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TRADITIONAL AND MODERN THERAPEUTIC APPLICATIONS OF HONEY: AN UPDATED REVIEW

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ABSTRACT:

Honey is defined as the natural sweet substance produced by honeybees. Honey consist mainly sugars but also contains some amounts of acids, phenolic contents, HMF (Hydroxyl Methyl Furfural), minerals and water. Honey is well known for its anti-inflammatory and antioxidant capacities, which may be useful for the prevention of chronic inflammatory process like atherosclerosis, diabetes mellitus and cardiovascular diseases. It has been used both as food and medicine since ancient times. It has been reported to have an antimicrobial effect on many pathogenic microorganisms. Antioxidant capacity of honey is important in many disease conditions and is due to a wide range of compounds including phenolics, peptides, organic acids, enzymes. Honey also been reported as an alternative medicine for gastrointestinal, cardiovascular, inflammatory states. It is also useful as anticancer, antidiabetic and weight management agent. Beside the medicinal values, it also acts as prebiotic compound and so it stimulates the growth of probiotics. This review covers the pharmacological properties, composition and some important medical uses of honey.

Keywords: Honey, Madhu, *Yogvahi*

INTRODUCTION:

Honey is the sweet natural substance, produced by honeybees from the nectar of plants or from excretions of plant-sucking insects on the living parts of plants, or from secretions of living parts of plants, which is collected by bees, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature[1]. Honey is mentioned as the best *Yogvahi* in Ayurvedic literature[2]. The principle of *Yogvahi* is more or less similar to the concept of bio-enhancers in contemporary science. Therefore, it can be stated that honey has been used as *Anupaan*to increase the palatability and bioavailability of the principle drug. It is used as a vehicle in union with some medicines to alleviate its efficacy or reduce the side effects of other medications. Honey is one of the five elements of *Panchamrit*, or "the five nectars," in Hindu rituals. The other four ingredients are ghee, milk, sugar, and buttermilk [3].

Morphological Characteristics of Honey:

Synonym: *Pushpasava, Pushpsara, Ksaudra, Madhvika*;Biological sources: Apismelifera and dorsota; Order: Hymeropetra; Family: Apidae; Geographical sources: Honey is produced in India, Britain, New Zealand, Africa, and Australia.

Properties and Action[4]

i. *Rasa: Madhura, Kashaya*
ii. *Guna: Laghu (Sushruta), Guru (Charaka), Ruksha, Picchila, Yogavahi*
iii. *Veerya : Sita*
iv. *Vipaka: Katu*
v. *Karma: Agnideepana, Chaksushya, Pittaprashman, Ropana, Sandhana, Shleshmprasamana, Sodhana, Tridoshprasamana, Vatapittaghana,Vishaghana.*

Vernacular Names

i. Assamese: Madhu
ii. Bengali: Madhu, Mau
iii. English: Honey
iv. Gujrati: Madh
v. Hindi: Madhu, Shahad
vi. Kannada: Jentuppa
vii. Malayalam: Then
viii. Marathi: Madh
ix. Orrisa: Mahu
x. Punjabi: Shahad
xi. Tamil: Then
xii. Telugu: Tene
xiii. Urdu: Shahad

***Rasapanchak* and *Doshaghanta* according to Acharyas:**

Attributes	***Charaka Samhita***	***Sushruta Samhita***	***AshtangaSangraha***	***AshtangaHridya***
Rasa	*Madhura, Kashaya*	*Madhura*	*Madhura, Kashya*	*Madhura, Kashya*
Anurasa	-	*Kashaya*	-	
Guna	*Guru, Ruksha*	*Laghu, Ruksha, Picchila*	*Guru, Ruksha*	*Ruksha*
Virya	*Sheeta*	*Sheeta*	*Sheeta*	-
Vipaka	-	-	*Katu*	-
Dosghanta	*Vatkarak, Kaph pitta nashak*	*Tridoshnashak*	*Vatkarak, Kaphpittanashak*	*Vat karak, Kaph pitta nashak*

Historical Review

Ancient Literature: The First description of Madhu is found in Rigveda (Rigveda).

