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Review

Bee propolis: Production optimization and applications in Nigeria

Okhale S. E.[1*], Nkwegu C.[1], Ugbabe G. E.[1], Ibrahim J. A.[1], Egharevba H. O.[1], Kunle O. F.[1] and Igoli J. O.[2]

[1]Department of Medicinal Plant Research and Traditional Medicine, National Institute for Pharmaceutical Research and Development, P. M. B. 21, Garki, Abuja, Nigeria.
[2]Department of Chemistry, College of Sciences, University of Agriculture, P. M. B. 2373, Makurdi, Nigeria.

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Propolis is a resinous substance produced by bees with a wide range of medicinal uses. It is collected by bees from buds, leaves and bark exudates of several plants in both tropical and temperate regions. Propolis is sometimes referred to as "bee glue" as it is produced by bees for sealing and protection of their hives. Exploration and research into propolis and its biologically active constituents is increasing. Bee farming has become a popular commercial venture in several Nigerian communities and propolis which is a by-product of the bee hive is increasingly being produced and wasted as the economic benefits are completely unknown to the farmers or bee keepers. Propolis production has proven to be economically viable and sustainable. Phytochemical investigations of propolis had yielded several biologically active compounds which are potential drug candidates. This review examines local production and under-exploitation of propolis as a potential source of sustainable wealth creation in Nigeria.

Key words: Propolis, bee farming, production optimization, applications, wealth creation.

INTRODUCTION

The word propolis otherwise referred to as bee glue is derived from two Greek words: "pro" meaning in front and "polis" meaning city (Farre et al., 2004; Juliano et al., 2007; Bogdanov, 2016). The meaning of propolis supports the protecting role of propolis for the bee colony. Propolis in Greek also refers to the word "to glue". This describes the role of propolis to cement openings of the bee hive. The botanical origin of propolis was first postulated in 1970 by Popravko, a Russian scientist (Kosalec et al., 2004) who observed that bee glue showed resemblance with propolis obtained from poplar and birch bud exudates (Kosalec et al., 2004). Propolis is obtained from bud exudates of poplus species and hybrids in temperate zones. In countries like China and Turkey, propolis is obtained from buds of trees like: pines, cypress, willow, sumacs, eucalyptus and castanea. Propolis is a honeybee product with wide-ranging medical uses. Detailed review on propolis has been provided

*Corresponding author. E-mail: samuelokhale@gmail.com. Tel: +234-(0)8036086812.

Table 1. Types of propolis, geographical locations and plant sources.

S/N	Propolis type	Geographical location	Plant source	Main constituents	References
1	Poplar	Europe, non- tropic region of Asia, North America, New Zealand, Nigeria	Populus species most often *Poplus nigra* L.	Flavones, flavanones, cinnamic acids and their esters.	Bankova et al., 1991, 1992; Greenaway et al., 1990; Huang et al., 2007; Salatino et al., 2005; Omar, 2017
2	Green	Brazil, Nigeria	*Betula verrucosa* Erhr.	Flavones and flavonols	Salatino et al., 2005, Alencar S et al.,2007
3	Birch	Russia	Baccharis species redominantly. *Baccharis dracunculifolia.*	Prenylated para-coumaric acids, and diterpene acids.	Popravko and Sokolov, 1980
4	Clusia	Cuba, Venezuela, Nigeria	Clusia spp.	Polyphenylated benzophenones	Omar, 2017; Hernandez et al., 2005; Trusheva et al., 2004
5	Red propolis	Cuba, Brazil, Mexico, Nigeria	Dalbergia spp.	Isoflavonoids (isoflavans and pterocarpans)	Omar, 2017; Daugsch et al., 2008; Trusheva et al., 2006, Alencar S et al.,2007
6	Mediterranean	Sicily, Greece, Crete, Malta	Cupressacae species	Diterpenes (mainly acids of labdane type)	Popova et al., 2009, 2008
7	Pacific	Pacific region Okinawa, Taiwan, Indonesia	*Macaranga tanarius*	C-prenyl-flavanones -	Chen et al., 2003; Huang et al., 2007

(Anjum et al., 2019). Types of propolis, geographical locations and plant sources are highlighted (Table 1).

