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Honeybee Flora Resources of Guji Zone, Ethiopia

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Abstract
Adequate knowledge about honeybee flora is important for beekeeping. This study was undertaken to identify and document honeybee plants in Guji Zone using melissopalynological analysis of honey samples, semi-structured questionnaires and field observation. Nineteen honey samples were collected from different parts of the zone. Out of 19 samples, 15 were identified as monofloral honeys and 4 as multifloral honeys. This indicated that there is high diversity of honeybee plant species in 4 honey samples that give flowers in the same season contributing for production of multifloral honey and 15 samples were dominated by few major honeybee plants due to their abundance in addition to their quality for honey production. Twenty nine (29) plants species were identified as honey source plants based on melissopalynological analysis of honey. Of 29 species, *Eucalyptus globulus* (90.9%), *Schefflera abyssinica* (73.6% - 80.6%), *Guizotia scabra* (79%), *Syzygium guineense* (*65% - 77.8%), Terminalia brownii (77.2%), Ilex mitis (61.9%)* and *Hypoestes forskaolii (57.6%)* provided mono-floral honey. The flowering calendar of the zone indicated two major honey flow periods from April to June and October to November. The scarcity of honeybee forages were observed in July to mid of August and mid of February to mid of March. In many districts of the zone, herbaceous honeybee forage species were the dominant honey source plants in September to November. While, in March to May majority of honey source plants were trees and shrubs due to the phenological patterns of plants. To apply seasonal honeybee colony management, beekeepers should manage honeybee colonies following phenological pattern of honeybee plants. Preparation of pollen reference material is also recommended to identify the unknown bee plants species in honey pollen analysis.
Keywords: Honeybee plants, Melissopalynology, Honey, Mono-floral honey

Introduction

Honeybee plants are those plant species that provide bees with food sources in the form of nectar and pollen or both (Fichtl & Admassu, 1994; Admassu *et al*., 2014). Not all bee plants are equally important to bees and honey production (Nuru *et al*., 2017). Only about 16% of the world's flowering plant species contribute to honeybees as food sources (Crane, 1990). Some supply both nectar and pollen abundantly and others provide nectar or pollen only (Shubharani *et al*., 2012). Flowering plants and their flowering duration differ from one place to other due to variation in topography, climate and other cultural and farming practices (Alemtsehay, 2011). The extensive knowledge on type, density and quality of bee flora resources enable beekeepers to utilize the resources at the maximum level, so that, they can harvest a good yield of honey and other honeybee products in addition to effective pollination which enhances crop yields (Admassu *et al.,* 2014).

Ethiopia is endowed with natural and cultivated flora and diverse agro-ecological and climatic condition that are well-suited for beekeeping (Fichtl & Admassu, 1994; Admassu *et al.,* 2014). Guji Zone is one of the zones of Oromia Regional State in Federal Republic of Ethiopia that has great diversity of flowering plants species comprises forest trees, bushes, grasses and cultivated flowering plants that are potentially useful for beekeeping. In order to boost the production from this huge resource of the bee flora of zone, identification and documentation of economic bee forages and their flowering calendar is critical for increasing the honey production (Fitch & Admassu, 1994; Alemtsehay, 2011; Admassu et al., 2014).

Hence, identifying the availability of major honeybee forage species and their flowering calendar in different agroecological zone of the area is a very to know the frequency of honey harvest and to predict the honey flow period of an area to be applied in various beekeeping operation (Alemtsehay, 2011; Assemu *et al*., 2013). The nectar source plants can be identified from honey pollen analysis in addition to direct observation and surveying. Honey pollen analysis is used to identify botanical and geographical origin of honey during microscopic analysis (Sibel & Mustafa, 2007). Pollen grains of each plant species have its own genetic code of inheritance and special structural patterns, which enable us to differentiate pollen grains of one species from another (Chauhan and Trivedi, 2011). More valuable information about the characterization of honeys can be obtained from melissopalynological studies and the characterization of unifloral honeys is essential for both scientific and commercial interest (Sik et al., 2017). Blossom honey is considered to be from one source if the pollen frequency of that plant is more than 45% (Louveaux et al., 1978).

In Guji Zone, there is a useful tradition among the farmers in conserving and sharing of the natural resources on communal bases which creates a good opportunity for honeybees and beekeeping. As a result, government organizations and NGOs are undertaking beekeeping developments in the area as part of the household strategy in poverty reduction. However, honeybee forage resources in the area is not yet identified to

lay base for identifying high performing honeybee forages that could have helped in beekeeping development. Therefore, this study was mainly focused on identification and documentation of major and minor honeybee plants and to prepare honeybee flora calendar for the zone.

