

## REVIEW ON FACTORS CONTRIBUTES TO THE UNIQUE QUALITIES OF TIGRAY WHITE HONEY COMPARED TO HONEY FROM OTHER ETHIOPIAN REGIONS?

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Received: 14 August 2024, Revised and Accepted: 22 October 2024

### ABSTRACT

Tigray honey is celebrated for its exceptional quality and health benefits. Studies have confirmed that it meets international standards, boasting optimal moisture content, low ash levels, and a suitable pH level. The region's diverse flora, which includes honey bee sources such as *Hypoestes forskaoalii*, *Becium grandiflorum*, and *Leucas abyssinica*, contributes significantly to the honey's unique characteristics. Special white honey, believed to be produced from these specific floral sources, is particularly prized in Ethiopia, especially in Tigray. This honey has consistently demonstrated compliance with national and international quality standards in terms of moisture content, electrical conductivity, mineral composition, pH, and free acidity. The combination of Tigray's natural environment, beekeeping practices, unique floral sources, and rarity has resulted in a honey that is renowned for its exquisite taste, aroma, and health benefits. This exceptional product has garnered significant demand both domestically and internationally, making it a sought-after specialty honey.

**Keywords:** *Becium grandiflorum*, *Hypoestes forskaoalii*, *Leucas abyssinica*, White honey.

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### INTRODUCTION

Beekeeping is a traditionally significant agricultural activity for many rural communities in Ethiopia (Agonafir, 2005). Correspondingly, the country possesses a substantial natural resource base for honey production and other hive products. Beekeeping has been a well-established household practice in nearly all regions of Ethiopia (Yirga and Teferi, 2010). Among the regions, Oromia, Amhara, and the former Southern Nations, Nationalities, and Peoples' (SNNP) regional states contribute 46.4%, 21.8%, and 20.2% of honey production, respectively. These regions also account for 55%, 19.3%, and 15.6% of the bee colonies (Siraj and Abdi, 2021; Bessa, 2023; Dirriba, 2023). Meanwhile, Tigray and Benishangul-Gumuz represent 4.4% and 4.6% of the total bee colonies and 6% and 2.7% of total honey production, respectively (Seble, 2020; Benyam *et al.*, 2021; Siyoum, 2022).

Honey bee production in the Tigray region represents a longstanding tradition among most rural communities. Beekeepers possess indigenous knowledge regarding bee products. The region benefits from favorable climatic conditions and floral diversity, creating a high potential for beekeeping. Contributing factors include access to beehives, a sustainable honey market price, healthy bee colonies, and well-developed infrastructure (Haftu *et al.*, 2015). As part of an initiative aimed at poverty alleviation, the total number of beehives in Tigray increased from 173,948 in 2004 to 343,243 in 2020 (Ngussie and Hailu, 2023). Among the zones, North West Tigray, Central Tigray, Eastern Tigray, Southern Tigray, Western Tigray, and South Western Tigray have 24.62, 21.60, 22.90, 8.09, 11.22, and 11.56% of the bee colonies, respectively (CSA, 2022). Beekeeping in Tigray is a significant economic activity, supporting poverty alleviation and employment opportunities for over 58,000 beekeepers. However, the recent conflict in the region has put this valuable industry at risk (Ngussie and Hailu, 2023).

At present, honey production in the Tigray region is undertaken by individual smallholders, cooperative societies, women's groups, youth associations, and churches (Meaza, 2010). Each woreda within Tigray produces honey of various types and colors, ranging from white to red/dark (Gebrehiwot, 2015). The region is particularly renowned for its diverse honey colors, with a special emphasis on its specialty white

honey. This white honey, derived from unique floral sources found in the highland and mid-land areas of the region, is in high demand and commands a significant price in both domestic and international markets.

