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Review on Medicinal Value of Honeybee Products: Apitherapy

Bakalo Basa, Wendimagegnehu Belay, Alebachew Tilahun and Ayichew Teshale

Wolaita Sodo University, School of Veterinary Medicine, Ethiopia

Abstract: Honey bees are the "Golden insects" that produce honey and other vital honeybee products. However, the best known primary products of honey bees are honey and bee wax, but pollen, propolis, royal jelly, bee venom, queen bees and their larvae are also marketable primary bee products. Worldwide the usage of such primary products as propolis, royal jelly and bee venom have increased mostly due to inclusion in cosmetics preparation. Medicinal use will increase once better and more detailed studies are completed, which however may not yet be in the very near future. Honey has medicinal uses like antiseptics and wound healing properties while propolis is used to treat diabetes patients. Additionally, pollen has antioxidant property and anticoagulant and anti-inflammatory properties of bee venom serve to treat arthritis and other inflammatory conditions. In Ethiopia, the most widely used hive products are honey and beeswax serving many functions, ranging from local beverage to different medicinal uses. Thus, this paper reviews details of some of the most important medicinal uses of honeybee products.

Key words: Beeswax · Bee venom · Honey · Pollen · Propolis · Royal jelly

INTRODUCTION

Honey bees belong to the genus *Apis,* which in Latin means "bee, " the prefix "api" is often used in beekeeping terms such as, apiarist, a beekeeper or honey farmer; apiary, the location of bee hives; apiculture, the cultivation or farming of bees; and apitherapy, the use of bee products for health purposes. This social insect lives in a colony of several thousand bees and is in the order Hymenoptera, family *Apidae* and subfamily *Apinae*. There are several bee species that are cultivated for their products. The most widely used species is the honey bee, *Apismellifera*. The most harvestable products derived from honey bee cultivation include: honey, pollen, wax, propolis, royal jelly, venom, packaged bees and queen bees [1].

The use of natural honey (NH) and other honeybee products as food and medicine by mankind has been in existence from time immemorial. In fact, records have shown that raw honey is the most ancient sweetener and it was noted to have been in use throughout the world several million years ago [2]. Natural honey (NH) and other honeybee products are widely embraced by all ages and its use transcends the barriers of culture and ethnicity. The use of honeybee products is even advocated and embraced by all religious and cultural beliefs [3].

Apitherapy was the use of bee products such as honey, pollen, propolis, royal jelly, bee venom and wax to treat ailments such as liver, cardiovascular and gastrointestinal problems and, promote wound healing [4]. And also, apitherapy was 'the art and science of treatment and holistic healing through the honeybee and their products for the benefit of mankind and, all the animal kingdom. The roots of apitherapy can be traced back more than 6000 years to medicine in ancient Egypt [5].

Apitherapy also described (1400 years ago) in the Holy Book (Qur'an) says: And your Lord inspired the bees, saying: "Take your habitation in the mountains and in the trees and in what they erect. "Then, eat of all the fruits and follow the ways of your Lord made easy (for you)." There comes forth from their bellies, a drink of varying color, wherein is healing for men. Verily, in this is indeed a sign for people who think" (Al-Nahal (chapter of honeybee): 68, 69) [6].

Ancient Egyptians, Assyrians, Chinese, Greeks and Romans employed honeybee products for wounds and diseases of the intestine [7]. Since a few decades ago,

Corresponding Author: Alebachew Tilahun, Wolaita Sodo University, School of Veterinary Medicine, Ethiopia.

honey was subjected to laboratory and clinical investigations by several research groups. Honey and other honeybee products had a valued place in traditional medicine as well as modern therapeutics for centuries. However, they have a limited use in modern medicine due to lack of scientific support. Natural honey exhibits bactericidal activity against many organisms including *Salmonella, Shigella, Escherichia coli, Helicobacter pylori*, etc. [8].

Apitherapists believe that bee products can be used to cure most diseases. However, the use of bee products in conventional medicine is limited to certain indications where they have shown effects which are equal to or better than those of standard treatments, for example, in treating wounds and burns and as an interesting approach in arthritis [9].

Therefore, the objectives of this paper are to review on:

- Major medicinal benefits of honeybee products.
- Honeybee products and their utilization in Ethiopia.

Honeybee Products and Their Medicinal Value: Apiculture is the practice of keeping honeybees (*Apisindica, Apismellifera*) for their products such as NH, beewax, propolis, pollens, cerume (a mixture of wax and propolis) etc. It has been shown that NH and other honeybee products are natural resources, yet to be taken full advantage of as economic earner of little investment with huge returns [10].