Materials and Methods

The study was conducted in Guji Zone in Oromia Regional State, Ethiopia. The study sites were selected based on the potentiality of the area for beekeeping. Bore, Adola, Oddo Shekkiso, Wadera, Goro Dola, Uraga and Anna sorra districts were selected for honey samples and other data collection. After selection of the study sites, 63 informants were selected randomly for general informants depending on the information obtained from agricultural offices of the sub-districts, and purposively for key informants depending on their knowledge of beekeeping (Albuquerque *et al*., 2014).

Secondary data were collected from Livestock and Fishery Development Office of the districts. Semi-structured interview, direct field observations and focused group discussion was conducted as described in standard ethnobotanical manuals by Martin (1995) and Alexiades (1996) to collect both botanical and ethnobotanical data.

Nineteen (19) honey samples were collected during honey flow seasons from farmer's gate of the beekeepers. Each sample weighing a minimum of 500gm was purchased.

The honey samples were first strained using double sieves and cheese cloth in Holeta Bee Research Center (HBRC) laboratory to separate the pure honey from the wax with moderate warming when necessary before passing to any kind of laboratory investigation. The samples were then stored at 4^{o}C before under taking any analysis.

The pollen spectrum was obtained based on the Louveaux *et al*. (1978). The prepared pollen slides were observed and compared with the reference material for identification using light microscope. Counts were expressed as percentages after counting 1200 pollen grains. Then, honey samples with frequency classes of pollen grains attributed as predominant pollen (P>45%) were considered as a mono-floral honey (Louveaux *et al*., 1978). Finally, descriptive statistics were used to analysis both survey and laboratory data.

Results

Seasonal availability of honeybee plants

On the basis of the response of the informants, secondary data collection, focus group discussion and field observation at total of 51 plant species belonging to 28 families were identified as honeybee source plants in the zone. Forty three percent of these honeybee forage plants are flowered in September to November while 33% flowered in March to May. Out of 51 species, 64.7% are trees, 25.5% are shrubs and 9.8 % herbs including cultivated crops (Table 1). Among the plant species *Croton macrostachyus and Vernonia* species are widely distribute honeybee plants in Guji Zone.

Table 1: Important honeybee source plant species, habits and flowering periods in Guji Zone based on survey and field observation

Scientific name	Family name	Local name(A/Oromo)	Life form	flowering season
Acacia brevispica	*Fabaceae*	HAMARESSA	tree	March - May
Acacia senegal	*Fabaceae*	SAPHANSA	tree	March - May
Acacia tortolis	*Fabaceae*	TADDACHA	tree	January -May
Allophyllus abyssinicus	*Sapindaceae*	SAREJJI/MALKAKO/HIRKUMA	tree	May-November
Carica papaya	*Caricaceae*	PAPAYA	tree	September - November
Catha edulis	*Celastraceae*	CHAT	shrub	After rainy season
Coffea arabica	*Rubiaceae*	BUNA	shrub	After rainy season
Combretum molle	*Combretaceae*	BIKKA/DIDESSA	tree	January-April
Cordia africana	*Boraginaceae*	WADDESSA	tree	September - December
Croton macrostachyus	*Euphorbiaceae*	BAKKANNISA	tree	April - July
Dichrostachys cinera	*Fabaceae*	HATE/ADDESSA/GIRMI	shrub	February - May
Dombeya torrida	*Sterculiaceae*	DANNISA	tree	September - November
Erythrina brucei	*Fabaceae*	WALENSU	tree	November-February
Eucalyptus camaldulensis	*Myrtaceae*	BARZAFI DIMA	tree	After rainy season
Eucalyptus citrodora	*Myrtaceae*	BARZAFI SHITTO	tree	March - May

