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*Review Article*

# HONEY PHYSIO-CHEMICAL PARAMETERS AND ITS APPLICATION WITH REFERENCE TO ETHIOPIA

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**ABSTRACT**
Ethiopia owns about 10 millions of bee colonies, the largest bee population in Africa and the largest honey producer in Africa and the ninth largest honey producer all over the world. The total honey production of Ethiopia is estimated up to be 43 000 tons, and only a small portion of this is marketed. Beside poor marketing conditions the main reason is that about 80% of the total Ethiopian honey production goes into the local "Tej" preparation, (honey mead), a national drink consumed in large quantities. More than 95% of the honey in Ethiopia is produced through traditional hives. In recent years some honey processing enterprises have appeared in the market, involved in the production of cream and table honey. Mostly, these enterprises collect honey from groups of outgrower farmers in Southern Ethiopia (Keffa region, Agaro Area), Gojam, Gonder, Wollo and Tigray. Those enterprises plan to export abroad including the European Union and the Middle East markets[24,69].

**KEYWORDS***:* honey production, Tej, parameters, Ethiopian honey.

## INTRODUCTION

Honey is a natural, sweet, viscous liquid that honey bees *Apis mellifera* produce from nectars of blossoms, from plant secretions or from excretions of plant sucking insects on the living parts of plants[1-7]. Honeybees collect this material, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in the honey comb to ripen and mature[4-6,8]. Freshly extracted honey is a viscous liquid, with a greater density (1.5 g/cm$^3$) than water (1g/cm$^3$ at 4ºC); having a strong hygroscopic character, relatively low heat of conductivity, low surface tension and various colors[1]. The current international honey market trend, regarding quality is every day more demanding. Hence, it is necessary to promote all feasible activities in order to produce residue free honey[18]. No food ingredient additives, like color, vitamins and Honey is an easily digestible foodstuff that contains a range of nutritionally important compounds [9,10]. The major components of honey include various saccharides, water, amino acids, proteins, vitamins, and unstable compounds such as enzymes[3,4,7,9]. In addition to these, honey contains inorganic substances, including trace elements essential for vital processes. The composition and properties of honey depend on the sort, location, environment, collection time, climatic conditions[11-15]. The composition of nectar and honeydew honeys is different. Light nectar honeys have a lower content of components than darker honey [11,12,16]. In general, higher antioxidant content was found in darker honeys and in honeys with higher water content [1,16] at 4ºC having a strong hygroscopic character, relatively low heat of conductivity, low surface tension and various colors[1]. Honey is an easily digestible foodstuff that contains a range of nutritionally important compounds [9, 10]. The major components of honey include various saccharides, water, amino acids, proteins, vitamins, and unstable compounds such as enzymes[3,4,7,9]. In addition to these, honey contains inorganic substances, including trace elements essential for vital processes. The composition and properties of honey depend on the sort, location, environment, collection time, climatic conditions [11-15]. The composition of nectar and honeydew honeys is different. Light nectar honeys have a lower content of components than darker honey[11,12,16]. In general, higher antioxidant content was found in darker honeys and in honeys with higher water content[1,16]. Food safety is a major public concern worldwide. During the last decades, the increasing demand for food safety has stimulated research regarding the risk associated with consumption of foodstuffs contaminated by pesticides, heavy metals and/or toxins [17]. The current international honey market trend, regarding quality is every day more demanding. Hence, it is necessary to promote all feasible activities in order to produce residue free honey[18]. No food ingredient additives, such as: color, vitamins and minerals or preservatives to honey are allowed and also it shall not have any objectionable matter, flavour, aroma, or taint absorbed from foreign matter during its processing and storage[3,4,7,19].