They have high nutritional value and immense health (therapeutic) benefits [2]. Honey has medicinal uses like antiseptics and wound healing properties while propolis used to treat diabetes patients. Additionally, pollen has antioxidant property and anticoagulant and anti-inflammatory properties and bee venom serve to treat arthritis and other inflammatory conditions [11].

Medicinal Value of Honey: Honey was the natural sweet substance produced by honeybees from the nectar of blossoms or from the secretion of living parts of plants or excretions of plant sucking insects on the living parts of plants, which honeybees collect, transform and combine with specific substances of their own, store and leave in the honey comb to ripen and mature [12].

Indeed, medicinal importance of honey has been documented in the world's oldest medical literatures and since the ancient times, it has been known to possess antimicrobial property as well as wound-healing activity. The healing sproperty of honey is due to the fact that it offers antibacterial activity, maintains a moist wound condition and its high viscosity helps to provide a protective barrier to prevent infection [13].

Its immunomodulatory property is relevant to wound repair too. The antimicrobial activity in most honeys is due to the enzymatic production of hydrogen peroxide. However, another kind of honey, called non-peroxide honey (viz., Manuka honey), displays significant antibacterial effects even when the hydrogen peroxide activity is blocked. Its mechanism may be related to the low pH level of honey and its high sugar content (high Osmolarity) that is enough to hinder the growth of microbes [14].

Antimicrobial agents are essentially important in reducing the global burden of infectious diseases. However, as resistant pathogens develop and spread, the effectiveness of the antibiotics is diminished. This type of bacterial resistance to the antimicrobial agents poses a very serious threat to public health and for all kinds of antibiotics, including the major last-resort drugs, the frequencies of resistance are increasing worldwide. Therefore, alternative antimicrobial strategies are urgently needed and thus this situation has led to a re-evaluation of the therapeutic use of ancient remedies, such as plants and plant-based products, including honey [15].

The belief that honey is a nutrient, a drug and an ointment has been carried in to our days and thus, an alternative medicine branch, called apitherapy, has been developed in recent years, offering treatments based on honey and other bee products against many diseases including bacterial infections [16].

Anti-Bacterial Properties of Honey: In addition to important role of natural honey in the traditional medicine, during the past few decades, it was subjected to laboratory and clinical investigations. Antibacterial activity of honey is one of the most important findings that was first recognized in 1892 by Van Ketel [17].

Pathogens Found Sensitive to Honey: Honey has been reported to have an inhibitory effect to around 60 species of bacteria including aerobes and anaerobes, gram-positives and gram-negatives [18]. Pathogens that are found to be sensitive to anti-infective properties of honey are manifold [19]. Various results are in favor of its activity against *Bacillusanthracis*, *Corynebacteriumdiptheriae, Haemophilusinfluenza, Klebsiellapneumoniae, Listeria* monocytogenes, Mycobacterium tuberculosis, Pasteurellamulticoda, *Yersinia enterocolitica*, *Proteus species, Staphylococcus aureus, Streptococcus faecalis,*

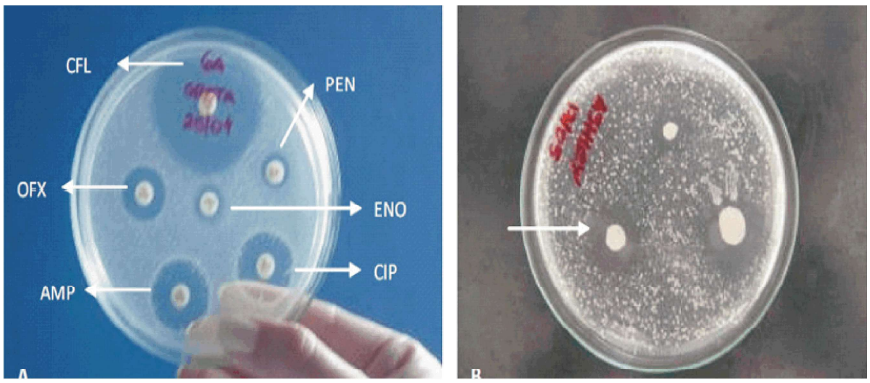

Fig. 1A: Inhibition formed in antibiotic susceptibility testing commercial - CFL (cephalexin – 40 mm), OFX (ofloxacin – 15 mm), PEN (penicillin – 10 mm), ENO (enrofloxacin – 10 mm) and AMP (ampicillin – 21 mm) , CIP (ciprofloxacin – 20 mm). B) Inhibitionformed in antibiogram with *Tetragoniscaangustula*honey.
Source: Mello and Cabral [23].