In the Tigray region of Northern Ethiopia, considerable research has been undertaken, resulting in documentation of various aspects related to honey production (Yirga and Teferi, 2010; Gebremedhn and Estifanos, 2013; Haftu *et al.*, 2015; Gebreyohans and Gebremariam, 2017; Gebregiorgis *et al.*, 2018), as well as its physical and chemical characterization (Nigussie *et al.*, 2012; Gebremedhin *et al.*, 2013; Gebru *et al.*, 2015; Lewoyehu and Amare, 2019), processing and value addition (Gebrekirstos, 2015; Kelelew *et al.*, 2015; Abreha *et al.*, 2020), and marketing issues (Abebe, 2009; Gebremeskel *et al.*, 2014; Gebrehiwot, 2015). Nevertheless, the reasons behind the distinctness of honey from the Tigray region, as compared to that from other regions in Ethiopia, have not been critically reviewed. Consequently, this review aims to explain the primary factors contributing to the distinctness of honey from Tigray relative to other regions within the country.

### METHODS

The investigation titled "What factors contribute to the unique qualities of Tigray honey compared to honey from other Ethiopian regions?" formed the basis of a systematic review conducted through "Google Scholar," a web-based search engine that offers a convenient and efficient method for locating and accessing published literature, including articles, journals, books, and conference proceedings. The search employed thematic terms such as white honey, marketing price, *Becium grandiflorum* honey, *Hypoestes forskaoalii* honey, and *Leucas abyssinicus* honey.

### Production of honey in Ethiopia

Ethiopia stands as a prominent honey producer in Africa, possessing substantial potential in beekeeping, with an estimated annual capacity of 500,000 tons (Sebeho, 2015; Tigistu, 2020; Mohammed and Hassen, 2021). Nevertheless, the current production is constrained to a range of 50,000–58,000 tons due to various limitations (Tigistu, 2020; Mohammed and Hassen, 2021). The country utilizes three distinct honey production systems: Traditional, transitional, and modern (Mohammed and Hassen, 2021). Traditional methods prevail, leading to lower yields

and quality when compared with modern practices (Gebrehiwot, 2015; Sebeho, 2015). The principal challenges encompass a shortage of trained personnel, restricted access to contemporary equipment, the prevalence of pests and diseases, as well as inappropriate pesticide application (Tigistu, 2020; Mohammed and Hassen, 2021). Despite these challenges, beekeeping remains vital in the efforts toward poverty alleviation and the advancement of agricultural growth (Gebrehiwot, 2015).

Numerous varieties of honey are harvested across the various regions of Ethiopia. The types of honey collected range from light to dark amber (WEEMA, 2016). It is not uncommon to encounter distinct flavors of honey within a particular region. In general, Ethiopian honey is recognized for its low moisture content and high nutritional value. However, the quality and pricing of honey vary across different regions (Tigistu, 2020). The honey that is most sought after among Ethiopians originates from Eastern Tigray, whereas honey varieties from the Amhara, Oromia, SNNPR, Gambella, and Benishangul-Gumuz regions possess commendable qualities and are priced more affordably than Tigray honey (Agonafir, 2005).

Yellow honey commonly known as multiflora honey is produced and available in nearly all regions of Ethiopia. It is harvested from various parts of the country and derives its color from the diverse crops cultivated (Tigistu, 2020). Another type of honey, referred to as Lalibela honey (*Acacia* honey), is produced in central Ethiopia. Its primary characteristics are a light color and a fine creaminess, which result from bees foraging on *Acacia* trees. This particular variety of honey is well-recognized and highly sought after in the domestic market (USAID, 2012).

Less-appreciated varieties of Ethiopian honey are characterized by their dark brown color and bitter taste, which render them less favored for consumption. These honeys are produced in regions with altitudes ranging from 1,200 to 2,400 m above sea level (Tigistu, 2020). The final type of honey that is widely produced and marketed is crude red honey. Its primary utility and popularity among beekeepers stem from its minimal quality requirements, as Tej houses purchase it in its crude, entirely unprocessed form to create a traditional Ethiopian type of mead (Agonafir, 2005).

Ethiopian honey exhibits variations not only in color, taste, and quality but also in the quantity produced and the timing of harvesting seasons, which differ by region and type of honey (Miklyaev *et al.*, 2014). The primary harvesting seasons include October through December for Tigray and Lalibela honey, with an additional harvest period for Tigray's white honey occurring in June and July; November and December for yellow honey; April and May for white honey from the southwest and southeast highlands; and February, March, May, and June for dark-brown varieties of honey (GDS, 2009).

