose oxidase, and catalase are attributed to the antioxidant properties of honey. The possible relationship between antioxidant activity (as measured by the oxygen radical absorption capacity assay) and the levels of different honey components have been studied [48].

Phenolic compound

Phenolic compounds are fragrant compounds with at least one hydroxyl group that act as antioxidants, disposing of free radicals and inhibiting lipid oxidation. In view of their chemical structure, they can be partitioned hydroxybenzoic and hydroxycinnamic acids and there are around 10,000 phenolic compounds [49]. They can be separated as flavonoids and non-flavonoids, flavonoids (phenolic acid) have bioactive capacities which found in plant and food, serve as secondary metabolites needed for the ordinary cycle of normally happening plants (Andersen and Markham, 2006).

In Ethiopia, the total polyphenol content of the honey mentioned by Sime, et al. [50] ranged from 330 ± 38 mg GAE /100g (from bore) to 610 ± 5 mg GAE /100g (from woliata soddo); Adgaba, et al. [11] also mentioned a range of 233.3 ± 24.0 mg GAE /kg to 693.3 ± 26.8 mg GAE /kg. Additionally, from west Shewa Oromia Mesert, et al. (2018) stated the highest mean value (196.54 ± 6.47 GAE /100g), and the lowest mean value (161.16 ± 6.46), and Mekuanint and Meareg (2019) also reported honey from the Amhara Region Showed higher total phenolic content and better antioxidant activity than from Tigray with the highest mean value of 196.54 ± 6.74 mg GAE /kg and the lowest value 161.15 ± 6.48 mg GAE /kg. In general, the total phenolic contents of Ethiopian honey had been numerous from 423.925 to 264 ± 96 (higher mean value) to 221.33 ± 79.97 (lower mean value).

Most phenolic compounds studied by several authors are vanillic acid, caffeic acid, syringic acid, p-coumaric acid, ferulic acid, quercetin, kaempferol, myricetin, pinobanksin, pinocembrin, chrysin, ellagic acid, galangin, 3-hydroxybenzoic acid, chlorogenic acid, 4-hydroxybenzoic acid, rosmarinic acid, gallic acid, hesperetin, benzoic acid and others [40,51].

Antioxidant, antimicrobial, antiviral, their capacity to scavenge or reduce the formation of free radicals and anticancer activities of the honey are affected by the floral foundation, concentration and form of polyphenolic substances [52].

Enzyme activity

Honey holds small amounts of enzymes of which diastase and invertase are the most important because they are carefully chosen for the validation of honey quality. In addition, the α - and β -glucosidase, catalase, acid phosphatase, and glucose oxidase are also the most common enzyme found in honey [8]. Ortiz-Valbuena, et al. [53]; Sabatini [46] report, the enzymatic content of honey is associated with proline amino acids which control nectar enzymatic transfer, basically, nectar transformation in honey allow secretion of invertase.

In addition, catalase and acid phosphatase are derived from pollen, honeydew, or nectar. Enzymes, actually serve as an indicator of aging and overheating (thermolabile), subsequently, their performance is minimized in the situation. Basically, nectar abundance flow and transformation degree, state and strength of the colony, seasonal activity, temperature and state, and strength of the colony are a factor that affects the enzyme content in honey [54–56].

In Ethiopia, studies led by Gebru, et al. [19] report a mean value of diastase content 6.25 DN (with a mean of 8.10 DN for modern hive and 6.60 for traditional hive) from Tigray Region for honey gathered from known apiculture regions. This report is beneath as far as possible set by EU and FAO/WHO (>8DN). Starch and dextrans are hydrolyzed by diastase to shape more modest sugar and the content of diastase activity in honey may vary.

The physiological time of the colony, the nectar assortment period, age of honey bee, and a large amount of nectar flow and its sugar content in light of the fact that a high movement of concentrated nectar prompts a lower catalyst substance and pollen utilization [55–64]. Then again, a few investigations were directed by various researchers like by Fredrick, et al. (2013), from Kenya which report diastase content (4.5 ± 1.04 – 11.2 ± 0.44 DN) in acceptable range by national and EU and FAO/WHO.

Conclusion and recommendation

In this review, most of the physical and chemical characterized (moisture contents, reducing sugars (glucose and fructose), free acidity, pH, HMF, enzyme activity, phenolic compounds, minerals, and water-insoluble solid and antioxidant activity) results of the honey are agreed with the national and international set quality standards set by Quality Standard Authority of Ethiopia, Codex Alimentarius Commission and EU Council.

It can be concluded that Ethiopian honey is a good quality bee product for the local and international market. Honey from the northern part (Amhara and Tigray region) of the country exhibited better total phenolic content and higher antioxidant activity. However, most of the research findings done in the



other regional part of the country do not focus on the medicinal value of honey. Hence, more research would be important to focus on honey from medicinal plants and to establish the possible relations between the bioactive substances in plant parts and their nectar.

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