Streptococcus mutans, Strepococcuspneumonia, Strepococcuspyogenes and Vibrio cholera, Pseudomonas aeruginosa, Acinetobacterspp, Salmonella diarrhea, Salmonella typhi, Serratiamarcescens, Shigella dysentery [8].

Unlike most conventional antibiotics, it has been reported that honey dose not lead to development of antibiotic resistant bacteria and it may be used continuously [20]. Honey can act as both bacteriostatic and bactericidal depending on the concentration used. Pasture honey (4-8%) and Manuka (5-11%) honey was bacteriostatic whereas bactericidal activity was achieved at 5-10% and 8- 15% (v/v) concentrations, respectively. In contrast, artificial honey (sugar solution which mimics composition of honey) was bacteriostatic only (at 20- 30%) and not bactericidal [21].

Possible Mechanisms of Antibacterial Activity of Honey: The antibacterial activity (Table 1) is related to four main properties of honey. First, honey draws moisture out of the environment and thus dehydrates bacteria. The sugar content of honey is also high enough to hinder the growth of microbes, but the sugar content alone is not the sole reason for honey's antibacterial properties [22].

Second, the pH of honey is between 3.2 and 4.5 and this acidity is low enough to inhibit the growth of most microorganisms. Hydrogen peroxide produced by the glucose oxidase (*i.e.*the activation of the enzyme glucose oxidase that oxidizes glucose to gluconic acid and H_2O_2) is the third and probably the most important antibacterial component [18]. But, in some cases, the peroxide activity in honey can be destroyed easily by heat or the presence of catalase, several other non-peroxide factors such as methyl syringate and methylglyoxal(MGO) have been found to be responsible for the unique antibacterial activity of honey [19].

Effect of Honey on Gastritis, Gastroenteritis, Gastric and Duodenal Ulcers: Gastritis, gastric and duodenal ulcers are complications resulting from infection with *Helicobacter pylori*. Nowadays, over half of the human population is colonized by *Helicobacter pylori* (*H. pylori*), a Gram-negative, microaerophilic bacterium. If untreated, infection is usually life-long and leads to chronic active disease. Although most infected people are asymptomatic, 5-10% of those infected with this bacterium develop severe gastro duodenal diseases, including gastric and duodenal ulcers, gastric lymphomas and gastric adenocarcinomas [25].

Conventional treatment for the eradication of *H. pylori* like triple therapy regimen consisting of a proton pump inhibitor, such as omeprazole and two antibiotics, clarithromycin and either amoxicillin or metronidazole is far from satisfactory, due to the prevalence of antibiotic resistance; thus there is search for alternative treatment. Honey-derived remedies constitute a potential source of new compounds that may be useful in the management of *H. pylori* infections. Clinical and animal studies have shown that honey reduces the secretion of gastric acid. Additionally, gastric ulcers have been successfully treated by the use of honey as a dietary supplement. An 80% recovery rate of 600 gastric ulcer patients treated with oral administration of honey has been reported [26].

Table 1: Antibacterial factors found in honey and mechanisms

S.No	Antibacterial factors	Mechanisms
1	Osmotic effect (hygroscopic, high sugar content).	Based on high osmotic properties it can extract water from bacterial cells and cause them to die.
2.	Acidity (low PH between 3.2 and 4.5).	The pH being between 3.2 and 4.5 is low enough to be inhibitory to many pathogens.
3.	Hydrogen Peroxide (H_2O_2).	Germicidal due to:-Acidic nature below 4 Ph. :-High concentration nature which exerts high Osmotic pressure. :-Dehydrate and inhabit growth of most pathogens, leads to death.
04.	Phytochemical Components (non-peroxide factors *i.e.* presence of catalase (absence of glucose oxidase)).	Antibacterial factors(methyl syringate Andmethylglyoxal).
5	Induction of increased lymphocyte and phagocytic activity.	Peripheral blood B-Lymphocytes, T-lymphocytes and phagocytes stimulated at concentrations as low as 0.1%. monocyte (1%) release cytokines, tumor necrosis factor (TNF)-alpha, interleukin (IL)-1 and IL-6, which activate the immune response to infection.
6	Phenolic products (benzoic acids, cinnamic acids and Flavonoids).	Antibiotic activity.

Source: Rakhi *et al*. [24].