#### Honey price and color in the domestic market

Domestic honey prices in Ethiopia exhibit significant variations based on region and type of honey. The flavor, color, and various physical, chemical, and nutritional properties of honey are predominantly influenced by its botanical origin and the climatic conditions of the production areas (Getachew *et al.*, 2014; Belay *et al.*, 2017; Lewoyehu and Amare, 2019). Among the physical properties, color is immediately perceived by consumers and plays a vital role in the acceptance and valuation of honey (Krell, 1996; Bertoneclj *et al.*, 2007; Belay *et al.*, 2017). The color of honey is indicative of its floral source (Tesfaye *et al.*, 2016; Damto, 2022), and consumers' preferences are often determined by the color of honey (Tesfaye *et al.*, 2016). The three distinct types of honey produced by bees in the Tigray region are white, red, and yellow. Tigray white honey is characterized by an uneven, granular texture, excellent consistency, and a striking bright white color (Gebremariam and Brhane, 2014).

Tigray is renowned for its white honey, which is highly esteemed in the local markets of Ethiopia due to its low moisture content, distinctive aroma, color, and flavor (Lewoyehu and Amare, 2019). Traditionally, it

has been utilized in various capacities, including as food, in winemaking, and as a medicinal aid. Tigray white honey is primarily produced between October and November in regions where flowers of *B. grandiflorum*, *H. forskoolii*, and *L. abyssinicus* are abundant, specifically in the Eastern, Central, and Southern zones of Tigray (Ngussie and Hailu, 2023). Among the top three foraging sources for white honey are *B. grandiflorum*, *H. forskoolii*, and *L. abyssinicus* (Berhe and Egziabher, 2016). Haftom *et al.* (2013) indicated that *B. grandiflorum* and *H. forskoolii* are among the primary honey bee plants in the Tigray region. White honey, particularly which is derived from *B. grandiflorum*, generally commands the highest prices (Belay *et al.*, 2015).

In the Amhara region, the price of processed honey reached up to 90 Birr/kg at the Zembaba Farmers' Cooperative Union and 80 Birr/kg at the Marutie Bee Products Cooperative. In addition, in the year 2020, prices ranged from 60 to 70 Birr at the farm gate (Araya, 2020). In the Oromia region, the average price for crude honey at the farm gate was between 30 and 35 Birr/kg, whereas traders sold it for 70–80 Birr/kg. Occasionally, honey collectors sold crude honey to Tej houses at an average price of 40–45 Birr/kg (Araya, 2020). In the Southern Nations, Nationalities, and Peoples' region, honey prices ranged from 35 Birr/kg at the farm gate to 80 Birr/kg in urban areas (Araya, 2020). In southwest Ethiopia, the average selling price for a kilogram of honey was 92.2 Birr (Tadesse *et al.*, 2021).

#### Current price of Tigray honey

In 2024, the estimated wholesale price range for natural honey in Ethiopia is between US\$ 2.05 and US\$ 12.33/kg. The retail price range for natural honey in Ethiopia falls between US\$ 2.93 and US\$ 17.61/kg. In Addis Ababa and Dire Dawa, the retail price range for natural honey is between ETB 159.25 and ETB 955.47/kg (<https://www.selinawamucii.com/insights/prices/ethiopia/natural-honey>). The price of honey in the Tigray region has been increasing daily, to the point where it has become unaffordable for local consumers (Gebrekirstos, 2015). In 2023, the price of red honey reached US\$ 21.84/kg at commercial producers and US\$ 14.76/kg at the farm gate. In the local market, traders sell white honey at prices ranging from US\$ 4.58 to US\$ 15.94/kg (Fig. 1a). The maximum local market price for yellow honey was recorded at US\$ 6.95/kg (Fig. 1b). Honey prices in Ethiopia fluctuate based on quality and color, ranging from US\$ 2.37 to US\$ 4.57/kg in 2019 (Chanie *et al.*, 2019).