### Origin and distribution of honey

As the only available natural sweetener honey was an important food for *Homo sapiens* from his very beginnings. Indeed, the relation between bees and man started as early as Stone Age[21]. From ancient times, honey was not only used as a natural sweetener but also as a healing agent [16]. In most ancient cultures honey has

been used for both nutritional and medical purposes [2, 21]. It was used by the ancient Greek sand Sumerians. In ancient Egypt it was used as a wound treatment, mixed with grease and fibre and for gut conditions. Hippocrates recommended honey and vinegar for pain, water and honey for thirst and a mixture of honey, water and other substances to treat acute fevers, as well as recommending its use to treat ulcers. The belief that honey is a nutrient, a drug and an ointment has been carried into our days. For a long time in human history it was an important carbohydrate source and the only largely available sweetener until industrial sugar production began to replace it after 1800. An alternative medicine branch, called apitherapy, has developed in recent years, offering treatments based on honey and the other bee products against many diseases. Russian soldiers in World War 1 used it, apparently successfully, for wound healing purposes. Honey, lime leaves and palm kernel are traditional medicines for wound healing in Ghana and among the Bambara of Mali; honey is a traditional treatment for measles, both via the oral route and as an eye ointment [2, 22].

**Honey Production in Ethiopia**

The countries in the world probably no country has a longer tradition of beekeeping than Ethiopia. Already the hieroglyphs of the ancient Egyptians give a hint, that this country has been a source for honey and beeswax ever since. The dissemination of Christianity moreover strengthened the beekeeping system because of its demand for wax for religious ceremonies. Ethiopia, with about three to five million bee colonies, is the country with the highest bee density in Africa. As in many other Africa countries, beeswax is a very important product of beekeeping. Thus, after China, Mexico, and Turkey, Ethiopia is the fourth largest wax producing country with an estimated two thousand one hundred tones per year. It is one of the five biggest wax exporters to the world market. According to FAO estimation, the production of honey amounts almost to twenty-one thousand tones per year with this amount Ethiopia is the largest honey producing country in Africa and world wide it stands in tenth place.

## HONEY PROCESSING

**Heating**

Heating is the basic processing treatment of bee honey. The principal objective of heating is to change the state of the product from solid to liquid. Additionally, when properly combined with filtration, it prolongs the re-crystallization of honey. The effect of heating and filtration on honey re-crystallization has been generally recognized for all long time. Based on those two treatments, a number of methods were developed which are devised 5 to maximize the duration of the liquid state of the product. Another method recommends heating honey up to 77°C for 5 min. and, subsequently, filtering it carefully and cooling down rapidly to room temperature. There is yet another approach to honey processing that makes honey stay liquid for a long time, a method that additionally makes use of small quantities of water being added at the initial heating stage to facilitate the dissolution of crystals [25, 26]. The use of excessive heat in honey processing for liquefaction or pasteurization, however, has adverse effects on honey quality, *i.e.* loss of volatile compounds, accumulation of HMF and reduction of invertase and diastase activities. However, it should be noted that improper storage of honey leads also to similar changes of HMF and enzyme activity.

**Honey filtration**

Honey should not be strained with a mesh size smaller than 0.2m in order to prevent pollen removal. On the other hand, the recently revised Codex Alimentarius Honey Standard (Codex Alimentarius Commission, 2001) and EU Directive relating to honey [6, 27] allow a removal of pollen if it is unavoidable for the removal of foreign matter. Such honey should be labeled as “filtered”. Since microscopical pollen analysis is still the most important tool for the determination of botanical and geographical origin of honey, any removal of pollen by filtration will make authenticity routine testing much more difficult, if not impossible.

**Fermentation**

Harvesting of honey with high moisture content, or subsequent addition of water can result in honey fermentation and spoilage. Honey spoilage can be first tested by a microscopic yeast count .This test on its own does not yield conclusive results, as counted yeast could be in an inactive status not taking part in the fermentation process. Determination of the fermentation products is more reliable, *i.e.* by determining the glycerol or ethanol content [19].