Wound Healing Properties of Honey: Honey is an effective treatment of wounds because it is non-irritating, non-toxic, self-sterile, bactericidal, nutritive, easily applied and more comfortable than other dressings. Nearly all types of wounds like abrasion, abscess, amputation, bed sores /decubitus ulcers, burns, chill blains, burst abdominal wound, cracked nipples, fistulas, diabetic, malignant, leprosy, traumatic, cervical, varicose and sickle cell ulcers, septic wounds, surgical wound or wounds of abdominal wall and perineum are found to be responsive to honey therapy [21].

The treatment of wounds with honey has rendered them bacteriologically sterile within 7-10days of the start of the treatment and promoted healthy granulation of tissue. Honey was found to be more effective as an antibacterial agent against several *Pseudomonas* and *Staphylococcus* strains than the antibiotic, gentamicin [27].

Conversely, generous soaking of wounds and abscess cavities with honey, sometimes using castor oil to facilitate dressing, was found to include the following advantages: first, cross-infection of wounds often encountered with conventional therapy, was prevented because honey forms a mechanical and/or chemical barrier to infectious agents (effective in starting the healing process in non-healing ulcers lepers and diabetics); and second, a shorter duration of treatment and therefore hospitalization [28]. In a more recent report on honey treatment of wounds, ulcers and skin graft preservation, the importance of sterile, residue-free honey for medical use was pointed out. It is advisable to use honey derived from specified pathogen- free hives, which have not been treated with drugs and are gathered in areas where no pesticides are used [29].

Effect of Honey on Cardiovascular Diseases: Ischemic heart disease (IHD) causes more deaths and disability and incurs greater economic costs than any other illness in the developed world. Arrhythmias and myocardial infarction (MI) are serious manifestations of IHD. In the course of cardiac surgery and MI, ventricular arrhythmias such as ventricular tachycardia and ventricular fibrillation are the most important causes of mortality [31].

In management of such conditions; drug therapy (especially anti-arrhythmic drugs) may be lifesaving. On the other hand, the hazards of anti-arrhythmic drugs (such as lethal arrhythmias in some patients) have led to a limitation on the administration of anti-arrhythmic drugs. Hence, there is a tendency to use drugs which have less adverse effects and more efficacies. Natural honey has been applied for medicinal purposes since ancient times [32].

A wide range of phenolic compounds is present in honey which has promising effect in the treatment of cardiovascular diseases. In coronary heart disease (CHD), the protective effects of phenolic compounds include mainly antithrombotic, anti-ischemic, anti-oxidant (vitamin C, monophenolics, flavonoids and polyphenolics) and vasorelaxant. It is known that flavonoids decrease the risk of CHD by three major actions: improving coronary vasodilatation, decreasing the ability of platelets in the blood to clot and preventing LDLs from oxidizing [33].

Medicinal Value of Pollen: Bee pollen is an agglomerate of pollen grains from various botanical sources, which are collected by the bees and mixed with nectar and secretion from the hypo pharyngeal glands such as β-glycosidase enzymes. Bee pollen has a complexchemical composition constituted of carbohydrates, proteins, amino acids,

Fig. 2: Some commercial honey preparations used in wound healing: (a) Wound dressing with Medihoney gauze (b) Medihoney for wound care
Source: Bugra *et al*. [30].

vitamins and minerals and is considered a good nutritional source, beneficial to health, particularly because of the presence of phenolic compounds with antioxidant activity [34].

The old Egyptians describe pollen as "a life-giving dust". Pollen and its nutritional value are still surrounded by mysteries. It is called the only perfectly complete food. The consumption of plant producing seed, the pollen, is praised in the Bible, Genesis 1:29: And God said, See, I have given you every plant producing seed, on the face of all the earth and every tree which has fruit producing seed: they will be for your food[35].

It is still used as a remedy in folk medicine as a constituent of 'bio-cosmetics', 'health foods' and for numerous other purposes. Bee pollen contains all of the eight essential amino acids in amounts that vary between five to seven times the levels found in vit.C and bioflavonoid, as well as the complete B complex; especially pantothenic acid (B5) and niacin. The high levels of vitamin B5 are particularly beneficial for the adrenal glands which are adversely affected during stress. Bee pollen has been used traditionally as an anti-aging food and an energy food. As a matter of fact, it has been used by a number of Olympic athletes to improve their performance. Now a day it is widely used for treatment of prostatic problems and allergies [36].

Effect of Pollen on Prostate Problems and Allergies: The long-term observations on the medicinal effect of pollen are related to prostate problems and allergies. Several decades of observations in Western European countries and a few clinical tests have shown pollen to be effective in treating prostate problems ranging from infections and swelling to cancer. The phytochemicals lycopene, beta-sitosterol, other phytosterols and numerous flavonoids contained in bee pollen have been shown to inhibit the growth of prostate tissue and to reducepain, inflammation and the risk of prostate cancer [37].