White honey sourced from the Tigray mountains is recognized for its high market value in foreign markets (FAO, 2020). In 2023, the selling price of white honey from traders in Tigray was recorded at US\$ 43.92/kg. In 2022, the price of white honey was US\$ 32.88/kg at commercial producers and US\$ 30.03/kg at the farm gate (Fig. 1c). The price for white honey at the farm gate was estimated to range between US\$ 17.56 and US\$ 22.77/kg during the years 2019 and 2021 (Fig. 1c). According to the pooled survey results, regardless of quality and color, honey prices in Tigray, Northern Ethiopia, in 2023 ranged from US\$ 14.76 to US\$ 21.84 for red honey, US\$ 6.95–US\$ 8.00 for yellow honey, and US\$ 34.74–US\$ 43.92 for white honey (Fig. 1a-c). Due to its superior quality, the domestic price of white honey at 1,000 Ethiopian Birr/kg is comparable to prices found in European markets (Ngussie and Hailu, 2023). The average lagged price of honey per kilogram, as reported by sampled respondents in the year 2022, was 187.5 Birr, whereas the average price per kilogram sold by respondents in 2023 was 218.0 Birr in the Amhara region, Northern Ethiopia (Hando, 2023). The prices of white honey and red honey in the study area were significantly higher compared to a study conducted in and around Maksegnit Town, Amhara Region, Ethiopia, which reported prices of US\$ 4.57 and US\$ 3.34/kg, respectively (Chanie *et al.*, 2019).

#### Physicochemical properties of Tigray honey

Understanding the physicochemical properties of honey is essential for both the honey industry and consumers who seek the unique advantages offered by these natural products. The determination of quality aids in the standardization of honey and the identification of significant interventions

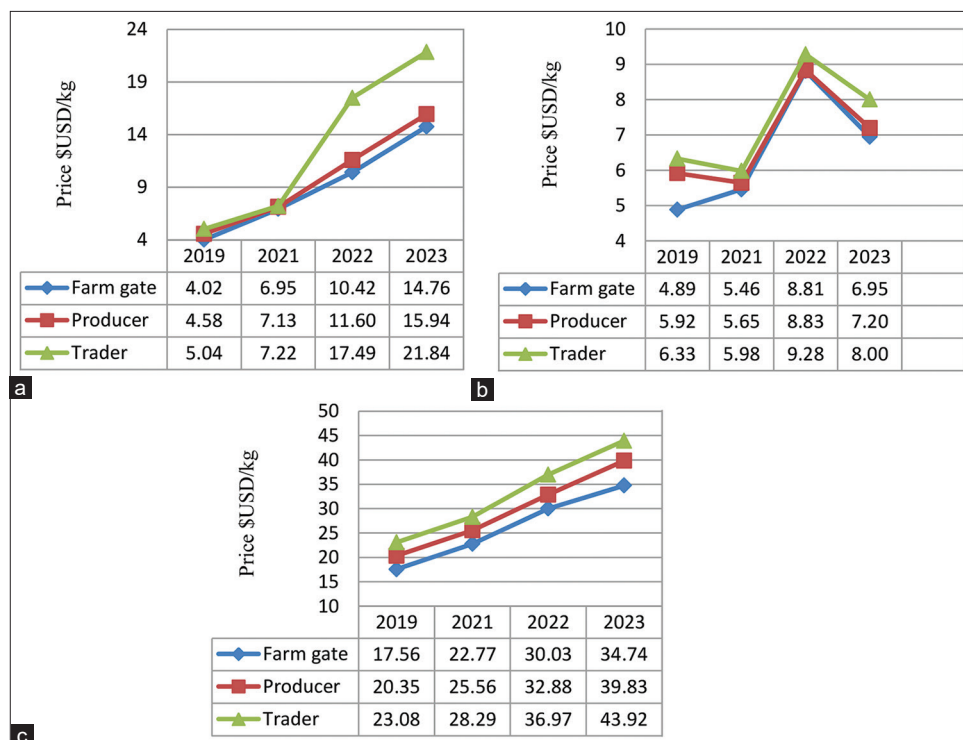


Fig. 1: Price of red (a), yellow (b), white (c) honey in the year of 2019, 2021, 2022 and 2023 (1 USD=57.57 Ethiopian Birr during July, 2024)

