Bioprospecting Potential of Stingless Bees *Trigona species*

for Access and Benefit Sharing

Image of Stingless bees adopted from Pauly, A. and Zewdu Ararso (2013)

Reviewed by Manaye Misganaw

Genetic Resources Access and Benefit Sharing Directorate

June, 2018

1. Introduction

Ethiopia is one of the top biodiversity-rich countries in the world. The country is endowed with great diversity of plant, animal and microbial genetic resources (EBI, 2014). The variable agro-ecological conditions and availability of diverse floral resources makes the country as one of the very suitable place for the existence of large and unique biodiversity both in plants and animals including honeybee subspecies. As a result, the country is well known for its endemism and as a centre of biodiversity for a number of plant and animal species (Nuru Adgaba, 2002).

There are 10 million honeybee colonies in Ethiopia; of which 7 million are kept in local beehives by farmers and the remaining exist in the forests as wild colonies. This makes Ethiopia have the highest bee density in Africa (Ayalew Kassaye, 2001). However, like other developing countries, lack of technical expertise and monetary resources known as the main challenges faced while using the potential genetic resources of the country. Therefore, the only option for Ethiopia is to collaborate with the developed nations, domestic investors and interested ones in other companies interested to participate in the wise utilization of the potential genetic resources of the country for mutual benefits.

Ethiopia has issued a proclamation on Access to Genetic Resources and Community Knowledge, and Community Rights (Proclamation No 482/2006 and Regulation 169/2009). The Proclamation includes ownership, User rights, conditions for access, benefit sharing, types of benefits, powers and responsibilities between Users and Providers. Based on these frameworks, Ethiopia has been implementing the access and benefit sharing objective of CBD. Therefore, the objective of this information is to motivate and encourage any bioprospecting company or an interested individual to work on the genetic resource, stingless bee (*Trigona spp.*) products for medicinal uses of its products, and its potential in food industries, as flavoring and preservative agent.

2. Description of stingless Bees (*Trigona spp.*)

Stingless bees, sometimes called stingless honeybees, can be classified into 2 genera, namely, the *Melipona* and the *Trigona.* According to Michener (2013), the *Melipona* genus is numerically large, even larger than that of the common honey bee (*Apis mellifera* Linnaeus). They are highly eu-social bees like the honeybees of the genus Apis, live with many individuals in a nest where honey and pollen are stored (Eardley, 2004).

Five hundred stingless bee species are recorded and they are classified into five genera: *Melipona, Trigona*, *Meliponula, Dectylurina* and *Lestrimelitta;* of which, *Trigona* and *Melipona* are the honey producing bees (Gupta, 2014). Stingless Bees (*Trigona spp.*) are classified under Class Insecta and Order Hymenoptera. They belong to the Family Aphidae and the Tribe Meliponini.

3. Distribution of stingless bees (*Trigona spp.*)

Unlike honeybees (*Apis mellifera*), which are mostly domestic, the stingless honeybees are wild and they keep their honey in storage pots built of resinous cerumen in the ground ("*Tazma*" honey) or in the tree trunk ("*Tinign*" honey). *Tazma* and *Tinign* honeybees, the same as the stingless bees, could nest in the ground or tree trunks depending their preferences.

Stingless bees can be found in tropical and sub-tropical areas of the world, such as Australia, Africa, Southeast Asia, south and Central America (Rasmussen and Cameron, 2010). They live usually in nests in hollow trunks, tree branches, underground cavities, or rock crevices. The stingless bees occur throughout the tropical and southern subtropical regions of the world (Michener, 2007). Their nesting places may be holes in the ground, in hollow trees or small cavities in walls, rocks or human-made buildings and on the underside of branches (Souza *et al.*, 2006).

Ethiopia has a great potential for the existence of different species of stingless bees, which are known for the production of stingless bees honey annually. These stingless bees are found and distributed throughout Ethiopia at a medium altitude of up to 2300 m above sea level (Fichtl and Admasu Adi, 1994). In Gedeo zone, two types of stingless bees *Trigona Spp.* are known to nest in ground and hollow trees (Teklu Gebretsadik and Dinku Negash, 2016). Ground nesting comprises 30% of the total population of stingless bee in the area and is known for their better productivity. Teklu Gebretsadik and Dinku Negash (2016) reported that about 20 % of the beekeepers have a chance and tradition of harvesting stingless bee honey every year. According to Awraris Getachew *et al*. (2012), in Kaffa, Sheka and Bench-Maji zones of Ethiopia, around 50% of the beekeepers of the area have a chance of harvesting stingless bee honey every year with an average harvest of 2 litres of honey/per nest. Besides, many Gojjam and Tigray areas are also the main sites of these stingless bees (Pauly and Zewdu Ararso, 2013).