PRODUCTION OF PROPOLIS

Collection of propolis by bees

During the day, worker bees of not more than 15 days old (called foragers) gather resinous exudates originating mainly from buds, leaves, branches and barks using their mandibles and proboscis and store in their pollen bag on the hind leg (Burdock, 1998; Bankova, et al.,1998). About 10 mg of propolis is gathered into the hive per worker bee per flight. In the construction of the honey combs by bees, the walls of the hive and comb are both made and covered with wax. Bees use propolis to seal perforations in the hive. Other insects who intrude into the bee hive are mummified and incapacitated with propolis. Propolis is known to be composed of 50% resins, 30% flavonoids and phenolic acids, 10% essential oils and 5% of other organic compounds and minerals such as iron and zinc, vitamins (B1, B2, B3 and B6), benzoic acid, fatty acid esters, ketones, lactones, steroids and sugars (Bogdanov; 2016). Figure 1 showed collection of propolis by bees. Chemical composition of propolis varies depending on the variety of nearby plants from which the bees collect the exudates.

Methods of harvesting propolis

The old method adopted by most beekeepers for harvesting propolis is to scratch off the propolis present in the comb frames or in the hive. This

Figure 1. Collection of propolis by bees.

Figure 2. Harvesting of propolis using a plastic bag on top of the hives.

method does not usually yield good quality propolis. Instead, the propolis obtained is high in impurities. An innovative method of harvesting (Figure 2) to produce good quality propolis has been developed. This method mimics the bee's inherent tendency to seal any crack in the hives. The bee keepers place plastic nets or grids with a mesh diameter of 2 to 4 mm on the beehives. The bees then seal these net holes with propolis. In temperate zones, the plastic nets are placed on the beehives at the end of the bee season when the bees are preparing for winter. The propolis is then harvested when the net mesh is filled out. The nets are frozen for easy removal of propolis. Propolis is relatively stable. However, propolis and its extracts should be stored in an airtight container in a dark place, away from excessive and direct heat. If stored properly, propolis can maintain its integrity for over 12 months. It has been shown that propolis ethanol extracts exhibited unchanged antimicrobial activity after 15 years of storage (Meresta, 1997). Lyophilization or freeze drying of extracts has been described as a method which preserves the antibacterial features. Ethanolic extract of propolis has a shelf-life of up to 3 years. Frozen raw propolis packaged in an airtight container can last for about 10 years. Honey-propolis mixture has a shelf-life of 2 years.

Bees gather propolis for the purpose of sealing openings in their hives thereby reinforcing the structural stability of their hives, vibration reduction and general protection of the hive. A significantly higher yield of propolis was obtained in hives with the 'top bar spacing' method. This suggests that a direct relationship exists between the size of 'top bar space' and propolis gathering activities (Osipitan et al., 2012). The "top bar spacing" method of inspiring bees to gather propolis may be employed in addition to other methods like the Loycart method (Figure 3) and other methods that use special frames placed between the supers in hives with moveable frames such as Lang troth. Most beekeepers in Africa still adopt the 'Kenya top bar hives' and this makes the method of "top bar spacing" relevant. The draw back in the use of this method is that top bars with too wide openings may be covered by the bees using wax instead of propolis. The quality and quantity of propolis is also affected by seasonal variations. Ordinarily, bees gather

Figure 3. Loycart method of harvesting propolis.

more propolis between April and September and gather propolis with the best quality between the months of June and July (Osipitan et al., 2012).

CHEMICAL CONSTITUENTS OF PROPOLIS

Biologically active and inactive constituents of propolis

The wide applications of propolis in modern medicine have drawn growing attention to its chemical composition (Bueno-Silva et al., 2013; Fernandes-Silva et al., 2013; Hernandez et al., 2010). The phytochemical composition of propolis is dependent upon the source flora location. For example, propolis obtained in temperate regions contained flavonoids without B-ring substituents such as chrysin, galangin, pinocembrin, pinobanksin and caffeic acid phenethyl ester. However, propolis obtained in tropical regions especially Brazilian green propolis, contained mostly prenylated molecules, phenylpropanoids (such as artepillin C) and diterpenes. For propolis produced in the Pacific region and African region, geranyl flavanones were the major constituents (Ito, 2001). Propolis from Libya and Saudi Arabia were known to yield useful compounds such as prenylflavanones (propolins A-H) as shown in Figure 4, flavonoids, psiadiarabin, 3,4-dihydro-2-(3,4-dihydroxyphenyl)-2H-chromene-3,7-diol, diterpenes (prosiadin and psiadin), xanthones and lignans (Márquez, 2004; Fabris et al., 2013; Almutairi et al., 2014). As shown in Table 2, these constituents belong to various chemical classes such as, phenylpropanoids, chalcone, terpenenes, lignans, coumarins, aromatic acids and their esters (Adil, 2017)..