**Nutritional benefits of honey**

Many health-promoting and curative properties attributed to honey are the basis for some traditional folk medicine treatments throughout the world today [16]. There are many reports of the traditional medicinal use of honey in a large number of cultures. It has been used in a wide range of conditions, including skin, eye, respiratory and gastrointestinal illnesses[2,21,22]. If honey is consumed at higher doses of 50 to 80 g per intake, it has a variety of positive nutritional, healing, and prophylactic properties [16,21,29,30]. Bee honey can be a good source of major and trace elements needed by humans. The mean content of mineral substances in honey has been calculated to be 0.17%**,** although this can vary within a wide range [8, 31]. In order to have a beneficial effect, honey must be free of any contaminating agents. If heavy metals present in honey above the admitted levels by pollution standards, are threats to human body through the possible negative effect of the contaminants [2,29,32,33]. As a widely consumed food, honey has a very long history of safe use. Liquid honey does not spoil because of its high sugar concentration and low moisture content, which kills most bacteria by plasmolysis and impedes the development of air borne yeasts. The moisture content of natural raw honey varies from 17.5 to 21%. As long as the moisture content remains below 18%, virtually no microorganisms can successfully multiply in honey [3, 34].

The smaller amount of moisture in honey is not the only explanation for its antimicrobial activity. Some studies have studied sugar syrups of the same water activity as honey and found them to be less effective than honey at

inhibiting microbial growth [2,16]. When applied topically to wounds, osmosis would be expected to draw water from the wound into the honey, helping to dry the infected tissue and reduce bacterial growth [2,35]. Honey has been demonstrated in many studies to have antibacterial effects, attributed to different factors: its high osmolarity (due to its high sugar content), low pH, hydrogen peroxide content and content of other uncharacterized compounds. Honey is mildly acidic, with a pH between 3.2 & 4.5. Gluconic acid is formed in honey when bees secrete the enzyme glucose oxidase, which catalyses the oxidation of glucose to gluconic acid. The low pH alone is inhibitory to many pathogenic bacteria and, in topical applications at least, could be sufficient to exert an inhibitory effect [2,5,16]. Honey has been also claimed to have therapeutic properties applied as ointments for the treatment of minor burns, cuts and skin infections, in the treatment of digestive, respiratory, cardiac and rheumatic disorders. It may be suitable for use in oral rehydration products [2,4,22, 29].

**Chemical Composition of honey**

Honey contains about 181 substances[36]. The various chemical components of honey include: carbohydrates that comprise the major portion of honey, small amounts of proteins, minerals, vitamins, aroma compounds, organic acids and poly phenols[2,6,13,16,21,65].

**Carbohydrates**

The sugars fructose (approximately 38% w/w) and glucose (~31%) are the two main sugars present in honey, with lesser amounts of sucrose (~1%). Additionally, about 25 different oligosacharides have been detected [11,21]. In the process of digestion after honey intake the principal carbohydrates fructose and glucose are quickly transported into the blood and can be utilized for energy requirements by the human body. A daily dose of 20 g honey will cover about 3% of the required daily energy[11]. In other words it is a more concentrated source of energy than other common sweeteners. Furthermore, besides its high nutritional value (330 kcal/100 g) its carbohydrates are absorbed rapidly on consumption [5].

**Proteins**

Honey contains roughly 0.5% proteins, mainly enzymes and free amino acids. The contribution of that fraction to human protein intake is marginal[11]. Enzymes are the most important and also the most interesting honey components. They are accountable for the conversion of nectar and honeydew to honey[37]. The three main honey enzymes are diastase (amylase), decomposing starch orglycogen into smaller sugar units, invertase (sucrase, α-glucosidase), decomposing sucrose into fructose and glucose, as well as glucose oxidase, producing hydrogen peroxide and gluconic acid from glucose. Furthermore, honey has eighteen free amino acids, carboxylic acid group, of which most abundant is proline [1,2,4,11,16,38].