There are promising results that pollen can also be used to prevent allergies. The anti allergic activity of bee pollen phenolic extracts (BPPE) and the flavonoid myicetin (MYR) was tested in a murine model of ovalbumin (OVA)-induced allergy in mice. BPPE(200 mg/kg) and MYR (5 mg/kg) treatments showed inhibition of different allergic reactions[38].

Since mast cells play a central role in the pathogenesis of various allergic diseases, the effect of bee pollen ingestion by rats significantly reduced the cutaneous mast cell activation elicited specific antigens. It also reduced in vitro mast cell degranulation and tumor necrosis factor-X production. These indicates that the anti-allergic action of bee pollen was exerted by inhibiting the activation of mast cells, which plays important roles, not only in the early phase, but also in the late phase of the allergic reaction [38].

Antioxidant/Anti-Aging Activities of Bee Pollen: The oxidative damages caused by free radicals have been implicated in quite a number of disease processes and is the primary factor in aging. Antioxidants are capable of providing protection, sometimes significant protection,

against this oxidative damage. The health enhancing effects of pollen in cardiovascular health and also its anabolic, growth stimulating properties make it a good candidate for treating age-connected conditions such as arteriosclerosis and chronic fatigue. Interestingly, bee pollen appears to provide significant antioxidant activity, which may explain its traditional use as an anti-aging food [39].

Other Benefits of Bee Pollen: The effects and benefits derived from pollen consumption, according to some of the non-scientific literature on the subject are endless. Many people report improvement of sometimes chronic problems. Most of the major ailments reported to improve with pollen preparations are listed in the Table (2) below. However, one should be aware that the benefits reported are not usually from scientific studies but are merely personal experiences without any medical or other scientific investigation of claims. Sometimes, the disappearance of symptoms was witnessed by physicians, but the reasons for such cures were not confirmed through further investigations [40, 41].

Medicinal Value of Propolis: Propolis (bee glue) is a resinous honeybee product collected by honey bees from various plant sources. It has a long history of being used in folk medicine dating back to many centuries. It also has been reported to possess various biological activities, namely anticancer, antioxidant, anti-inflammatory, antibiotic, antifungal and anti-hepatotoxic. Propolis, or "bee glue, " means a gum that is gathered by bees from various plants. It is strongly adhesive resinous substance, collected, transformed and used by bees to seal holes in their honeycombs [42].

Etymologically, the Greek word propolis means pro, for or in defense and polis, the city, that is “defense of the hive.” Bees use it to seal holes in their honeycombs, smooth out internal walls, as well as to cover carcasses of intruders who died inside the hive in order to avoid their decomposition. Propolis also protects the colony from diseases because of its antiseptic efficacy and antimicrobial properties [43].

Propolis provides wide beneficial effect on human health. It has been extensively employed by man, especially in folk medicine to treat several maladies. Nowadays, propolishas important pharmacological properties and it can be used for a wide range of purposes as anti-inflammatory and hypotensive agent, immune system stimulant and bacteriostatic and bactericidal agent, among many other uses [44].

Table 2: Non-scientific claims and reports of benefits, cures or improvements derived from the use or consumption of bee-collected pollen

Improvements	Cures of benefits
Athletic performance[b]	Cancer in animals [a]
Digestive assimilation[b]	Colds[b]
Rejuvenation [a]	Acne [a]
General vitality [a]	Male sterility[a]
Skin vitality[b]	Anaemia[b]
Appetite[b]	High blood pressure[b]
Haemoglobincontent[b]	Nervous and endocrine disorders[b]
Sexual prowess [a]	Ulcers [a]
Performances (of a race horses) [a]	

Source: Ridi *et al*. [40] and Sharmaand Singh [41]

Antimicrobial Activity of Propolis: Currently, it is known that propolis shows several biological activities, such as antimicrobial, anti-inflammatory and immunomodulatory, are among others. The composition ofpropolis is very complex. We can observe the following: antibacterial activity, conferred by the presence of flavonoids, aromatic acids and esters in its composition; bactericidal action resulting from the presence of cinnamic acid and coumarin; *in vitro* antiviral activity (herpessimplex, influenza), due to the action of flavonoids and aromatic acids derivatives [45].

Many researchers had investigated the antibacterial activity of propolis and its extracts against Gram-positive and Gram-negative strains and found that propolis had antibacterial activity against a wide range of Gram-positive rods but had a limited activity against Gram-negative bacilli [46].