Eucalyptus globulus	*Myrtaceae*	BARZAFI ADI	tree	March-May
Euphorbia abyssinica	*Euphorbiaceae*	ADAMI/TULU	shrub	October-January
Ficus sycomorus	*Moraceae*	LOHO/ODA	tree	December - February
Grewia bicolor	*Tiliaceae*	HARORESSA	tree	September - November
Guizotia scabra	*Asteraceae*	TUFO	herb	September - December
Hagenia abyssinica	*Rosaceae*	HETO	tree	September - December
Hypoestes forskaolii	*Acanthaceae*	DERGU	herb	After rainy season
Ilex mitis	*Aquifoliaceae*	HANGADHI/TILTO	tree	September - November
Lonchocarpus laxiflorus	*Fabaceae*	KALKALCHA/AMARO	tree	January-March
Maesa lanceolata	*Myrsinaceae*	ABAYYI/GESHI	shrub	September - November
Maytenus obscura	*Celastraceae*	KOMBOLCHA	tree	October - December
Milletia ferruginea	*Fabaceae*	SARITI	tree	November-February
Nuxia congesta	*Buddlejaceae*	IRBAN	tree	October-January
Ocimum basilicum	*Lamiaceae*	URGO/KAJIMA/KEKEWWE	herb	After rainy season
Ocimum sauve	*Lamiaceae*	WANCABBI	shrub	March-April
Olea europea	*Oleaceae*	EJERSA	tree	April-June
Pavonia urens	*Malvaceae*	INCHINNI	shrub	December - February
Persea america	*Lauraceae*	AVOCADO	tree	November - January
Phytolacca dodecandra	*Phytolaccaceae*	ANDODE	Climber	October-March
Pouteria adolfi-friedericii	*Sapotaceae*	KERERO	tree	December - February
Polyscia fulva	*Araliaceae*	GUDUBA/HUDHA	tree	December - February
Prunus africana	*Rosaceae*	SUKKE/HOMI/MIESSA	tree	October - March
Psdium guajava	*Myrtaceae*	ZEYITUNA	tree	After rainy season
Psydrax schimperiana	*Rubiaceae*	GALLO	shrub	April - May
Pterolobium stellatum	*Fabaceae*	HARANGAMA	shrub	After rainy season
Rhus natalensis	*Anacardiaceae*	DABOBESSA	tree	March - May
Schefflera abyssinica	*Araliaceae*	GATAMA	tree	March - May
Syzygium guineense	*Myrtaceae*	BADESSA/GOSU	tree	February - April
Terminalia brownii	*Combretaceae*	BIRDHESA	tree	October-December
Terminalia laxiflora	*Combretaceae*	RUKKENSA/DEBEKA	tree	October-December
Trichilia emetica	*Meliaceae*	ANANNO	shrub	September - November
Vernonia amygdalina	*Asteraceae*	EBICHA	shrub	December - February
Vernonia auriculifera	*Asteraceae*	REJI	shrub	November-February
Zea mays	*Poaceae*	BOKOLLO	herb/crop	March - May & Sep-Nov
Ziziphus mucronata	*Rhamnaceae*	ADO-KURKURA	tree	September - November

Melissopalynological Analysis

On the basis of the honey pollen analysis 29 plant species were identified as honey source plants. The most

predominant pollen types **(> 45%)** were recorded for *Schefflera abyssinica, Syzygium guineense, Terminalia brownii, Guizotia scabra, Eucalyptus globulus, Hypoestes forskaolii and Ilex mitis* (Table 2). The secondary pollen source plants **(16-45%)** recorded were *Vernonia spp , Biden spp, Brassica spp, Ocimum spp, Coffea arabica*, *Dombeya torrida and Croton macrostachyus* and finally the minor important pollen source plant species **(3-16%)** were *Aloe debrana, Rhus glutinosa, Zea mays, Echinopes spp and Clematics simensis* and the rest of the species were rare **(<3%)** (Table 2). The diversity of secondary and important minor honey source plant species were higher than predominant species.

Table 2: Predominant, Secondary, important minor and minor honey source plants in districts of Guji Zone based honey pollen analysis category