**Vitamins, minerals and trace compounds**

Honey contains trace amounts of the B vitamins: riboflavin, niacin, folic acid, pantothenic acid and vitamin $B_6$ and ascorbic acid [1,7]. It also contains varying amounts of mineral substances ranging from 0.02 to 1.03g/100g, minerals such as: calcium, iron, zinc, potassium, phosphorus, magnesium, selenium, chromium, manganese, *etc*. and 9 organic acids such as acetic, butyric, citric, succinic, lactic, malic, and gluconic acid and a number of aromatic acids[1]. The chemical composition of honey is influenced by many factors. It varies depending on plant source (botanical origin of the nectar) visited by bees, season, environmental conditions and production methods but the main constituents are the same in all honeys [2,8,15, 21,22,39]. Storage conditions may also influence final composition, with the proportion of disaccharides increasing over time [2, 40].

**Sources of residues and contaminants in honey**

Honey has two sources of residues pesticides and veterinary drugs as well as contaminants **(**microbial and heavy metal ions). The primary sources of both residues contaminats include pollen, dust, air, soil and nectar; secondary sources are those arising from honey manipulation by people, they include cross-contamination by food-handlers, containers and packaging, transport, storage facilities, honey extractors and processing machines. Primary sources of honey contamination are very difficult to control. Conversely, secondary sources of residues and contaminants in honey can be controlled by good apicultural and manufacturing practices. Detectable pesticides and veterinary drugs arise from the poor agricultural practices where residues in the nectars of flowers will be collected by the bees. No application of pesticides and drugs is a guarantee to arrest residues. There are two ways to avoid residues in honey from the sources (i) no application of these substances in the area close to the apiary (organic practice); (ii) good apicultural and apicultural practices in the uses of these substances

It is important to take account of the type of equipment used to produce honey as well as the quality of the equipment used to store honey after harvesting as possible sources of honey contamination with heavy metals. For example contact with stainless steel surfaces during harvesting, processing and/or preparation of honey for the market, can 10 generate high Cr content, due to the corrosive effect of honey acidity. Likewise, storing honey in galvanized containers can be a source of Zn contamination[30]. However, variation in trace element content in different honey types is primarily due to botanical origin rather than geographical and environmental exposition[41]. The concentrations of inorganic species present in honey vary according to the resources in the soil[20]. Plants absorb elements from the earth and deliver them to the nectar, which is a major resource used by bees to make honey. Honey will vary in mineral content not only according to the resources in the soil where its evolution starts, but also according to the kind of plants from which the bees took nectar [20, 31,59]. Honey contains a number of acids which include amino acids (0.05-0.1%) and organic acids (0.57%, range: 0.17-1.17%). The average pH of honey is 3.9 (with a typical range of 3.4 to 6.1).The total acidity of honey is 29.12 meq/kg (average) with a range of 8.68 to 59.49 meq/kg and a standard deviation of 10.33 meq/kg.1. A number of organic acids are known to occur in honey, including acetic, butyric, citric, formic, gluconic, lactic, malic, pyroglutamic, and succinic. The major organic acid is gluconic acid. Gluconic acid is produced in honey by the action of the enzyme glucose-oxidase on glucose. The organic acids present in honey are significant because they interact with other flavors. Gluconic acid has flavor enhancing properties. About 18 free amino acids are

known to occur in honey, but they are present in small amounts with little nutritional significance. Honey contains 0.05- 0.1% amino acids. Proline is the most abundant. Honey contains a range of aliphatic and aromatic acids. The aromatic acids of honey are important contributors to its flavor. Both free and bound aromatic acids have been reported in a variety of monofloral (from a single type of flower) honeys. Their presence can be used to describe floral sources of honey [24,64,6628,43,62,63].