(Teshome *et al.*, 2020). Investigations into the physicochemical properties of honey are critical for the certification process that establishes honey quality (Zerrouk *et al.*, 2011). The physicochemical properties of honey, including those from Tigray, may vary due to factors such as floral sources, climatic conditions, and processing methods (Kebede *et al.*, 2012; Tadesse and Gebregziabher, 2014).

Studies have demonstrated that honey from the Tigray region adheres to international quality standards, exhibiting optimal moisture content, low ash content, and appropriate pH levels (Gebremedhin *et al.*, 2013; Nigussie *et al.*, 2012). This honey showcases significant antioxidant activity attributed to its phenolic content and displays antimicrobial properties (Lewoyehu and Amare, 2019). Tigray honey is rich in various minerals, with iron being the most prevalent (Nigussie *et al.*, 2012). The distinctive characteristics of Tigray honey can be traced back to the region’s diverse flora, which impacts its composition and properties (Lewoyehu and Amare, 2019). The moisture content generally ranges from 16.34% to 19.83%, indicating maturity and appropriate harvesting practices (Nigussie *et al.*, 2012; Lewoyehu and Meareg, 2019). The pH values of the honey are relatively acidic, ranging from 3.59 to 4.45 (Nigussie *et al.*, 2012). Electrical conductivity is reported to vary between 0.19 and 33.5 mS/cm (Nigussie *et al.*, 2012; Lewoyehu and Meareg, 2019). The color of the honey varies from white to amber, with light amber being the most common (Gebremedhin *et al.*, 2013).

According to reports by (Belay *et al.*, 2017; Adgaba *et al.*, 2020; and Tesfay *et al.*, 2024), the average moisture content of honey from *B. grandiflorum*, *H. forskoolii*, and *Leucas abyssinica* ranged from 14.79% to 14.97% (Table 1). These values are below the recommended thresholds set by the National (21%), International (18–23%), and World Health Organization/Food and Agriculture Organization (21–23%) standards. Furthermore, the mean ash content of the honey from *B. grandiflorum*, *H. forskoolii*, and *L. abyssinica* varied from 0.17% to 0.46% (Table 1). The mineral contents of all honey samples fell within the acceptable ranges of the national (<0.6) and international (0.02–1) standards for honey quality. The electrical conductivity of honey from *B. grandiflorum*, *H. forskoolii*, and *L. abyssinica*, which ranged from 0.22 to 0.38 mS/cm (Table 1), was also found to be within the acceptable

range (0.1–3 mS/cm) as per the International Standard (CSA, 2012). The average sucrose content for this honey was between 2.56% and 4.4% (Tesfay *et al.*, 2024) (Table 1). Honeys collected from the Tigray Region were found to be whiter than those from the Amhara Region, and the higher ash content in samples from Amhara districts compared to those from Tigray may also be attributed to differences in sample color (Gebru *et al.*, 2015).

**Unique honey bee floras sources for unique Tigray white honey**

The flora associated with honey bees in Ethiopia, particularly in the Tigray region, is pivotal to honey production. Numerous studies have identified a variety of plant species that serve as primary forage for bees, encompassing trees, shrubs, and herbs (Gebru *et al.*, 2015). The Tigray region boasts a rich diversity of flora from which bees can forage, including several endemic plant species. This diversity contributes to honey characterized by a unique flavor profile, often described as complex, floral, and aromatic. The honey produced in Tigray, derived from nectar-rich vegetation and favorable climatic conditions, results in a distinctive white cream honey with relatively low moisture content (Gebreamlak *et al.*, 2020). There exists potential to leverage this high-quality variety through a branding initiative targeting the international market. Within Tigray, a specific type of honey, known as white honey, enjoys significant popularity and high demand in the local market (UNIDO, 2009). This variety is regarded as the most expensive among locally produced honey and is typically sourced from specific districts, including Degua Temben, Atsby-Wonberta, Adigrat, and Wukro (Taddele and Nejdán, 2008). These districts serve as primary habitats for *H. forskoolii*, *B. grandiflorum*, and *L. abyssinica* (Haftom *et al.*, 2013). Consequently, honey sourced from these districts commands a premium price in the local market (Taddele and Nejdán, 2008). These plant species are predominantly found in exclusion areas (Belay *et al.*, 2017). The unique plant sources confer a distinctive flavor and color to the honey.