Effect of Propolis on Diabetes: In modern medicine no satisfactory effective therapy is still available to cure diabetes mellitus, which is a syndrome resulting from a variable interaction of hereditary and environmental factors and characterized by abnormal insulin secretion (Type- 1) or insulin receptor or post-receptor (resistance, Type- 2) events affecting metabolism involving carbohydrates, proteins and fats in addition to damaging β-cells of pancreas, liver and kidney in some cases. Several attempts have been made to tackle hyperglycemia and comorbidities(Cardiovascular, renal, hepatic, ophthalmic, neurological and osteopathic-, endothelial- and sexual-dysfunction, etc.)that come with increased blood glucose level [47].

To this effect drugs like sulfonylurea that stimulate insulin secretion by the islets and α-glucosidase inhibitors that augment glucose utilization and suppress glucose production have been developed. Despite the limited efficacy of these therapies, it is also not devoid of

side effects, therefore necessitating the search for new classes of drugs to combat this disorder. To this effect, many substances from plant source have been found to possess anti-diabetic activity with minimal side effects and the search is on-going [48].

There is a trend towards using natural products to control hyperglycemia and associated pathologies. Propolis, an apiproduct, has been rediscovered as a medicinal agent. Propolis has been reported to have a broad spectrum of biological activities; the anti-oxidant, oxygen radical scavenging activity of propolis (and its extracts) is mainly due to the presence of phenolics and flavonoids. The beneficial effects of propolis in diabetes have been confirmed by a number of studies in experimental animals [49]. Long term propolis consumption in patients with type 1 DM has the potential to reduce both macrovascular and microvascular complications. Long term propolis therapy also in type 2 DM resulted in a decrease in fasting glycemia [50].

Medicinal Value of Royal Jelly: Royal jelly is secreted by hypopharyngeal gland (sometimes called the brood food gland) of young worker (nurse) bees, to feed young larvae and the adult queen bee. Royal jelly is always fed directly to the queen or the larvae as it is secreted, it is not stored. Royal jelly is therefore, related to the method of production, it is the food intended for queen bee larvae that are four to five days old [35]. Royal jelly is nutrition-packed; it has a high nutritional value like other honey bee products. It has been used to strengthen the immune system and to boost energy. In addition, there is very preliminary evidence that it may have the ability to promote some antibiotic, anti-inflammatory, wound-healing and anti-cancer effects [51].

General Systemic Activities of Royal Jelly: Royal jelly has a history of folk use as a skin tonic and hair growth stimulant. The skin benefits are supposed to include a nourishing process that reduces wrinkles, although there is no actual scientific research that supports these claims (or the hair growth claims). Royal jelly has also been considered to be a general tonic that has a general systemic action rather than any specific biological function, which benefits menopause and sexual performance. Perhaps its most significant use has been as an aid for increasing energy [52].

Anti-Tumor, Anti Bacterial and Anti Inflammatory Activities of Royal Jelly: Scientific research on royal jelly has revealed that it possesses antitumor activity in experimental mouse with leukemia. Additional research has demonstrated that royal jelly has antibacterial activity against Gram-positive bacteria, but not against Gram-negative bacteria. Furthermore, research with chronically diabetic rats demonstrated that royal jelly possesses an anti-inflammatory action and is able to augment wound healing. Royal jelly has also been shown to prevent the cholesterol elevating effect of nicotine and has lowered serum cholesterol in animal studies. Some research has also demonstrated that royal jelly can lower cholesterol levels in humans [53].

Medical Value of Bee Venom: Honeybee venom is produced by two glands associated with the sting apparatus of worker bees. One is lying in the abdomen, rather long and known as acids gland of the sting producing acid, while the other gland is short, thick and known as alkaline gland. Its production increases during the first two weeks of the adult worker's life and reaches a maximum when the worker bee becomes involved in hive defense and foraging. It diminishes as the bee gets older. The queen bee's production of venom is highest on emergence, probably because it must be prepared for immediate battles with other queens [35].

Bee venom therapy uses the stings of live bees to relieve symptoms of many syndromes such as pain, loss of coordination and muscle weakness. Stinging is not limited to any specific area of the body, as stings in different places seem to produce different results. Apitherapy researchers suggest that certain compounds in bee venom, namely melittin, apamin, phospolipaseA_2 and adolapin, help reduce inflammation and pain and that the combination of all the "ingredients" in bee venom somehow helps the body to release natural healing compounds in its own defense. In the modern world honey bee venom has found wide uses in treating arthritis and other inflammatory and degenerative diseases [54].