District	Predominant pollen source (> 45%)	*Secondary pollen source (16-45%)*	Important minor pollen source (3-15%)	Minor pollen source (< 3%)
Wadera	*Hypoestes forskaolii*	*Hypoestes forskaolii* *Ocimum urticifolium*	*Terminalia brownii* unknown pollen *Ocimum basilicum* *Zea mays*	*Guizotia scarba* *Acacia lahai* *Satureja paradoxa* *Plectranthus assurgens* *Aloe debrana*
Goro Dola	*Terminalia brownii*	*Vernonia amygdalina* *Hypoestes forskaolii* *Terminalia shimperana*	*Pterolobium stellatum* *Acacia lahai* *Aloe debrana*	*Guizotia scarba* *Hypoestes forskaolii*
Oddo Shekkiso	*Eucalyptus globulus* *Syzygium guineense*	*Vernonia amygdalina* *Bidens pilosa* *Trifolium spp* *Vernonia auriculifera*	*Eucalyptus camaldulensis* *Schefflera abyssinica* *Echinops longisetus* *Acacia lahai* *Acacia abyssinica* *Croton macrostachyus*	*Hypoestes forskaolii* unknown pollen *Rhus glutinosa* *Coffea arabica*
A/sorra	*Syzygium guineense*	*Eucalyptus camaldulensis* *Eucalyptus globulus* unknown pollen *Vernonia auriculifera*	*Clematis simensis* *Vernonia amygdalina* *Trifolium spp* unknown pollen	unknown pollen
Uraga	*Schefflera abyssinica*	*Trifolium spp* unknown pollen	*Coriandrum sativum* unknown pollen	unknown pollen unknown pollen
Adola Redde	*Guizotia scarba* *Syzygium guineense*	*Brasslca carinata* *Eucalyptus globulus* *Eucalyptus camaldulensis* *Coffea arabica* unknown pollen	unknown pollen *Vernonia auriculifera*	unknown pollen *Vernonia amygdalina*
Bore	*Schefflera abyssinica* *Ilex mitis*	*Eucalyptus globulus* unknown pollen	*Trifolium spp* unknown pollen *Dombeya torrida*	unknown pollen

The identified 29 honeybee plant species from honey pollen analysis represent 17 families. The families with the highest number of species (from highest to lowest) were Asteraceae with five (17.2%) species; Lamiaceae with four (13.8%); Myrtaceae and Fabaceae each with three (10.4%) species; Combretaceae with two (6.9%) species and the others with one species. From these 29 species 38%, 38 % and 24% were herbs, trees and shrubs respectively (Table 3). This result indicated that weeds and some cultivated crops have also great contribution for honey production.

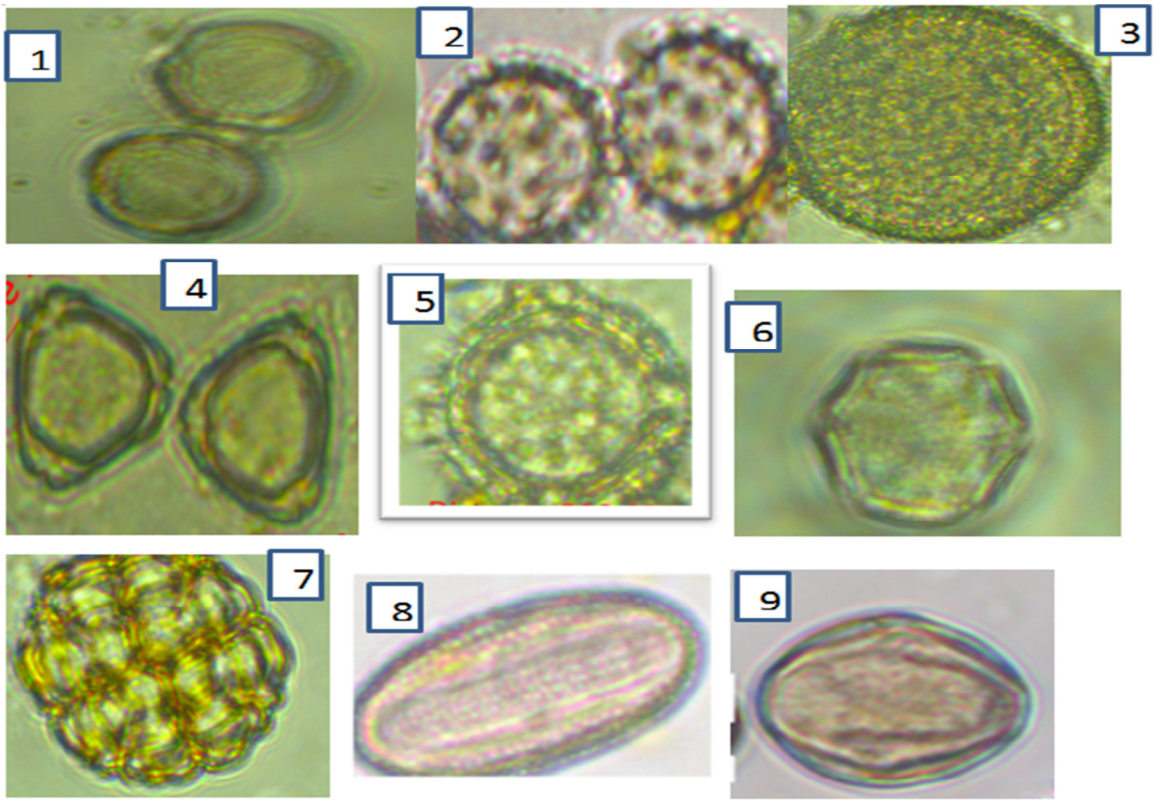
Table 3: List of honeybee plants identified from Honey Pollen Analysis in Guji Zone