**Essential and Toxic Metals**

As food stuff used for healing purposes, honey must be free of objectionable contents. It should contain only small amounts of trace metals[29,30]. Heavy metals in foods and beverages are classified into two based upon their essential and toxic nature. For example Fe, Zn, Cu, Mn, Cr and Co are described as essential trace elements for humans. Apart from these trace elements which are indispensable for the human body, there are other groups of trace elements such as Pb, Cd, As and Hg which are toxic even in minute quantities[7,8,12,30,31,42-44]. Trace elements may play an important role in a number of biochemical processes; they ensure the natural development of physiological reactions, take part in metabolism and impact general metabolism, circulatory systems and influence the reproduction as catalysts of various biochemical reactions. Trace elements are the constitutive parts of the structures of different active bio-compounds: zinc, copper and manganese are found in enzymes, cobalt in vitamins and hormones, copper and iron in respiratory enzymes[8,13,30,44]. Lead, cadmium arsenic and mercury are potentially toxic within specific limiting values. Excessive content of these metals in food is associated with a number of diseases, especially of the cardiovascular, renal, nervous and skeletal systems. These heavy metals are also implicated in carcinogenesis, mutagenesis and soon [13,17,30,44]. Therefore, honey shall be free from heavy metals in amounts which may represent a hazard to human health [6].

**Roles played by essential and non essential metals**

General roles played by the trace heavy metals: Fe, Zn, Mn, Cu, Co, Cr, Pb, Ni and Cd are presented in the following section.

**Nickel**

Nickel is now quite firmly established as an essential nutrient[42] and its compounds are generally recognized as safe when used as a direct ingredient in human food. Little is known about the actual chemical forms of nickel in various foods or whether dietary nickel has distinct “organic” forms with enhanced bioavailability analogous to those of iron and chromium. Although a number of cellular effects of nickel have been documented, a deficiency state in humans has not been described. Research showed that nickel was to be found in blood and tissues at quite consistent levels associated with DNA and RNA in amounts that suggest physiological significance [45]. Nickel is frequently responsible for allergic skin reactions and has been reported to be one of the most common causes of allergic contact dermatitis, as reflected by positive dermal patch tests [44, 45].

**Zinc**

Zinc is a multifunctional nutrient involved in glucose and lipid metabolism, hormonal functions, and wound healing, and it is also essential in proper hair growth [46]. But excess intake of it results in gastrointestinal distress and diarrhea [8]. Zinc is a component of enzymes or a functional cofactor of a large number of enzymes. It is essential to carbohydrate metabolism; protein synthesis [47]. Zinc is an essential trace element that must be supplied in the diet of human beings so that growth and health can be maintained. It is necessary for protein synthesis and the metabolism of vitamin A. It helps the healing process of internal and external wounds, decreases cholesterol deposits and promotes mental awareness. A deficiency can cause loss of appetite, growth retardation and immune-logical abnormalities [48, 49].

**Copper**

Copper plays important roles in normal carbohydrate and lipid metabolisms. Copper and iron are essential to life because they play major roles in blood building and the functioning of critical enzyme systems[46]. Copper is essential for good health but very high intake can cause adverse health problems, such as liver and kidney damage [8].

**Iron**

In animals, Iron is a constituent of hemoglobin. Body iron content is regulated by the amount absorbed. The absorption is influenced by body stores and by the amount and type of iron in ingested foods. It is a vital component of many enzymes; it can promote resistance to disease and prevent fatigue. A deficiency can cause anemia, resulting in impaired concentration, reduced physical performance and work capacity, and decreased immune function. Ascorbic acid is necessary for the proper assimilation of iron. There are no reported cases of toxicity 13 from foods but iron poisoning may occur from ingesting large amounts of medicinal iron supplements [48, 49].

**Manganese**

Manganese is an essential component of numerous enzymes involved in bone formation and in the metabolism of amino acids, lipids, and carbohydrates. Its deficiency has been reported in animals but rarely in human[48,50]. A deficiency can cause poor reproductive performance, growth retardation, abnormal formation of bone and cartilage, and an impaired glucose tolerance [48].

**Cobalt**

It is a part of vitamins $B_{12}$, an essential vitamin in animal nutrition. Pernicious anemia can result from cobalt deficiency, for which Vitamin $B_{12}$ is a well-known treatment, being organically complexed with cobalt.