Samhita kala:

Charaka Samhita: In *Charaka Samhita* it is mentioned in Ikshu Varga[5].

***Sushruta Samhita*: (1000 BC- 2nd cent. AD):** In *Sushruta Samhita* it is mentioned in *Madhu varga*[6].

***Ashtanga Sangraha& Ashtanga Hridaya*: (7th cent. AD):** In *Ashtanga Sangraha*&*Ashtanga Hridaya,* it is mentioned in *Madhu Varga*[7][8].

Nighantu Kala:

Table 2. Classification of honey in different *Nighantus*

Name of *Nighantu*	**Category**
***Ashtanga Nighantu*[9]**	*ViprakeernaPrakarana*
***Dhanvantari Nighantu*[10]**	*SuvarnadiVarga*
***Hridaya Deepak Nighantu*[11]**	*DwipadaVarga*
***Madan Pal Nighantu*[12]**	*IkshukadiVarga*
***Raj Nighantu*[13]**	*PaneeyadiVarga*
***Kaiyedev Nighantu*[14]**	*OushadhiVarga*
***Bhav Prakash Nighantu*[15]**	*Madhu Varga*

Chemical constituents:

Honey is a supersaturated sugar solution with approximately 17.1 percent water. It consists chiefly of fructose (40-50%), glucose (30-40%), and small amounts of sucrose (0.1-10%), dextrin, formic acid, volatile oil, and pollen grains. In addition to these, traces of enzymes, vitamins, proteins, maltose, melezitose, pentosans, gums, trace elements, amino acids, and coloring matter are also present*[16].* The antioxidant activity of honey is also due to the presence of these enzymes[17].

Varieties of Honey:

According to the *Charaka Samhita*, honey is of four types, namely *Bhramara,Makshika,Pouttika,* and,*Kshaudra[18].* The best type of honey, i.e*Makshika,* is produced by a reddish variety of honey bees. It resembles the color of *TilaTaila* (sesame oil). *Bhramara* type of beeproduces*Bhramara* honey. It is ofwhite color and *Guru* (heavy) in *guna*. A Small type of honey beeproduces*Kshaudra* honey and is of brown color. Large type of bee produces *Pouttika* honey and is of the color of ghee *Acharya Sushruta* described eight varieties of honey which as follows:[19]

1. *Bhramara*: It isexcessive*Madhur*that is why *Guru* (heavy).
2. *Pouttika*: It is formed from poisonous flowers. *RukshaGuna*and *Ushna Veerya* and lead to the vitiation of *Vata*, *Pitta,* and *Rakta*.
3. *Kshaudra* : It is *Laghu* (light) and *Sheet* (cold) in potency.
4. *Makshika*: It is the best honey, and it is largely utilised for *Kasa* and *Shwas* management.
5. *Chhatra*: It is primarily used for *Shwitra* (vitiligo), *Raktapitta*(bleeding disorders), diabetes mellitus and related diseases, and worm infestation.
6. *Ardhya* : It is best for the eyes.
7. *Auddalaka*: It is beneficial for voice and is used to treat dermatological disorders, anorexia, etc.
8. *Dala*: It vitiates*Pitta* and is used to manage vomiting and diabetes mellitus & related disorders.

Adulterants:

Honey is adulterated with corn syrup, cane sugar, and artificial invert sugar obtained by acid hydrolysis of sucrose. The sugar contains furfural, which gives a red color with resorcinol in the presence of hydrochloric acid on prolonged heating or storage of the honey; furfural may be formed in the genuine honey.

Chemical tests:

Following test can be done to determine adulteration:[16]

i. Fiehe'test for artificial invert sugar:Honey (10ml) is shaken with petroleum or solvent ether (5ml) for 5-10 minutes. The upper ethereal layer is separated and evaporatedusing a china dish. On addition to a 1% solution of resorcinol in hydrochloric acid (1ml), a transient red color is formed in natural honey, while in artificial honey, the color persists for some time.

ii. Reduction of Fehling's solution:To an aqueous solution of honey (2ml) Fehling solutions 1 & are added, the reaction mixture is heated on a steam bath for 5-10 minutes, brick red color is produced due to the presence of reducing sugars.