Scientific name of plant	Family name of the plant	Vernacular name	Life form
Acacia lahai	*Fabaceae*	BURKUKKE/DEROT/GERBI	tree
Aloe debrana	*Aloaceae*	HARGISA	herb
Bidens pilosa	*Asteraceae*	KELLO	herb
Brasslca carinata	*Brassicaceae*	RAFU	herb
Clematis simensis	*Ranunculaceae*	EDAFITI	Liana shrub
Coffea arabica	*Rubiaceae*	BUNA	shrub
Coriandrum sativum	*Apiaceae*	DEMBO/DEMBILALA	herb
Croton macrostachys	*Euphorbiaceae*	BAKANNISA	tree
Dombeya torrida	*Sterculiaceae*	DANNISA	tree
Echinops longisetus	*Asteraceae*	KOSHOSHILLA/KORE ADI	shrub
Eucalyptus camaldulensis	*Myrtaceae*	BARGAMO DIMA	tree
Eucalyptus globulus	*Myrtaceae*	BARGAMO ADI	tree
Guizotia scabra	*Asteraceae*	TUFO/HADA	herb
Hypoestes forskaolii	*Acanthaceae*	DERGU	herb
Ilex mitis	*Aquifoliaceae*	HANGADI	tree
Ocimum basilicum	*Lamiaceae*	URGO/KAJIMA/BASOBILA	herb
Ocimum urticifolium	*Lamiaceae*	DAMAKASE	shrub
Plectranthus assurgens	*Lamiaceae*	AJOFTU	herb
Pterolobium stellatum	*Fabaceae*	HARANGAMA	shrub
Rhus glutinosa	*Anacardiaceae*	TATESSA	tree
Satureja paradoxa	*Lamiaceae*	TENEDDAM	herb
Schefflera abyssinica	*Araliaceae*	GETAMA	tree
Syzygium guineense	*Myrtaceae*	BADESSA	tree
Terminalia brownii	*Combretaceae*	BIRDESSA	tree
Terminalia shimperana	*Combretaceae*	DABAKA	tree
Trifolium spp	*Fabaceae*	SIDISA	herb
Vernonia amygdalina	*Asteraceae*	EBICHA	shrub
Vernonia auriculifera	*Asteraceae*	REJI	shrub
Zea mays	*Poaceae*	BOKOLLO	herb

From the above identified honeybee plants based on the honey pollen analysis revealed that the honey samples belonged to 15 mono-floral honeys originating from 7 plant types that are produced in different parts of the zones. Mono-floral honey of *Syzygium guineens* produced in Oddo Shekkiso, Annasorra and Adola Redde districts from March to April. Monofloral honeys of *Schefflera abyssinica* was also produced in Bore and Uraga districts (Table 4). Due to their wide distribution, *Schefflera abyssinica, Syzygium guineens, Ilex mitis and Eucalyptus globulus* were appeared as predominant honey source plants during April to May. On the other hand, *Terminalia brownii, Guizotia scabra and Hypoestes forskaolii are* predominant plant species in mid and lowlands of the zone.

Table 4: Monofloral Honey collected from districts of Guji Zone with its botanical origin and honey harvesting season

No. of sample	District	Plant species	Pollen frequency (%)	Harvesting season
01	Adola Redde	*Guizotia scarba*	79	October to November
02	Adola Redde	*Syzygium guineens*	65	April to May
03	Adola Redde	*Guizotia scarba*	50	October to November
04	Anna sorra	*Syzygium guineens*	67.6	March to April
05	Anna sorra	*Syzygium guineens*	69.2	March to April
06	Bore	*Schefflera abyssinica*	73.6	April to May
07	Bore	*Ilex mitis*	61.9	October to November
08	Goro Dola	*Terminalia brownii*	64.8	October to November
09	Goro Dola	*Terminalia brownii*	77.2	October to November
10	Oddo Shekkiso	*Syzygium guineens*	77.8	March to April
11	Oddo Shekkiso	*Eucalyptus globulus*	90.9	April to May
12	Uraga	*Schefflera abyssinica*	80.6	April to May
13	Uraga	*Schefflera abyssinica*	76.92	April to May
14	Uraga	*Schefflera abyssinica*	100	April to May
15	Wadera	*Hypoestes forskaolii*	57.6	October to November