**Chromium**

Chromium is another micronutrient for animals. Trivalent chromium is required for maintaining normal glucose metabolism. Evidence shows that chromium improves glucose tolerance. Diabetes and coronary heart disease are associated with low chromium concentrations in human tissue. The chemical forms of chromium in foods are not known with certainty, but the bioavailability of chromium compounds has been found to be high in brewer's yeast, shellfish, whole wheat bread and mushrooms [51].

**Cadmium**

Because of its toxicity, presents a major problem for foodstuffs. Contamination through fertilizers becomes an increasing problem.

**Moisture content**

The amount of water in honey is a function of many factors involved in ripening, including on the botanical origin of the sample, weather conditions, the original moisture of the nectar, harvest season, the conditions of storage and the degree of maturity [8]. Honey has moisture content with a range of between 15.1 and 21.0%. As long as the moisture content remains below 18%, virtually no microorganisms can successfully multiply in honey [3,5,34]. Anomalous values may be an index of adulterations[5]. Due to high abundance and low cost of water it is the most frequently added substance to various foods in an attempt of economic fraud[8,53]. The water content is the most important measure and related to honey quality, especially concerning the risk of spoilage due to fermentation[8], and hence it is important parameter in honey preservation [36]. Generally honeydew honeys have lower water content than blossom honeys. However, water content can be artificially altered during honey processing and is therefore not a reliable indicator for the botanical origin[53].

**The pH value of Honey**

All honeys are acidic with a pH-value generally lying between 3.5 and 5.5, due to the presence of organic acids that contribute to honey flavour and stability against microbial spoilage[53]. The pH is indeed a useful index of possible microbial contamination and adulteration. The pH of adulterated honey samples is higher than that of pure samples[3], and has high relevance during the extraction and storage of honey because it is related to the stability and the shelf life of the product. Most bacteria and moulds grow in a neutral and mildly alkaline environment respectively.

**Electrical conductivity**

Electrical conductivity depends predominantly on the mineral content of honey [54]. This measure and was recently included in the international standards replacing the determination of ash content[53,54]. Electrical conductivity can be determined with an inexpensive conductometer and was found to be the most important variable for the classification of unifloral honeys. The range of electrical conductivity in honey lies between 0.06 and 2.17 $mscm^{-1}$ Honeydew contains considerably higher amounts of minerals compared to blossom honeys. 18 Generally honeydew honeys have an electrical conductivity higher than 0.8 $mscm^{-1}$ blends between blossom and honeydew honeys have conductivity values between 0.51 and 0.79 $mscm^{-1}$ and pure floral honeys exhibit conductivity values between 0.15 and 0.50 $mscm^{-1}$. A reliable determination of the botanical origin, however, can not be based on electrical conductivity only [53,58].

**Ash content**

The ash content in honey is generally low and influenced by the chemical composition of nectar that varies according to the different botanical sources involved in honey formation. It can vary between 0.02 and 1.0 % and the maximum limit allowed by legislation for honey from floral sources is 0.6% [6,27]. Normally, however, ash contents between 0.1 & 0.3 % are found for floral honeys. Very high mineral contents about 1.0% are actually encountered only in honeydew honey and ash content is often used to identify this kind of honey [55].

**Honey as bio-indicator**

Analysis of honey for trace elements content is necessary in food quality control as well as the monitoring of the bee environment[56]. Honey is the result of a bio accumulative process that is useful to collect information about the environment within the bees' forage area. Bees are estimated to forage on plants growing in a relatively large area of more than 7 $km^2$[8, 20]. If it is assumed that any hive includes at least 1000 worker bees and that each of them forages on 1000 flowers /day, the honey produced daily can be considered the outcome of at least one million interactions. In this way, the forage area is effectively sampled for trace elements and the concentration in honey of heavy and transition metals reflects their levels in the foraged area[8]. Presently, many countries are considering the use of honeybees to monitor environmental pollution. Those substances that potentially 19 could be monitored in the environment by honeybees include heavy metals, pesticides, veterinary drugs and radioactive substances. However, the analysis of honey for trace elements content in the monitoring of the bee environment may be a difficult task because of low contaminant concentrations and complex interpretation of results[56].