4. Significance of Stingless bee (*Trigona spp.*)

4.1. Medicinal uses of stingless bee honey

Stingless bees produce small quantities of highly prized medicinal honey, and also for the wax and propolis, produced and gathered by the bees and used for its household and curative properties. A traditional medicine branch, called apitherapy, developed in recent years, offers treatments based on honey and the other bee products against many diseases (Bogdanov, 2016). Stingless bees honey is believed to have medicinal value and has higher market demand in India with 20 times costlier than normal honey (Kumar *et al*., 2012). Stingless bee honey has biological and pharmacological activities in the treatment of diabetes, metabolic and neurological disorders, cancer, cardiovascular disease-related complications and hypercholesterolemia and in wound healing (Rao *et al.*, 2016). Besides it cures asthma, arthritis, overcomes hepatitis; treats bladder infection; improves brain function; treats cough, stomach disturbance, sore throats, tonsillitis; can be used in wound dressing and so on. Soad *et al*. (2017) reported that showed effect of stingless bee honey have statistically resulted in significant reduction in the number of episodes of oral mucositis, bacterial and fungal infections.

5. Chemical composition of stingless bee honey

Honey is a natural product produced by both honeybees and stingless bees. Both types of honey contain unique and distinct types of phenolic and flavonoid compounds of variable biological and clinical importance. Honey has been reported to contain up to 200 substances, which are complex mixture of carbohydrates as well as small amounts of other constituents such as minerals, proteins, vitamins, organic acids, flavonoids, phenolic acids, enzymes and other phyto-chemicals. Thus the stingless bee honey as well as the honeybee honey can be considered an important part of traditional medicine (White, 1979). The honeys produced from stingless bees are said to have a range of nutrients and higher nutritional value compared to honeybees.

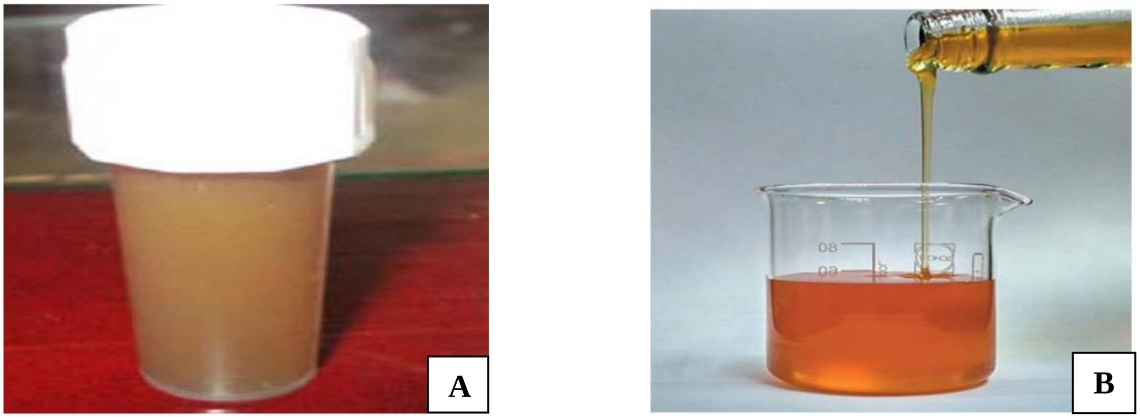

Fig. Images of stingless bee honey (A) and (B) adopted from Pauly, A. and Zewdu Ararso (2013) and Abd Jalil *et al.* (2017), respectively.

Sugars comprise approximately 95–99% of honey's dry matter. Of the sugars in honey, fructose is the most prevalent, comprising approximately 32–38% of its total sugar. In addition to fructose and glucose, several other disaccharides and oligosaccharides, including sucrose, maltose, maltotriose and panose, can be found. Organic acids, minerals and trace elements such as calcium, potassium, sodium, magnesium, phosphorus, sulphur, iron, zinc, copper and manganese are other components present (Rao *et al*., 2016).

In addition, various vitamins, including ascorbic acid (Vitamin C), thiamine (Vitamin B1), pantothenic acid (Vitamin B5), riboflavin (Vitamin B2), nicotinic acid (Vitamin B3), pyridoxine (Vitamin B6), biotin (Vitamin B8), folic acid (Vitamin B9) and cyanocobalamin (Vitamin B12), are present (Ciulu *et al*., 2011). Compared to *Apis mellifera* honey, the most relevant differences with stingless bee honey are higher values of water, free acidity, electrical conductivity, maltose and nitrogen, and lower values of diastase in honey from stingless bee species (Vit *et al*., 1994; Bogdanov *et al*., 1996).