Anti-Inflammatory Activities of Bee Venom: While apitherapy encompasses use or consumption of bee products, in the anglosphere the term is most commonly associated with bee venom therapy and not the consumption of honey or other bee products. Due to its anticoagulant and anti-inflammatory properties bee venom was mainly used to treat many inflammatory disorders such as arthritis, bursitis, tendinitis, dissolving scar tissue (e.g. keloids), Herpes zoster, joint disease and rheumatoid arthritis, Lyme disease, multiple sclerosis and osteoarthritis [55]. Furthermore, research in various animal experimental models with inflammatory diseases

Table 3: List of diseases and health problems improved or healed by bee venom

Humans	Many types of Arthritis	Multiple sclerosis	Premenstrual syndrome
	Epilepsy	Bursitis	Ligament injuries
	Mastitis	Some types of cancer	Sore throat
	Chronic pain	Migraine	General immune-stimulant
	Decreases blood viscosity and coagulability	Dilates capillaries and arteries	Decreases blood cholesterol level
	Neuroses	Rhino sinusitis	Endo arteriosis
	Atherosclerosis	Polyneuritis	Radicultitis
	Infectious spondylitis	Neuralgiae	Endoarthritise
	Infect. Poly arthritis	Malaria	Intercostal myalgia
	Myositis	Tropical ulcers	Slowly healing wounds
	Thrombophiletritis	Cancer, temporary	Keratoconjunctivitis
	Irititis	Iridocytis	Asthma
Animals	Arthritis		

Source: Krell [58]

demonstrated that bee venom administration was successfully effective in suppressing the inflammation (arthritis). Interestingly, bee venom administration through acupuncture point (acupoint) was proven successful for producing a strong therapeutic effect as compared to non-acupoint injection [1].

There is no standardized practice for the administration of bee venom. Some reports suggest that the location of the sting is important, with the sting acting as a sort of acupuncture in combination with the effects of the venom, while others report the location is not important. The number of stings also varies widely from a few to hundreds and they may be administered either by live bees or by injection. This treatment can cause pain and even result in death if the subject has an allergy to bee venom, which can produce anaphylactic shock [56].

Other Benefits of Bee Venoms: The venoms' benefits to human beings as well as to animals are very long. Most of the reports of cures are of individual cases, though several unrelated patients have experienced the improvement or cure of similar ailments. BV treatments are often accompanied by changes in life style, nutrition or other which may account for part, if not most of the benefits from treatments [57]. The diseases and problems which have been reported by patients or doctors as improved or healed with bee venom therapy are listed in (Table 3 below). On the other hand stinging should never be tried unless there is immediate access to emergency treatment in case of an allergic reaction. Bee venom has long been used in traditional medicine for the treatment of various kinds of rheumatism. Although venoms of the different honeybee species differ slightly, there have been reports of successful rheumatism treatment with *Apisdorsata*venom and with *A. cerana*venom [41].

Medicinal Value of Bee Wax: Bee wax is produced from the bee's own body during the worm period. The bee uses wax to build the comb cells in which their broods are reared and also the cells in which honey and pollen are stored. It is a thin scale produced by glands of 12-17 days old worker bees on the ventral (stomach) surface of the abdomen. Worker bees have eight wax producing glands from abdominal segments 4-7 [35].

Slow Drug Releasing Function of Bee Wax: Beeswax is considered safe for human consumption and has been approved as an ingredient in human food. As a coating for drugs or pills, beeswax facilitates ingestion but, retards dissolution of the enclosed compounds until they reach the digestive tract. Beeswax can also be prepared as a mixture with the drug and then functions as a time release mechanism, releasing the drug over a longer period of time. It is inert, i.e. it does not interact with the human digestive system at all and passes through the body unaltered. However, substances dissolved or encapsulated in waxes are slowly released [59].

Other Benefits of Bee Wax: Chewing dark comb (but not the old, black brood comb) without honey, brood or bee-bread is known to be effective against colds. A study has shown that even the wax fractions of propolis have antiviral activities. Older combs contain among many other things a good portion of propolis. Bees wax is the least allergenic bee product. There is only one report on skin allergy caused by beeswax. Beeswax has antibacterial properties and when applied to the skin improves its elasticity and makes it look fresh and smooth. It can be chewed for strengthening the gingival and to increasing saliva and stomach juices [60].