**Digestion of honey**

Metal determination in sugar-rich foodstuffs has been a challenging analytical task because of the interference caused by the organic matrix [38]. Honey is a complex matrix consisting mostly carbohydrates, water and minor components (organic acids, enzymes, amino acids, vitamins, pigments). The direct FAAS analysis of an aqueous solution of honey sample is restricted because such a matrix, following pyrolysis in argon atmosphere, led to the progressive accumulation of a carbonaceous residue into the graphite atomizer, deteriorating both sensitivity and precision. For this reason, a wet digestion stage is generally recommended. This involves destruction of the organic matter by acids [56].

**Scope and benefits of the study**

The research concerning the determination of mineral content of honey is increasing during the last years[20]. Since Honey offer a potential dietary supplement and shows therapeutic features, it is important to know the levels of trace elements that are essential to health. In this research work it was aimed to find some relationships among individual groups of honey and the correlation among individual constituents.

**Lead**

Lead which is known to be xenobiotic has no beneficial effects in human physiology but has detrimental effect to the physiologies of humans and other living organisms. It is a typical cumulative poison[45,46]. Lead can trigger both acute and chronic symptoms of poisoning. Acute intoxications only occur through the consumption of relatively large single doses of soluble lead salts. Chronic intoxications can arise through the regular consumption of foodstuffs only slightly contaminated with lead. Lead is a typical cumulative poison. Basically, as a result of their comparatively high affinity for proteins, the lead ions consumed bond with the hemoglobin and the plasma protein of the blood. This leads to inhibition of the

synthesis of red blood cells and thus of the vital transport of oxygen. If the bonding capacity here is exceeded, lead passes into the bone-marrow, liver and kidneys. Such intoxication leads to encephalopathy in the central nervous system (CNS), disturbances in kidney and liver functions progressing as far as necrosis, damage to the reproductive organs & anemia and many metabolic deficiency symptoms. Particularly dangerous to all forms of life are the organic lead compounds. They cause injuries to mental development such as reduction of intelligence and growth disturbances [4, 44].

**Physicochemical properties of honey**

Honey specifications (*e.g*. Ethiopian Standard, ES: 1202:2005 and the Revised Codex Standard) [6, 34] require physicochemical criteria for honey characterization– namely, water content, ash, pH, electrical conductivity, HMF, glucose, fructose, sucrose as well as diastase activity. Reported works in the published scientific journals also reflect the importance of these honey specifications [8,15,18,34]. Chemical, physicochemical and palynological analyses have been used to characterize honey samples in order to distinguish their source type (honeydew or nectar) or floral origin or to control their quality [39].

**Colour**

The flavor and aroma of honey to be a characteristic "honey flavor," almost an infinite number of aroma and flavor variations can exist. As with color, the variations appear by the floral source. In general, light-colored honey is mild in flavor and a darker honey has a more pronounced flavor [67-68]. Exceptions to the rule sometimes endow a light honey with very definite specific flavors. Since flavor and aroma judgments are personal, individual preference will vary, but with the tremendous variety available, everyone should be able to find a favorite honey. The colours of honey form a continuous range from nearly water white to dark amber [6]. The colour of honey is related to its mineral content and is characteristic of its floral source. Light coloured honey typically has a mild flavor, while dark colored honey is usually stronger in flavor [52].