1. *Schefflera abyssinica*
2. *Guizotia scabra*
3. *Croton macrostachysyus*
4. *Eucalyptus globulus*
5. *Vernonia amygdalina*
6. *Satureja paradoxa*
7. *Acacia abyssinica*
8. *Hypoestes forskaolii*
9. *Coffea arabica*

Figure 1: The pollen grains of some species identified from honey pollen analysis

Majority (53.6%) of major honey source plants identified from honey pollen analysis are flowered from September to November followed by March to May (28.6%) and finally 17.8% flowered in March to May (Table 5). As a result these two seasons are considered as major honey harvesting season in Guji Zone. The high scarcity of honeybee forage was observed in July to mid of August and mid of February to mid of March.

Table 5: Flowering seasons of major honeybee plants in Guji Zone

Scientific name of plant	Jan	Feb	Mar	Ap	M	Jun	Ju	Aug	S	Oc	Nov	Dec
Acacia lahai												
Aloe debrana												
Bidens pilosa												
Brasslca carinata												
Clematis simensis												
Coriandrum sativum												
Croton macrostachyus												
Dombeya torrida												
Echinops longisetus												
Eucalyptus camaldulensis												
Eucalyptus globulus												
Guizotia scabra												
Hypoestes forskaolii												
Ilex mitis												
Ocimum basilicum												
Ocimum urticifolium												
Plectranthus assurgens												
Pterolobium stellatum												
Rhus glutinosa												
Satureja paradoxa												
Schefflera abyssinica												
Syzygium guineense												
Terminalia brownii												
Terminalia shimperana												
Trifolium species												
Vernonia amygdalina												
Vernonia auriculifera												
Zea mays												

Discussion

Seasonal availability of honeybee plants

Knowledge of honeybee plants, proper understanding of mutualism between honeybees and available plant species is very important to improve the productivity of beekeeping. In Guji Zone experienced beekeepers also familiar with honeybee plants that give good honey, when they bloom and for how long they remain in blooming. Furthermore, Nicola (2009) reported that some beekeepers are always paying attention to monitor the herbaceous plants, shrubs and trees that are especially important for honeybees (Niguse & Haftom, 2015).

Variation in seasonal availability of honeybee forage species was observed in the zone and many of them are flowered from September to November and March to May. In many districts of the zone, herbaceous honeybee forage species were the dominant honey source plants in September to November due to disturbances and expansion of agricultural crops. Some of those herbaceous honeybee forage plants include *Guizotia* species, *Bidens* species, *Trifolium* species and *Hypoestes* species which grow in farmland and edge of the forest. However, in March to May majority of honey source plants were trees and shrubs in comparison to herbaceous. For example: The tree species such as *Schefflera abyssinica, Syzygium guineense, Croton macrostachyus and Eucalyptus spp* are flowered in this season. Admasu et al. (2014) also stated that *Schefflera abyssinica, Syzygium guineense and Croton macrostachyus* are the most important honey producing trees and flowered from April to May. The high scarcity of honeybee forage was observed in July to mid of August and mid of February to mid of March.

When honeybee plant identification is conducted as major and minor honeybee plants in honey pollen analysis, the main problem was that a given honeybee plant is major in one district and minor in the other districts. This is due to variation in the abundance of the species. For example in Wadera District *Guizotia*

scabra was not widely distributed and considered as the minor honeybee plants (1.2% in honey sample pollen analysis) and 79% in Adola Redde District which is major honeybee plants. This indicated that the abundance of a given honeybee plant species has great impact on honey production potential and mislead to consider the plant as best honeybee forage plant.

Some beekeepers cited that the apiary site is nearby the forest area where the diversity of bee forage species are high and the strength of honeybee colony is good throughout the year, but honey obtained from the area is very low. This is due to only a few bee forage plants flowered at the same time and many of them flowered in different time of the year with less abundant bee forage plants. Hence, the resource is used for honeybee colony maintenance rather than honey production. In such areas, particularly estimation of honeybee colony carrying capacity is very important to use the resource effectively in each honey harvesting season. Because adjusting a number of honeybee colonies with available resource is used to increase the productivities of honeybee colonies by overcoming the problem of colony overstocking (Nuru et al., 2017). Niguse & Haftom (2015) also reported that a good beekeeping area is the one in which honeybee plants grow abundantly and with a relatively long blooming season. Hence, beekeepers should select appropriate site that have enough supply of honeybee forage plants within the flight range of honeybees for honey production (Crane, 1990). In addition to this estimation of honeybee colony carrying capacity of a given site is very important within a radius of 3 km around the apiary, which can forage the honeybees within one flight (Jacobs et al*.,* 2006).