Warm beeswax has excellent warming properties when applied against inflammations of muscles, nerves and joints. Therefore, beeswax is the main bee product to be used for thermo-therapy. For this purpose following application is suggested applied after muscle, nerve and tendon inflammation due to colds, lumbago, neuritis, mialgitis, arthosis and arthritis. Beeswax can be used to fill capsules with equal amounts of drugs or other ingredients of various granule sizes. The granules of drugs are made adhesive by coating them with molten wax (about 90 g molten waxes for 3kg of granules), fat or glycerol, by spraying with liquid paraffin or by mixing them with powdered wax or fat and heating. After thorough mixing the hard capsules are pressed with their open end into an evenly spread layer of the mixture [61].

Honeybee Products and Their Utilization in Ethiopia: Ethiopia has substantial potential in beekeeping with rich flora, proper ecological conditions and existence of large bee colonies. However, modern beekeeping faced with challenges in respect to lack of bee management skill and understanding their medicinal value. There are several bee species that are cultivated for their products. The most widely used species in Ethiopia is the honey bee, *Apismellifera (*true honeybees*)*. The most harvestable products derived from honey bee cultivation in Ethiopia are mainly honey and beewax [62].

Honey: Ethiopia ranks 10th and 4th in the world in honey and wax production, respectively. The current annual honey production is estimated at approximately 24 tones, accounting for about 24% and 2% of the total Africa and world honey production, respectively. With this level of production the bee keeping farmers of the country gain approximately ETB 350 million annually [63].

In Ethiopia honey is almost exclusively used for local conception and to a very large extent (80%) for brewing of mead, locally called 'Teg'. Almost no wedding or other cultural, resinous and social events can be imagined without the honey wine 'Teg'. Even though honey satisfies the locally demand, it is so crude that it cannot compete in the international market [64].

However, the products obtained from this sub sector are still low as compared to the potential of the country. Although thousands of tones of honey are produced every year, it is usually poorly managed and unattractive in appearance. Because of this, its place in the local market being taken by imported money. Moreover, traditional hive honey is of good quality as long as it is in the hive. Faulty handling, from the time of its harvests until it reaches to market is responsible for its inferior quality. The type of hives used the methods of removing and storage of honey play a vital role in the quality of honey [65]. Accordingly the most important honey and beeswax production regions in Ethiopia are Oromia (about 46% of total production), Southern nations, Nationalities and Peoples Regional state(SNNPR) (22%), Amhara (25%) and Tigray (5%). In more detail, the major supply areas in the country include places like Sidama, Jimma, Gonder, Wollega, Illubabor, Bale and Gojjam [66].

Bee Wax: Bee wax or beeswax is a natural secretion from wax glands on the sides of the body of honey bees and is used primarily as a building block for the bees honeycomb cells in which the young are raised and honey and pollen are stored. It is the second most abundant bee hive product, which has high economic value and a good trade commodity [67].

Like honey, bee wax is also a multipurpose natural bee product, which is used in the manufacture of more than 300 commodities. Ethiopia is the 4th largest bee wax producing country in the world and the 3rd largest bee wax exporter in Africa with annual bee wax production of the country is estimated about 3, 658 tones and the annual average value of bee wax is estimated at about 125 million Birr [68].

In Ethiopia, beeswax is used traditionally for coating of church candles. A kilogram of beeswax could be enough to make about 50 candles it is pinest candle because it is smokeless and drip less. Demand of beeswax as a church candle is high here in this country because many of the church still follow the tradition of allowing any beeswax candles for special rights and ceremonies very little portion of the wax is also used for floor polish making [69].

CONCLUSIONS AND RECOMMENDATIONS

Bee keeping is an art of keeping bee colonies for means of economic benefits. The products of bee keeping are honey, wax, pollen, propolis, royal jelly and bee venom, which have marketable and economic benefit. Today in the demand for beekeeping products in the world in general is growing tremendously high due to the importance of it as inclusion in cosmetic preparation, as natural food, medicinal use and to other values. Different studies shown that, in microbiological and clinical tests, these honeybee products offer many advantages in controlling bacterial growth and in the treatment of certain health problems. Also the administration of honey for the

treatment of wounds has desirable features like absence of antibiotic resistance as found with conventional antibiotics, the lack of side effects in alleviating gastric pain and shortening the duration of diarrhea are all. Even in modern day society, the medicinal use of honey bee products still has a place.

Therefore, based on the above conclusion the following recommendations are forwarded:

- Beekeepers should understand the medicinal uses of honey bee products so as to exploit maximum benefit of honey bees.
- Modern technologies and research results in the subject area should be extended to farmers for better economic benefits.
- Conventional therapies have many side effects and high costsso, it is necessary to exploit medicinal value of honey bee products which are affordable, accessible nearby and have no side effects.

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