*H. forskoolii* (Vahl), commonly referred to as Girbia, is one of the primary honey bee plant species in Tigray that produces white honey (Adi *et al.*, 2014; Belay *et al.*, 2017). This plant is classified as a perennial herb and belongs to the *Acanthaceae* family (Fichtl and Admasu, 1994)



**Table 1: Physicochemical composition of *Becium grandiflorum*, *Hypoestes Forskaolii*, and *Leucas abyssinica* honey**

Physicochemical properties	<i>Hypoestes forskoolii</i>	<i>Leucas abyssinica</i>	<i>Becium grandiflorum</i>
Moister content (%)	14.96, 14.97*	16.86, 16.53*	14.79*
pH (%)	3.67	3.55	3.7
Free acidity (meq/kg)	24.49	20.27	-
Electrical conductivity ( $\mu\text{s}/\text{cm}$ )	0.38	0.22	0.3
Ash (g/100 g honey)	0.46	0.17	0.4
HMF(mg/kg)	23.92	19.75	-
Reducing sugar (g/100 g)	69.8	71.17	-
Sucrose (g/100 g)	2.56	2.9	4.4
	*Belay <i>et al.</i> (2017); Tesfay <i>et al.</i> (2024)	*Belay <i>et al.</i> (2017); Tesfay <i>et al.</i> (2024)	Belay <i>et al.</i> (2017); *Adgaba <i>et al.</i> (2020)

(Fig. 2). Honey bees forage on *H. forskoolii* primarily for its abundant pollen and nectar (Gebremedhn and Tesfay, 2012; Gebremedhn *et al.*, 2013; Subhatu, 2017). In Tigray, *H. forskoolii* blooms from September to November, which coincides with the region's main honey flow period (Gebremedhn and Tesfay, 2012; Gebremedhn *et al.*, 2013; Adi *et al.*, 2014; Gebre *et al.*, 2016). The honey derived from this plant is creamy white and tends to granulate easily, and in certain areas of Tigray, it has been classified as monofloral honey (Adi *et al.*, 2014; Belay *et al.*, 2017). Due to its appealing color and delicate flavor, the white honey produced from *H. forskoolii* commands a premium price in both local and international markets (Adi *et al.*, 2014).

*L. abyssinica*, commonly referred to as "Suwakerny," is one of the prevalent floral species found in the highland and mid-highland regions of Tigray (Gebreamlak *et al.*, 2020). This plant is considered one of the most significant honey bee plants, as honey bees frequent it to collect both pollen and nectar (Haftom and Tesfay, 2012; Gebreamlak *et al.*, 2020). *L. abyssinica* is characterized as a medium-sized, aromatic woody shrub that belongs to the *Lamiaceae* family (Fig. 3). In addition, this species is utilized for various purposes, including fuel wood, brooms, roofing materials, and traditional medicine for treating hemorrhoids (Fichtl and Admassu, 1994). In Tigray, the flowering period of *L. abyssinica* occurs from September to November, which closely aligns with the main honey flow period in the region (Subhatu, 2017). Beekeepers recognize *L. abyssinica* as a source of light and pure white honey, which is in high demand and commands a premium price in the market (Haftom *et al.*, 2013). Consequently, the plant is regarded as one of the best bee flora in Tigray, according to beekeepers and extension workers (Haftom *et al.*, 2013; Gebreamlak *et al.*, 2020). Notably, *L. abyssinica* is linked to the production of a special white honey in Tigray (Gebreyohans and Gebremariam, 2017).