**HONEY MECHANISM OF ACTION**

Honey having multi action in the body, it is considered as demulcent and laxative. Honey more than a year old is astringent, demulcent, pectoral, emollient and laxative. The fatty acids present in the honey stimulate peristalsis and digestion. It is the most potent fuel to provide energy for muscles and consequently most value for all important most vital muscle and the heart muscle also. Lime in honey is wonderful in regulating the secretions of internal glandular organs being equally good for person of both the sexes, irrespective of age from infancy to old age. It has hypnotic action in bringing sound sleep if taken with water before going to bed in dosage of two table spoons in the a big cupful of water .It decreases flatulence and increases general metabolism. It stimulates the mucous surfaces when applied locally. A special protein secreted by honey the bees contained in honey when inoculated into rabbits causes the formation of antibodies in the serum.

**Therapeutic investigations of honey**

Honey is mostly used in the preparation of confection and electuaries and as an adjunct to decoction, pills and powder. Among all the foods containing carbohydrate, honey is the most wholesome, valuable and delicious. As a demulcent and warm barley water are given internally in constipation and indigestion in bronchial asthma, chronic cold, and sore throat. When combined with milk honey forms an ideal food for growing children's and adults. A mixture of honey and distilled water, vinegar, lime juice in equal parts melted together by gentle heat is an excellent adjunct to cough mixture. In severe cases of malnutrition with heart weakness and in case of pneumonia honey has bound to have a marked effect in reviving the heart action and keeping the patient alive. In old age honey is especially useful in providing energy and heat to body, It dries up phlegm and clears the system of mucous which necessary in weakness that a man generally falls victim to in his old age. The use of honey internally and sunlight externally to the body directly has been ellogised as an ideal remedy to regulate the secretion of internal glands and calcium metabolism. Practioners of Hindu, Greek, Arabic schools of medicine gives honey to diabetics with many of their medicinal preparations, the ferment and a special protein as well as Vitamin in honey perhaps amount for beneficial action of honey in diabetics. A paste of Honey with flour is popular application to promote maturation of abscesses, ulcer, and buboes. Honey is used as an emollient, it is used as gargle to cure aphthae in a mouth and a vehicle to other agent it is used as an application to the throat infection. Honey with lime is used as an external application to the temples in headache. Honey by itself or mixed with ghee applied to burns, ulcer, soulds and wounds soother and has them rapidly. Rubbed over the teeth with charcoal powder makes them clean and white as snow Honey when rubbed over greasy dirty hands, it cleans them rapidly[61,23,65-68].

**Special investigations in therapy of honey with pollen**

Due the high content of potassium in honey it creates hygroscopic power and use as disinfectant. The germs thrive in moisture, this effect will deprived them of their nourishment and they die. Egyptian applied honey to open wounds and watched the healing pake place. Orientals applied an ointment of honey and pollen to open scrabs for skin break out to promote healing. The ancient Hebrew physicians combined honey with pollen for dressing on ulcerated wounds, burns and boils. Some Indian used pollen and honey for dressing their open wounds, in many regions of Europe people use a combination of honey and pollen to help healing respiratory ailments. Folklorist suggests that you dissolve one table spoonful of honey, one teaspoon of bee pollen and some lime juice in a cup of freshly boiled water. This mixture soothes respiratory distress, sore throat and other symptom of lungs discomfort. Early New England settler prepared this mixture-four tablespoonful of honey two teaspoons of pollen three teaspoon of apple cider vinegar in a cup of freshly boiled water, sip slowly at bed time, give natural sleep. Combine two table spoons of pollen , one tea spoon of chopped ginseng herb and dried orange peel , Take with a spoon, Oriental healer believe that this create a feeling of

total reinvention and vitality. We can use honey and pollen to solve problems of irregularity when taken with pollen either in liquid s on as a topping on thick black bread [5,23, 57,60,61].

## CONCLUSION

Ethiopia has huge potential for honey production, which is clearly observed in the last few years with significant increment, even though the subsector is still practicing with traditional with low productive systems. Research and extension made so far have tried to improve this scenario in the country. Various investigations in particular have identified the problems in the production and marketing of the Ethiopian honey industry. It is apparent that a lot more is to be done in improving the quality of the honey produced.

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