Flavonoids

Flavonoids are the major compounds found in propolis. They are a class of compounds with 15-carbon skeleton, which consists of two phenyl rings (A and B) and heterocyclic ring (C). Flavonoids are widely distributed in plants. Flavonoids have extensive range of biological activities which are not limited to antibacterial, antiviral and anti-inflammatory effects (Lopez, 2014). With reference to the chemical structure, flavonoids in propolis are classified into flavones, flavonols, flavanones, chalcones, dihydrochalcones, isoflavones, isodihydroflavones, flavans, isoflavans, neoflavonoids and flavanonols (Piccinelli et al., 2005).

Terpenoids

Terpenoids otherwise referred to as isoprenoids are a group of naturally occurring cyclic or acyclic unsaturated compounds. Terpenoids may be classified into monoterpenoids, sesquiterpenoids, diterpenoids, triterpenoids and tetraterpenoids. Monoterpenoids include acyclic, monocyclic, dicyclic monoterpenes and their derivatives. Myrcenes, p-menthanes and cineoles are examples of primary acyclic and monocyclic terpenes. The dicyclic monoterpenes in propolis are classified into five groups namely thujanes, caranes,

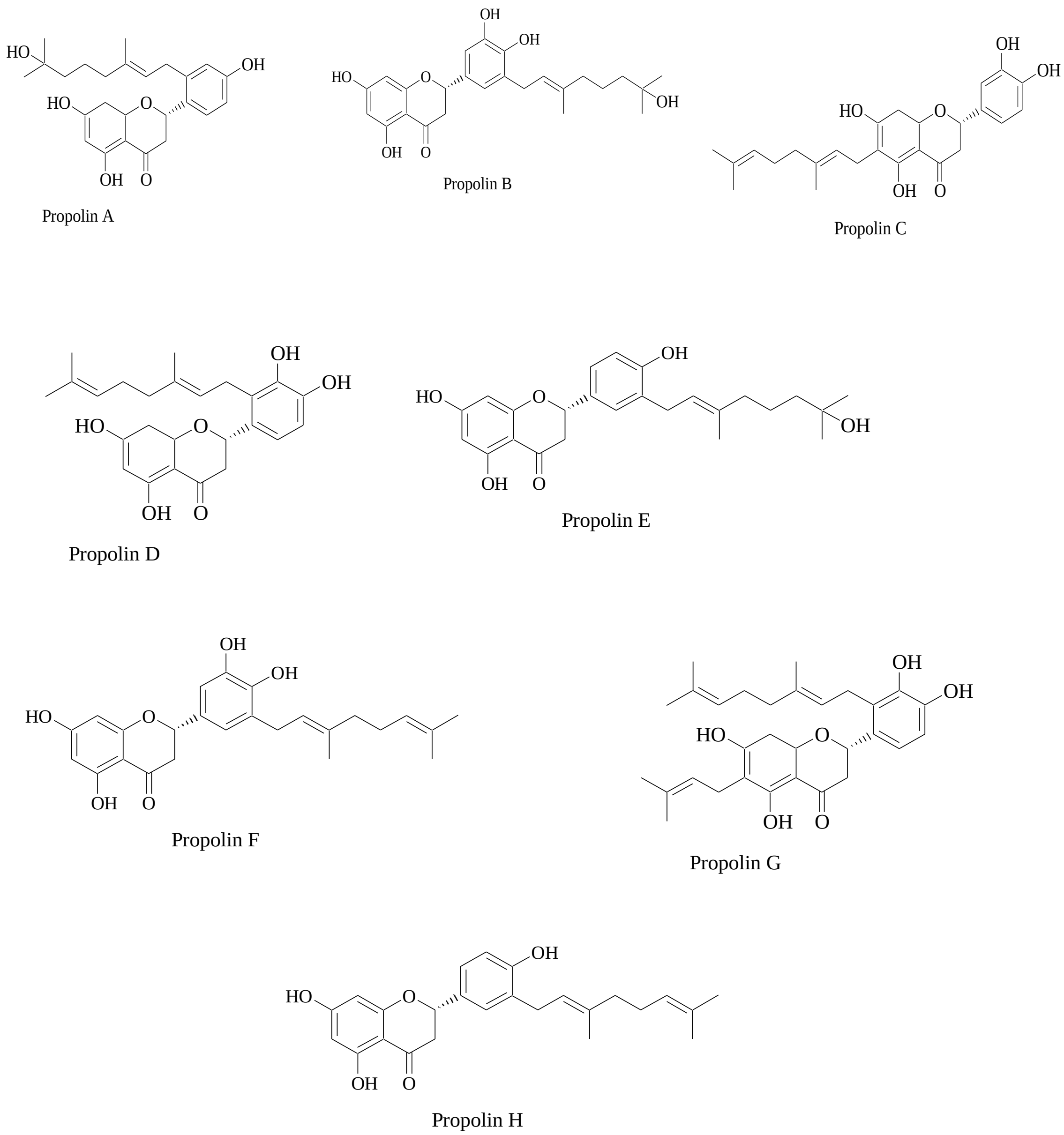


Figure 4. Chemical structures of some propolins in bee propolis.

pinanes, fenchanes and camphenes. Other examples of monoterpenoids found in propolis include trans-β-terpineol, linalool and camphor (Petrova et al., 2010; Oliveira et al., 2010; Nayoung and Marica, 2015; Pereira et al., 2002; Márquez, 2010; Hegazi and El Hady, 2002; Sirichai, 2005).

The major diterpenes in propolis are cembrane, labdane, abietane, pimarane, and totarane. Others included manoyl oxide, ferruginol, ferruginolone, 2-hydroxyferruginol, 6/7-hydroxyferruginol, sempervirol, abietic acid, 18-succinyloxyabietadiene, 18-succinyloxyhydroxyabietatriene, 18-hydroxyabieta-8,11,13-triene, imbricataloic acid, imbricatoloic, diterpenic acid, neoabietic acid, labda-8(17),12,13-triene, hydroxydehydroabietic