*B. grandiflorum* (L.), locally referred to as "Tebeb," is one of the prevalent floral species found in the highland and mid-highland regions of Tigray (Gebreamlak *et al.*, 2020). *B. grandiflorum* is characterized as a medium-sized, aromatic woody shrub that belongs to the *Lamiaceae* family (Fichtl and Admassu, 1994) (Fig. 4). This species is recognized as one of the most significant honey bee plants, attracting honey bees that visit to collect both pollen and nectar (Fichtl and Admassu, 1994; Haftom and Tesfay, 2012; Gebreamlak *et al.*, 2020). Beekeepers perceive *B. grandiflorum* as a source of light and pure white honey, which is in high demand and commands a premium price in the market (Haftom *et al.*, 2013). Moreover, *B. grandiflorum* is well-known for its additional values, including fuel wood, edible flowers that can be plucked and consumed fresh, brooms for cleaning threshing grounds, roofing materials for traditional houses, and traditional medicine for treating malaria (Guinad and Dechassa, 2001; Nurya, 2010; Haftom *et al.*, 2013).

#### Geographic and climatic conditions

A significant portion of the Tigray region is situated at high altitudes, frequently exceeding 2,000 m. The cooler temperatures and reduced oxygen levels at these elevations can influence nectar composition and honey production, resulting in distinctive characteristics. *L. abyssinica*, *B. grandiflorum*, and *H. forskoolii* are prevalent floral species in the

**Fig. 2: *Hypoestes forskoolii* honey bee forage****Fig. 3: *Leucas abyssinica* with its flower**

highland and mid-highland areas of Tigray, which extend to altitudes of up to 2,600 m above sea level (Fichtl and Admassu, 1994). The unique growing conditions and floral resources at these high altitudes can impart specific aroma and flavor characteristics to the honey. The pollen profile found in high-altitude honey may differ from that of honey produced at lower elevations, potentially affecting its nutritional and medicinal properties (Tanțău *et al.*, 2014). Tigray honey is frequently described as possessing a rich, robust flavor with complex notes that mirror the diversity of its nectar sources. The particular combination of local plants and environmental factors contributes to its distinctive taste. Consequently, these conditions may yield honey with a unique taste profile and composition when compared to honey from other regions.

#### Rarity and limited availability

Tigray honey is neither mass-produced nor widely exported, rendering it a relatively rare and exclusive variety. In contrast, many other regional honeys, even those of premium quality, tend to be more readily available in the global market. If the white honey flower could thrive in various locations, Tigray white honey would not be as rare a natural phenomenon. However, due to a limited blooming period,



**Fig. 4: *Becium grandiflorum* honeybee forage**

white honey flowers are exclusively found in specific microclimates within their native Northern Ethiopia, often in the most secluded hills and area enclosures. One of the primary factors contributing to the cost of white honey is the restricted geographical range where the *H. forskaolii*, *B. grandiflorum*, and *L. abyssinica* plants flourish. The unique combination of soil, climate, and environmental factors in this region contributes significantly to the exceptional quality of white honey. The striking blossoms of *H. forskaolii*, *B. grandiflorum*, and *L. abyssinica* attract honey bees in abundance, leading to the production of honey with the distinctive flavor profile characteristic of white honey. *B. grandiflorum* flowers for only 15–17 weeks each year and is susceptible to weather events, resulting in a limited and relatively small supply. On average, this plant can produce 267 head flowers and 35 flowers per head (Haftom and Kebebew, 2013). *H. forskaolii* has a flowering period of 65 weeks and produces approximately 2,029 flowers per plant (Haftom and Yaynished, 2012). This rarity further enhances the perceived prestige and value of Tigray honey.