Monofloral honey based on Melissopalynological Analysis

Based on the number of pollen source plant species and the share of each species in the total pollen count, 15 out of 19 analyzed samples were identified as monofloral honeys and 4 samples were identified as multifloral honeys. This indicated that there is high diversity of honeybee plant species in 4 honey samples that give flowers in the same season contributing for production of multifloral honey. Whereas 15 honey samples are dominated by few major honeybee plants and this is due to their abundance in addition to their quality for honey production. Microscopic analysis revealed that plant species variability is greatest in the minor pollen group (less than 3%), followed by the important minor pollen, secondary, and dominant groups. Sabo et al. (2011) also reported that variability is always small among pollen species in the dominant groups, while greater among minor pollen (less than 3%), important minor pollen, and secondary pollen groups. Honeybees provide a good resource for palynological studies by revealing the flowering activities of plants within the foraging radius and giving direct evidence of the in-situ vegetation. Analysis of the pollen content of honey is used to investigate the provenance and provide a quantitative measure of floral origin (pollen percentage) for use in market (Louveaux *et al*., 1978). It is very effective to determine and control the geographical origin of honeys and it also provides information about other important quality aspects (Werner et al., 2004).

Seven dominant plant species are identified based on honey pollen analysis. These are *Schefflera abyssinica*, *Syzygium guineense, Ilex mitis, Terminalia brownii, Hypoestes forskaolii, Guizotia scabra and Eucalyptus globulus.* The dominancy of these plant species in honey samples due to their abundance and nectar and pollen potentiality. Honey pollen analysis indicated that hundred percent dominated honey sample by *S. abyssinica* was produced in Uraga Distircts of Guji Zone. Gemechis (2013) also reported that the melissopalynological analysis of some honey samples showed that the pollen frequency was counted up to 100% of this plant.

Syzygium guineense provided mono floral honey in Oddo Shekkiso, Anna sorra and Adola Redde districts. Gemechis (2013) also reported that monofloral honey produced in Kefa, Sheka, Illu-Abbabor, Jimma, East and West Wollega Zones. *Ilex mitis and Terminalia brownii* is also a major honey source plants that provide monofloral honey in Bore and Goro Dola districts of Guji Zone respectively according to honey pollen analysis.

Eucalyptus globulus is major honey source plants that provided monofloral honey in Oddo Shekkiso District of Guji Zone. Gemechis (2013) also mentioned that *Eucalyptus* mono-honey comes mainly from *E. globulus* though there are other important species like *E. camaldulensis* and *E. citrodora* that serve as sources of honey. *Hypoestes forskaolii* is also produced monofloral honey in Wadera District. Honey from this plant fetched higher price both in local and international markets because of its attractive colour and being light to eat (Ensermu, 2006). *Guizotia scabra* is major honey source plants in Adola Redde District of Guji Zone that provide mono floral honey. Gemechis (2013) also reported that *Guizotia mono* honey mostly comes from *G. scabra* and along with this plant *G. abyssinica* and other weeds which flower in the same period and partly contribute to this honey (Admassu et al., 2014).

Conclusion

In conclusion, based on honey samples pollen analysis 29 plant species were identified as honey source plants. The percentage occurrence of the pollen grains in honey samples indicated that about 50% of the plants identified by the beekeepers and during the field observation were appeared in honey samples indicating beekeepers knows bee forage plants and honeybees are efficiently utilizing local floral resource for production of honey. The mono-floral honeys were produced from *Schefflera abyssinica*, *Eucalyptus globulus*, *Guizotia scabra*,

Syzygium guineens, Terminalia brownii, Ilex mitis and *Hypoestes forskaolii.*

In many districts of the zone, herbaceous honeybee forage plant species are the dominant honey source plants from September to November. However, in March to May majority of honey source plants are trees and shrubs species. The high scarcity of honeybee forage was observed in July to mid of August and mid of February to mid of March. Therefore, beekeepers should manage their honeybee colonies following phenological pattern of honeybee plants. Preparation of pollen reference material is also recommended to identify the unknown bee plants species in honey pollen analysis.