acid, dihydroxyabieta-8,11,13-triene, 13(14)-dehydrojunicedric acid, dehydroabietic acid, 18-hydroxyabieta-8,11,13-triene, junicedric acid, 14,15-dinor-13-oxo-8(17)-labden-19-oic acid, palmitoyl isocupressic acid, oleoyl isocupressic acid, 13-hydroxy-8(17),14-labdadien-19-oic acid, 15-oxolabda-8(17),13(E)-dien-19-oic acid, pimaric acid and totarolone (Petrova et al., 2010; Oliveira et al., 2010; Nayoung and Marica, 2015; Pereira et al., 2002; Márquez, 2010; Hegazi and El Hady, 2002; Sirichai et al., 2005).

Table 2. Summary of some important biologically active constituents of propolis.

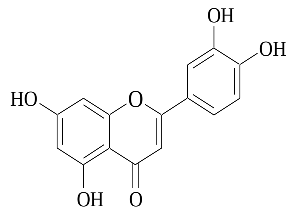
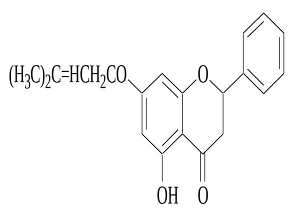
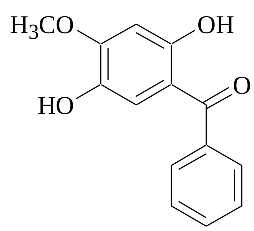
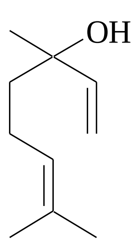
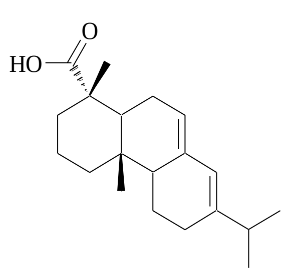
S/N	Constituents	Class of compounds	Chemical structure	Biological activity	Reference
1	Luteolin	Flavonoids		Antioxidant. Anti-inflammatory. Antimicrobial. Antineoplastic (inhibit angiogenesis).	López-Lázaro, 2009; Maciejewicz, 2001; Inui et al., 2012; Cao et al., 2004; Kumazawa et al., 2004; Camargo et al., 2013; Li et al., 2008; Tran et al., 2012
2	7-O-prenylpinocembrin	Prenylated flavanones		Antimicrobial activity (lipophilic prenyl group disrupt cell membrane and cell wall). Cytotoxicity.	Christov, 2006; Toreti et al., 2013; Bankova, 2005; Silici, 2005; Melliou and Chinou, 2004; Kumazawa et al., 2004; Awale et al., 2005
3	Cearoin	Neo-flavonoids		Anti-inflammatory activity (inhibition of IL-33-induced mRNA expression of inflammatory genes including IL-6, TNFα and IL-13 in bone marrow-derived mast cells (BMMC) and inhibition of IL-33-induced activation of nuclear factor κB (NF-κB).	Serra et al., 2012
4	Linalool and abietic acid	Terpenoids (Monoterpenes, Sesquiterpenes and Diterpenes)	 	Cardio-protective. Antioxidant activity that delays CVD onset.	Petrova et al., 2010; Oliveira et al., 2010; Nayoung and Marica, 2015; Pereira et al., 2002

Table 2. Contd.