#### The experience of beekeepers

The real-world experience accumulated over years of beekeeping constitutes an invaluable asset that enables skilled producers to extract the finest flavors and aromas from their honey. This expertise is a fundamental aspect of what makes exceptional honey distinctly unique and highly sought after. Beekeeping represents a significant agricultural activity in Tigray, Ethiopia, contributing to both livelihoods and food security (Ngussie and Hailu, 2023). Beekeepers in the region implement various management practices, including colony selection based on criteria such as worker bee population and body color (Tilahun *et al.*, 2016). Honey production in the region adheres to seasonal patterns, with peak harvests occurring in September and October (Gebreyohans and Gebremariam, 2017; Godfey *et al.*, 2018).

In Tigray, beekeepers frequently employ traditional, low-intervention techniques, including the use of woven grass hives. The experience of beekeepers significantly influences the overall quality of the honey produced. Experienced beekeepers possess the knowledge to strategically position hives to optimize access to the best nectar sources, taking into account factors such as sun exposure, wind direction, and proximity to ideal floral zones. They are adept at determining the precise timing for honey harvests to capture peak nectar flows, thereby ensuring optimal moisture content and preventing both under-ripened and over-dried honey. The methods employed to extract, filter, and package the honey demand meticulous care and technique to preserve its delicate flavors and aromas. Skilled beekeepers have refined these handling processes to perfection.

#### Perceived health benefits

Honey production in Tigray, Ethiopia, represents a significant agricultural activity that provides substantial economic and health benefits. Beekeeping contributes to poverty alleviation and generates

employment opportunities for over 58,000 beekeepers in the region (Ngussie and Hailu, 2023). Tigray honey adheres to most international quality standards (Gebremedhin *et al.*, 2013). Notably, honey sourced from this region exhibits considerable antibacterial activity against multidrug-resistant bacteria (Wasihun and Kasa, 2016). These findings underscore the importance of honey production in Tigray in relation to potential health benefits.

Furthermore, Tigray honey is sometimes perceived to offer additional health advantages, potentially attributable to the pristine environment and traditional production methods employed. However, further scientific research is essential to comprehensively validate any unique medicinal properties. Among the various types of honey in Ethiopia, Tigray honey is particularly renowned for its distinctive color and flavor. Its pure white hue and low moisture content have garnered significant recognition; some individuals even believe that this honey possesses medicinal properties (Tigistu, 2020). Although such claims regarding the healing capabilities of Tigray honey have yet to be scientifically substantiated, they remain deeply rooted in the local populace's beliefs and are widely accepted as fact (Agonafir, 2005; Tigistu, 2020). In addition, Tigray honey demonstrates antioxidant and antimicrobial properties (Lewoyehu and Meareg, 2019).

#### Cultural significance

Honey production in Ethiopia, particularly within the Tigray region, possesses substantial cultural and economic significance. Beekeeping, a time-honored agricultural practice, plays a vital role in poverty alleviation and food security (Wolde, 2016; Ngussie and Hailu, 2023). Tigray honey, derived from both traditional and modern hives, generally conforms to international quality standards (Gebremedhin *et al.*, 2013). The honey serves multiple purposes, including its use in cultural ceremonies, traditional medicine, and as a source of income (Wolde, 2016). In the Tigray region, honey holds considerable cultural importance, frequently utilized in traditional dishes and ceremonies. Moreover, Tigray honey is commonly incorporated into religious ceremonies, traditional medicinal practices, and various culinary applications. The expertise involved in the production and harvesting of this honey further enhances its esteemed status within the community.

#### CONCLUSION

Tigray white honey is a highly distinctive type of honey produced in Northern Ethiopia. Its health benefits and rich flavor render it one of the most unique and popular varieties of honey in Ethiopia. This golden elixir is sourced from the nectar of the delicate flowers of *B. grandiflorum*, *H. forskaolii*, and *L. abyssinicus*. Marketing prices for honey from the Tigray region tend to be higher than those of honey from other areas within the country. The perceived costliness of Tigray white honey can be attributed to several factors, including the limited geographical distribution of *B. grandiflorum*, *H. forskaolii*, and *L. abyssinicus* flowers, as well as the intensive efforts required by growers to optimize honey production efficiency. In conclusion, the unique floral sources, rarity, high-altitude origins, and cultural significance collectively contribute to the distinctiveness of Tigray honey compared to many other regional honey varieties.

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