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References

Admassu, A., Kibebew, W., Amssalu, B., & Ensermu, K. (2014). Honeybee forages of Ethiopia. Addis Ababa: United Printers.

Albuquerque, U., Cunha, L., Lucena, R., & Alves, R. (2014). *Methods and Techniques in Ethnobiology and ethnoecology*. London: Springer New York Heidelberg Dordrecht.

Alemtsehay, T. (2011). Seasonal availability of common bee flora in relation to land use and colony performance in Gergera watershed atsbi wembwrta district, eastern zone of Tigray, Ethiopia. MSc. Thesis, Debub University Wondo Genet College of Forestry Awassa, Ethiopia.

Alexiades, M., (1996). Collecting ethnobotanical data: An introduction to basic concepts and techniques. **In:** Alexiades, M., & Sheldon, J. (Eds). (pp. 53-80). Selected guidelines for ethnobotanical research; a field manual. New York: Botanical Garden.

Assemu, T., Kerealem, E., & Adebabay, K. (2013). Assessment of current beekeeping management practice and honeybee floras of Western Amhara, Ethiopia. *Inter J Agri Bio Sci,* 2(5), 196-201.

Chauhan, M.S and Trivedi, A. (2011). Pollen Analysis of honey from Lucknow District, Uttar Pradesh. J. Appl. Biosci., 37(1): 48-51.

Crane, E. (1990). Bees and beekeeping: science, practice and world resources. London: Heinnmann Newness.

Ensermu, K. (2006). Acanthaceae. In: Hedberg, I., Ensermu, K., Edwards, S., Sebsebe, D., & Persson, E. (Eds.). (pp. 345-495). Flora of Ethiopia and Eritrea, 5th edition. Gentianaceae to Cyclocheilaceae. The National Herbarium, Addis Ababa University, Addis Ababa and Uppsala Sweden.

Fichtl, R. & Admasu, A. (1994). Honey bee flora of Ethiopia .The National Herbarium, Addis Ababa University and Deutscher Entwicklungsdieenst, Mergaf Verlag, Germany.

Gemechis, L. (2013). Identification and characterization of major mono-floral honeys in Ethiopia. In Proceedings of the 20th Annual Conference of the Ethiopian Society of Animal Production (p. 274). Addis Ababa, Ethiopia.

Jacobs, F., Simoens, C., Graaf, D., & Deckers, J. (2006). Scope for non-wood forest products income generation from rehabilitation areas: focus on beekeeping. *Journal of the Dry lands,* 1(2), 171-185.

Louveaux, J., Maurizio, A., & Vorwohl, G. (1978). Methods of Melissopalynology. *Bee world,* 59, 139–157.

Martin G. J. (1995) Ethnobotany. A methods manual. Champan and Hall, Royal Botanical Gardens, Kew, London, UK. 268 pp.

Niguse, G., & Haftom, G. (2015). Assessment of Honey Bee Flora in Eastern Zone of Tigray, North Ethiopia. Journal of Biology, Agriculture and Healthcare, 5(1), 53-57.

Nicola, B. (2009). Bees and their role in forest livelihoods. A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products. No-wood Forest Products.

Nuru, A., Ahmed, A., Yilma, T., Awraris, G., Awad, M., Mohammad, J., Ayman, A., Seif Eldin, A., & Abdulaziz, S. (2017). Nectar secretion dynamics and honey production potentials of some major honey plants in Saudi Arabia. Saudi Journal of Biological Sciences, 24, 180-191.

Sabo, M., Potocnjak, M., Banjari, I., & Petrović, D. (2011). Pollen analysis of honeys from Varaždin County, Croatia. *Turk J Bot*, 35, 581-587.

Shubharani, R., Sivaram, V., & Roopa, P. (2012). Assessment of honey plants resources through pollen analysis in Coog honeys of Karnataka State. *The International Journal of Plant Reproductive Biology,* 4, 31-39.

Sibel Silici & Mustafa Gökceoglu (2007). Pollen analysis of honeys from Mediterranean region of Anatolia. Grana, 46:1, 57-64.

Şik L, Güvensen A, Durmuşkahya C, Erol O (2017). Pollen analysis of honeys from Ardahan/Turkey. Biological Diversity and Conservation 10(2): 12-19.

Werner, V., Livia, P., Maria, L., Monique, M., & Peter, M. (2004). Harmonized methods of melissopalynology. Apidologie, 35, 18–25.