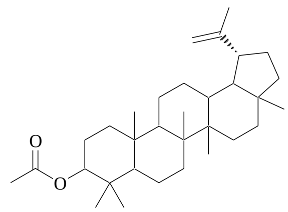
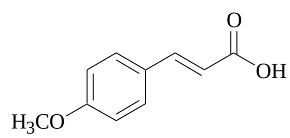
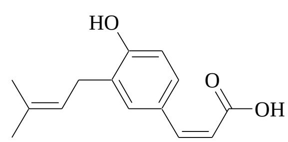
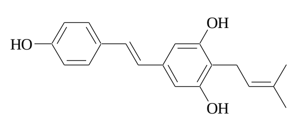
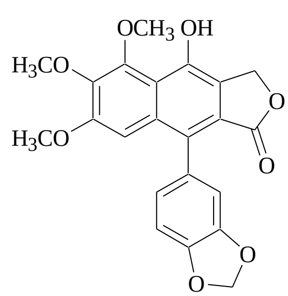
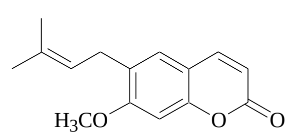
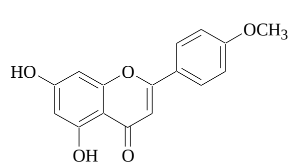
5	Lupeol acetate	Triterpenes		Antihyperlipidemic (antiatherosclerotic); Anti-inflammatory; Antioxidant and decrease of ROS levels. Induction of CAT and SOD activities. Mediation of NO synthase through targeting (PI3K)/Akt and TPA. Reduction of total cholesterol, triglycerides, and phospholipid levels.	Pereira et al., 2002; Márquez, 2010; Hegazi and El Hady, 2002; Sirichai et al., 2005
6	Para-methoxycinnamic acid	Phenylpropanoids and esters		Antidiabetic. Weak antiviral against against Coxsakivirus B1 and poliovirus type 1.	El Hady and Hegazi, 2000; Abu-Mellal et al., 2012; Marcucci, 2001; Tsenka et al., 2007; Schultz et al., 1992
7	3-Prenyl-4-hydroxycinnamic acid	Prenylated phenylpropanoids		Antioxidant, antiviral against Coxsakivirus B1 and poliovirus type 1 and antibacterial properties against *E. coli* and *Bacillus subtilis*.	Tsenka et al., 2007; Schultz et al., 1992
8	4-Prenylresveratrol	Stilbenes and prenylated stilbenes		Anti-fungal Antioxidant	Schultz et al., 1997; Trusheva et al., 2006; Adil, 2016
9	6-Methoxydiphyllin	Lignans		Anti-tumour. Antimitotic. Antiviral activity	Krol et al., 1996
10	Prenylated coumarin suberosin	Coumarins		Antibacterial Anticoagulant Antiretroviral	Adil, 2016; USP, 2009
11	Acacetin	Flavonoid		Anti-inflammatory	Crane, 1999

Table 2. Contd.