5.1. Physico-chemical properties of stingless bee honey

Physical and chemical properties of stingless bee honey strongly influence the healing capacity of honey (Basualdo *et al.*, 2007). It has been used not only in foods and beverages as a sweetener and flavoring, but also as a medicine since earlier times. The role of this product in the treatment of burns, gastrointestinal disorders, respiratory illnesses, infected and chronic wounds, skin ulcers and cancer has been studied recently by many researchers (Ramalhosa *et al.*, 2011). The physico-chemical property of stingless bees honey has high hygroscopicity, which is a basic characteristic of *Trigona spp.* honey. Moisture is one of the most relevant characteristics of honey, because it influences viscosity, specific weight, maturation, crystallization, taste and conservation of this food (Zamora *et al.*, 2006). Moisture levels within the reference standards enhance the shelf-life of the product, since it provides an unfavorable condition for microbial development (Bertoldi *et al.*, 2007). Moreover, stingless bees honey has antioxidant properties and thus it is important for wound treatment (Abd Jalil *et al.*, 2017).

5.2. Antibacterial Properties of stingless bee honey

Stingless bees (*Trigona sp.*) honeys have higher antimicrobial activity against pathogenic bacteria. Their honeys have low pH which inhibits the presence and growth of microorganisms and mostly increases shelf-life (Berhanu Andualem, 2014). The anti-bacterial activity of stingless bee honey is powerful (Temaru *et al.*, 2007) and it has inhibitory effect against *Escherichia coli* (ShiJing, 2016), and thus it is important for medical treatment. This is highly related to the physico-chemical properties of honey such as: acidity, moisture content, total sugar content, total phenolic content and hydrogen peroxide level. Yalemwork Ewnetu *et al*. (2013) noted the potential of stingless bees honey as therapeutic agents to treat both susceptible and drug resistant bacteria.

References

Abd Jalil, M.A., Kasmuri, A.R. and Hadi, H. (2017). Stingless Bee Honey, the Natural Wound Healer. A Review. *Skin Pharmacology and Physiology* **30**: 66–75.

Awraris Getachew Shenkute, Yemisrach Getachew, Dejen Assefa, Nuru Adgaba, Gebeyehu Ganga and Workneh Abebe (2012). Honey production systems (*Apis mellifera* L.) in Kaffa, Sheka and Bench-Maji Zones of Ethiopia. *Journal of Agricultural Extension and Rural Development* **4**: 528-541

Ayalew Kassaye (2001). Promotion of beekeeping in the Rural Sector of Ethiopia. In: **Proceeding of the 3rd Ethiopian Beekeepers Association (EBA**), pp.52-58, September 3-4, 2001, Addis Ababa, Ethiopia.

Basualdo, C., Sgroy, V., Finola, M.S. and Marioli, J.M. (2007). Comparison of the antibacterial activity of honey from different provenance against bacteria usually isolated from skin wounds. *Veterinary Microbiology* **124**: 375–381.

Berhanu Andualem (2014). Physico-chemical, microbiological and antibacterial properties of *Apis mellipodae* and *Trigona* spp. honey against bacterial pathogens. *World Journal of Agricultural Sciences* **10**: 112-120.

Bertoldi, F.C., Reis, V.D.A., Gonzaga, L.V. and Congro, C.R. (2007). Physico-chemical and sensory characterization of honey samples of Africanized bees (*Apis mellifera* L.) produced in the wetland. *Evidence Biotechnology and Food* **7**: 63-74.

Bogdanov, S. (2016). **Honey in Medicine**. Accessed from: Bee Product Science, http://www.bee-hexagon.net. 27p.

Bogdanov, S., Vit, P. and Kilchenmann, V. (1996). Sugar profiles and conductivity of stingless bee honeys from Venezuela. *Apidologie* **27**: 445-450.

Ciulu, M., Solinas, S., Floris, I., Panzanelli, A., Pilo, M.I., Piu, P.C., Spano, N. and Sanna, G. (2011). RP-HPLC determination of water-soluble vitamins in honey. *Talanta* **83**: 924–929.

Eardley, C.D. (2004). Taxonomic revision of the African stingless bees (Apoidea: Apidae: Apinae: Meliponini). *African Plant Protection* **10**(2): 63–96.

Ethiopian Biodiversity Institute (EBI) (2014). **Ethiopia's Fifth National Report to the Convention on Biological Diversity.** Government of the Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia. 86p.