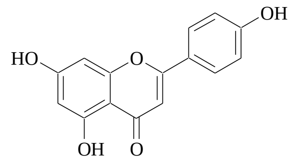
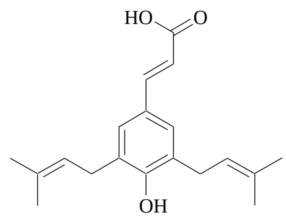
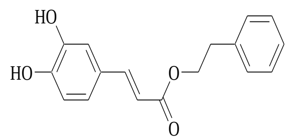
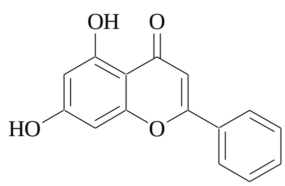
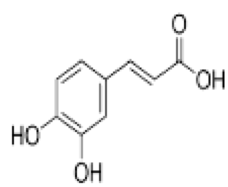
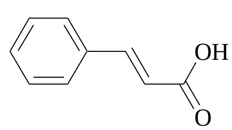
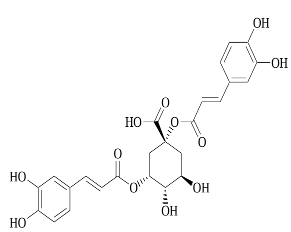
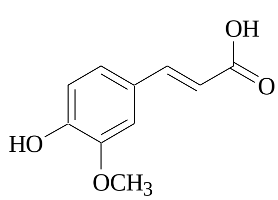
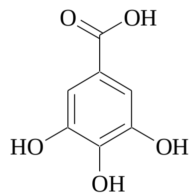
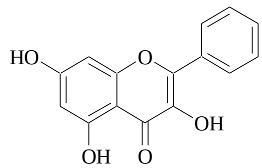
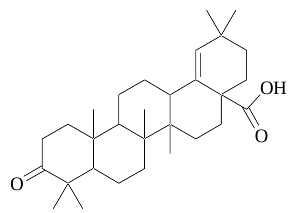
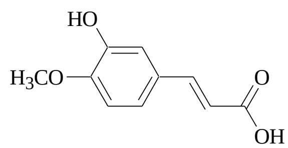
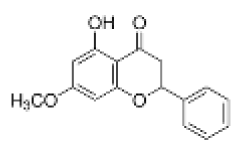
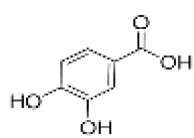
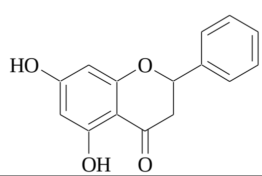
12	Apigenin	Flavonoid		Anti-inflammatory	Bogdanov, 2016
13	Artepillin C	Prenylated cinnamic acid		Antimicrobial, antitumor and antioxidant	Crane, 1999; Bogdanov, 2016
14	Caffeic acid phenyl ester	Phenolics		Antitumor and anti-inflammatory	Crane, 1999; Banskota, 2001
15	Chrysin	Flavonoid		Anti-inflammatory	Crane, 1999;
16	Caffeic acid	Phenolics		Anti-inflammatory. Antiviral, antibacterial	Bogdanov, 2016
17	Cinnamic acid	Cinnamic acids		Anti-inflammatory	Bogdanov, 2016
18	Dicaffeoylquinic acid derivatives	Polyphenolics		Hepatoprotective	Bogdanov, 2016
19	Ferulic acid	Phenolics		Anti-inflammatory	Bogdanov, 2016

Table 2. Contd.

20	Gallic acid	Polyphenolics		Anti-inflammatory	Crane, 1999
21	Galangin	Flavonoid		Anti-inflammatory	Bogdanov, 2016
22	Moronic acid	Pentacyclic triterpenoid		Anti-HIV	Bogdanov, 2016
23	Isoferulic acid	Phenolics		Anti-inflammatory	Bogdanov, 2016
24	Pinostrobin	Flavonoid		Local anesthesia	Bogdanov, 2016
25	Protocatechuic acid	Phenolics		Anti-inflammatory	Bogdanov, 2016
26	Pinocembrin	Flavonoid		Antibacterial, antifungal and anti-mold	Bogdanov, 2016; Banskota, 2001; Metzner et al., 1977

Sesquiterpenoids

Sesquiterpenoids are also classified based on number of rings. Therefore, they are either acyclic, monocyclic, dicyclic or tricyclic. Derivatives of fromane are the predominant acyclic sesquiterpenes in propolis. Others included junipene, γ-elemene, α-ylangene, valencene, 8-βH-cedran-8-ol, 4-βH,5α-eremophil-1(10)-ene, α-bisabolol, α-eudesmol, α-cadinol and patchoulene (Petrova et al., 2010; Oliveira et al., 2010; Nayoung anMarica, 2015; Pereira et al., 2002; Márquez, 2010; Hegazi and El Hady, 2002; Sirichai et al., 2005).

Triterpenoids

Tetracyclic triterpenes in propolis are lanostanes and cycloartane. Pentacyclic triterpenes are oleanane, ursane and lupine. Others include lupeol alkanoates, lupeol, lupeol acetate, lanosterol acetate, lanosterol, germanicol acetate, germanicol, β-amyrin acetate, β-amyrone, α-amyrin acetate, α-amyrone, 24-methylene-9,19-ciclolanostan-3β-ol, (22Z,24E)-3-oxocycloart-22,24-dien-26-oic acid, (24E)-3-oxo-27,28-dihydroxycycloart-24-en-26-oic acid, 3,4-seco-cycloart-12-hydroxy-4(28),24-dien-3-oicacid, cycloart-3,7-dihydroxy-24-en-28-oic acid and 3-oxo-triterpenic acid methyl ester (Petrova et al., 2010; Oliveira et al., 2010; Nayoung and Marica, 2015; Pereira et al., 2002; Márquez, 2010; Hegazi and El Hady, 2002; Sirichai et al., 2005).

Phenolics

These are a class of compounds identified by the presence of a hydroxyl functional group directly bonded to a benzene nucleus. Brazillian propolis is rich in phenylpropanoids (a type of phenolic compounds) including cinnamic acid, p-coumaric acid, caffeic acid, ferulic acid and their derivatives. Stilbenes are another category of phenolics, though not commonly found in all propolis types was found in Kenyan propolis. Lignans are another class of phenolics which were identified in Libyan, Kenyan and Brazilian propolis (Siheri et al., 2014).

Minerals

Atomic emission/absorption spectrometry has been used to determine the presence of trace elements in propolis. Propolis acquired from different regions in Croatia was found to contain calcium, potassium, magnesium, sodium, aluminum, boron, manganese, nickel, chromium, barium, zinc and lead. Among analysed minerals, Ca, Mg, K, Al, Fe and Zn were found to be the most abundant in raw propolis, ranging from 12.06 for Mg to 932.6 mg/100 g for Zn (Cvek et al., 2008).

Sugars

The sources of sugar found in propolis have been postulated to be either from the flower nectar or from the honey produced by the bees. Hydrolyzed glycosides of flavonoids may be another source of sugars. Mucilage containing sugar or alcoholic sugar residues may also be the source of sugars found in Propolis. Sugars such as galactitol, gluconic acid, galacturonic acid and 2-O-glycerylgalactose are the most common sugars contained in mostly African propolis (Huang et al., 2014).

APPLICATIONS OF PROPOLIS

Propolis has been used traditionally for its medicinal values since ancient times. Propolis was used as antibiotics in Egypt and also for mummifying corpses (Amoros et al., 1992). The Greeks used propolis for healing, seeing the bee as a god. It was utilized during the Boer war for regeneration of tissues and promotion of wound healing. In states like Balkan, propolis was used for the treatment of wounds, burns, stomach ulcer and even sore. In Chinese medicine, ethanolic extract of propolis was used for its anti-inflammatory properties (Camargo et al., 2013). Table 2 showed some important biologically active constituents of propolis.

Fabris et al. (2013) compared the antioxidant activity, of several Propolis obtained from Italy, Brazil and Russia. The antioxidant property of propolis was assessed by measuring their ability to inhibit the peroxidation of linoleic acid, their ability to scavenge free radicals like 2,2'-diphenyl-1-picrylhydrazyl (DPPH), their total phenolic content and their reducing capacity using both enzymatic and Folin method. The observed result obtained suggested that propolis collected from Italy and Russia, have similar polyphenolic composition, thus almost similar antioxidant activity. Brazilian propolis however, was observed to have lower polyphenolic and antioxidant characteristics Fabris et al. (2013). The anti-inflammatory activity observed with propolis is associated with one of its many constitutes called Caffeic acid phenethylester (CAPE). This propolis constituent was found to be a potent inhibitor of early and late T-cell receptor-mediated T-cell activation. CAPE inhibited the gene transcription and synthesis of interleukin (IL)-2 with high specificity (Márquez, 2004). CAPE also inhibited nuclear factor-B dependent transcription with no effect on the degradation of cytoplasmic nuclear factor-B inhibitory protein. However, the DNA binding of nuclear factor-B and Gal4-p65 hybrid protein transcriptional activity were all inhibited by CAPE (De Almeida, 2002).

Propolis was observed to have antifungal properties against *Candida albicans, Candida tropicalis*, *Candida krusei* and *Candida guillermondii*. Pure propolis extracts, at a concentration of 15-30 mg/ml inhibits the growth of *Candida albicans, Aspergillus flavus, P. notatum* and *Penicillium viridicatum* in a study by (Kovalik, 1979); pure propolis extracts was administered to 12 patients suffering from *Candida albicans* induced chronic sinusitis. Improvement in the condition of some patients was observed after 1-2 treatments with propolis. After 5-8 treatments, a clinical recovery occurred. All the patients recovered after 10-17 days of administration of Propolis (Kovalik, 1979). Moreover, Ethanolic Extract of Propolis (EEP) is known to inhibit up to 38 strains of fungi and 60 strains of yeasts (Cizmarik and Trupl, 1976. Also, the ethanolic and dimethyl-sulphoxide extracts showed activity against *Trypanosoma cruzi* and is lethal to *Trichomonas vaginalis* (Starzyk et al., 1977).