Fichtl, R. and Admasu Adi (1994). Honeybee Flora of Ethiopia. Weikersheim Margraf Verlag, 510p.

Gupta, R.K. (2014). **Taxonomy and Distribution of Different Honeybee Species**. Kashmir University of Agricultural Sciences. pp 63-99.

Kumar, M.S., Singh, A.R. and Alagumuthu, G. (2012). Traditional beekeeping of stingless bee (*Trigona* Sp) by *Kani* Tribes of Western Ghats, Tamil Nadu, India. *Indian Journal of Traditional Knowledge* **11**: 342-345.

Michener, C.D. (2013). The Meliponini. In: **Pot-honey: A Legacy of Stingless Bees**, pp 3–17 (Vit, P., Pedro, S.R.M. and Roubik, D., eds). New York, Springer.

Michener, C.D. (2007). **The bees of the World.** Johns Hopkins University Press. 2nd ed. 972p.

Nuru Adgaba (2002). **Geographical races of the Honeybees (*Apis mellifera* L.) of the Northern Regions of Ethiopia.** PhD Dissertation. Rhodes University, South Africa.

Pauly, A. and Zewdu Ararso (2013). Apini and Meliponini from Ethiopia (Hymenoptera: Apoidea: Apidae: Apinae). *Belgian Journal of Entomology* **16**: 1-35.

Ramalhosa, E.E., Gomes, T.T., Pereira, A.P., Dias, T.T. and Estevinho, L.M. (2011). Mead production tradition versus modernity. *Advanced Food Nutritional Research* **63**: 101–118.

Rao, P.V., Krishnan, K.T., Salleh, N. and Gan, S.H. (2016). Biological and therapeutic effects of honey produced by honeybees and stingless bees. *Revista Brasileira de Farmacognosia* **26**: 657–664.

Rasmussen, C. and Cameron, S.A. (2010). Global stingless bee phylogeny supports ancient divergence, vicariance, and long distance dispersal. *Biological Journal of the Linnean Society* **99**: 206-232.

ShiJing J.G. (2016). **Physicochemical properties and *in vitro* inhibitory effects of stingless bee (*Trigona* spp.) honey against *Escherichia coli*.** A project report submitted to the Department of Biomedical Science Faculty of Science Universiti Tunku Abdul Rahman. pp. 1-27.

Soad, K., Al Jaouni, Mohammad, S., Al Muhayawi, Abear Hussein, Iman Elfiki, Rajaa Al-Raddadi, Saad M. Al Muhayawi, Saad Almasaudi, Mohammad Amjad Kamal and Steve Harakeh (2017). Effects of honey on oral mucositis among pediatric cancer patients undergoing Chemo/Radiotherapy treatment at King Abdulaziz University Hospital in Jeddah, Kingdom of Saudi Arabia. *Evidence-based Complementary and Alternative Medicine* **3**:1-7.

Souza, B., Roubik, D., Barth, O., Heard, T., Enriquez, E., Carvalho, C., Villas-Boas, J., Marchini, L., Locatelli, J., Persano-Oddo, L., Almeida-Muradian, L., Bogdanov, S. and Vit, P. (2006). Composition of stingless bee honey: Setting quality standards. *Interciencia* **31**: 867-875.

Teklu Gebretsadik and Dinku Negash (2016). Honeybee production system, challenges and opportunities in selected districts of Gedeo Zone, Southern Nation, Nationalities and Peoples Regional State, Ethiopia. *International Journal of Research – Granthaalayah* **4**: 49-63.

Temaru, E., Shimura, S., Amano, K. and Karasawa, T. (2007). Antibacterial activity of honey from stingless honeybees (Hymenoptera; Apidae; Meliponinae). *Polish Journal of Microbiology* **56**: 281-285.

Vit, P., Bogdanov, S. and Kilchenmann, V. (1994). Composition of Venezuelan honeys from stingless bees (Apidae: Meliponinae) and *Apis mellifera* L. *Apidologie* **25**: 278-288.

White, J.W. (1979). Composition of honey. In: **Honey: A comprehensive survey**, pp157–158 (Crane, E., ed.), Heinemann. London.

Yalemwork Ewnetu, Wossenseged Lemma and Nega Birhane (2013). Antibacterial effects of *Apis mellifera* and stingless bees honeys on susceptible and resistant strains of *Escherichia coli*, *Staphylococcus aureus* and *Klebsiella pneumonia* in Gondar, Northwest Ethiopia. *Complementary and Alternative Medicine* **13**:269

Zamora, M.C., Chirife, J. and Roldán, D. (2006). On the nature of the relationship between water activity and percent of moisture in honey. *Food Control* **17**: 642-647.