Aqueous extract of Propolis exhibited hepatoprotective effects on rats against carbon tetrachloride (CCl_4) injury. This observed hepatoprotective property of the aqueous extract of Propolis is due to its ability to decrease the leakage of cystolic lactate dehydrogenase enzyme (LDH). Aqueous extract of Propolis also caused a decrease in the production of lipid peroxides, thus maintaining cellular glutathione content (GSH) (El-Khatib et al., 2002).

Trusheva et al. (2010) investigated the use of propolis for the treatment of *Helicobacter pylori* induced ulcers. 30% ethanolic extract of propolis was tested against 38 clinical isolates of *Helicobacter pylori* and *Campylobacter jejuni* using agar well diffusion method. Dried Propolis discs inhibited about 73.1% of *H. pylori* isolates with zone of inhibition measuring 15 mm in 36.4%. They concluded that Bulgarian Propolis has activity against *H. pylori* and *Campylobacter jejuni* (Hashemi, 2016). The biological activities of different Propolis extracts are very diverse. This is because constituent of Propolis may differ dependent on the plant exudates used for it production. Many prenylated flavanones have been observed to exhibit strong antimicrobial activity. This antimicrobial activity observed may be due to the presence of lipophilic prenyl group that can rapidly cause disruption and damage to cell membrane (Marcucci, 2001). Nweze and co-workers reported effects of Nigerian red propolis in rats infected with *Trypanosoma brucei* brucei (Nweze et al., 2017).

PROPOLIS PRODUCTS

(i) Whole raw Propolis: obtained from the comb frames or the hive box is grinded to powder using a mill.
(ii) Propolis tincture: Propolis tinctures are most often prepared as a solution of ethanol, glycol and olive oil. Ethanol is used when extraction of bioactive components is of main concern. Olive oil and propylene glycol are used in cosmetics. Glycol tinctures are highly antioxidant and can be used in skin protection (Marquele et al., 2005).
(iii) Aqueous Propolis extract
(iv) Propolis pills
(v) Propolis ointment.

TRADE OF PROPOLIS

The global market of Propolis is segmented based on its applications in pharmaceuticals, cosmetics and foods. It was projected that global propolis market size will grow by USD 26.07 million during 2019-2023. Presently, the price of Propolis worldwide varies according to origin and quality. Chinese Propolis sells at about 25-50 Euros per kg and Brazilian propolis in 2009 Propolis sells at 100-150 Euros per kg (Bogdanov, 2016).

Characteristics of good quality Propolis

(i) Low content of mechanical matter (wood and dead bees).
(ii) Minimal or complete absence of contamination by pesticides and heavy metals (best quality organic one).
(iii) High balsam content (Table 2).
(iv) High content of biologically active compounds (according to the chemical type).
(v) Low wax content.

FUTURE SCOPE

Propolis is a commodity that has high global economic trade value. One kilogram of good quality propolis is worth about 17,000 US Dollars (15,000 Euro). Though Bee farming has become a popular commercial venture in several Nigerian communities and propolis is increasingly being produced, it is not being economically exploited because its huge economic potentials are unknown to most of the farmers or bee keepers. A focus on the production and economic exploitation of propolis in Nigeria will empower many of the farmers economically, as well as create new source of employment and forex earnings for the country. It will do Nigeria and many countries in the sub-region good for the ministry of agriculture to embark on awareness creation and process development for the production of propolis and its products for local and global consumption. It is importance that modern techniques for optimizing its production and quality standardization for the global market be developed and adopted.

CONCLUSION

Propolis originally considered a waste product from bee farming has become a global commodity with enormous income generating capability. Different countries are standardizing their propolis for the global trade. The price of Propolis worldwide varies according to origin and quality. Chinese Propolis sells for about 25-50 Euros per kg and Brazilian Propolis sells for about 100-150 Euros per kg. There is Bulgarian Propolis, Kenyan Propolis and Libyan Propolis. There is no Nigerian Propolis in the global market. This is a cause for economic concern as propolis is being harnessed globally for wealth creation.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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