Experimental pharmacology

a. **Buckwheat honey increases serum antioxidant capacity in humans:** Nele Gheldof*et al.,* (2003) examinedthe acute effect of consumption of 500 mL of water, water with buckwheat honey, black tea, black tea with sugar, or black tea with buckwheat honey on serum oxidative reactions in 25 healthy men. Antioxidant capacity of human serum samples was measured using different methods: the oxygen radical absorbance capacity (ORAC) assay, ex vivo susceptibility of serum lipoprotein to Cu(2+)-induced oxidation, and the thiobarbituric acid reactive substances (TBARS) assay. The results showed that the serum antioxidant capacity determined by ORAC increased significantly by 7% following consumption of buckwheat honey in water[20].

b. **Anti-hyperglycaemic activity:** *Madhu* mixed with *Triphala Kashaya* (*Samyoga*) and processed with *Triphala Kashaya* (*Samskara*) was administered for 30 days at dose of 860mg/200g exhibited a significantreduction in serum glucose, serum cholesterol, and triglycerides concentration exhibiting antihyperglycaemic activity byStreptozotozin injection (30mg IP) /HFD (High fat diet) induced diabetes in obese Wistar albino rats[21].

c. **Antimicrobial and Anti-inflammatory activity:**Ilechie*et. al.,* (2012)studied the efficacy of Stingless bee honey (SBH) in bacterial conjunctivitis against *Staphylococcus aureus*and*Pseudomonas aeruginosa* in Hartley guinea pigs. The conjunctival application of honey or gentamicin one drop (70 µL) twice daily was used for treatment, and the results of this treatment were compared with control values. The topical application of SBH to infected conjunctiva eradicated bacterial infections and reduced both signs of inflammation and infectionduration. The SBH was more effective than gentamicin[22].

d. **Wound Healing:** To evaluate the effects of *Teucrium polium*honey on wound healing and tensilestrength, thirty-six Sprague-Dawley rats were randomly divided into four equal treatment and control groups. Over the dorsal

thoracicarea, two full-thickness incisions were made.After surgery, the animals were given Teucrium polium honey twice a day until complete recovery was accomplished. Histopathological examination revealed thatrelative epithelial proliferation, improved fibrous connective tissue, and angiogenesis granulation in *Teucrium polium*honey treated animals was excellent demonstrating that *Teucrium polium*honey can accelerate wound healing and tensile strength in rat skin wounds[23]. Bergman *et. al.,*(1983) conducted a study in which twenty-four male mice underwent skin excision (10x10 mm) from the nape of the neck, to the depth immediately above the first layer of muscle. Half of the animals had pure honey applied in a thin layer to the wounds, twice daily, while the control group had saline used at the same frequency and time of day. The honey-treated tissue underwent more rapid and more extensive epithelisation than did the saline-treated control. After three days, the honey-treated tissue had 58% more skin growth; after six days, it had 114% more, and after nine days, 12% more than the controls. Honey-treated mice had a greater thickness of granulation tissue in the centre of the wounds compared to the control mice[24]. Gupta *et. al.,*(1992) studied the effect of topical natural honey on the healing of infected skin wounds in buffalo calves and compared this effect to ampicillin ointment and ampicillin mixed with honey. They found that honey was significantly more effective than ampicillin or 2.5% ampicillin sodium in honey inaccelerating wound healing[25].Postmes*et al.,*(1997) conducted a study in which Deep skin burns were applied in twelve places on the flanks of three pigs and compared the efficacy of honey to sugar solutions and silver sulfadiazine (1% cream) in healing burn tissue. Honey and sugar both produced more rapid healing than silver sulfadiazine, with wounds closing within 21 days for honey and sugar but requiring 28-35 days for silversulfadiazine, suggesting honey produced more rapid and effective healing[26].

e. **Honey and gastric ulcers**: Kandil*et. al.,* (1987) studied Acetylsalicylic acid (50 mg/kg body weight) to induce gastric ulcers in 60 rats in a study. Twenty-four hours after administration of acetylsalicylic acid, 0.5 ml of either floral honey, honey produced by bees feeding on sugar, or saline was administered to each rat for three days. The dose of the test substance would be approximately equal to 4 g/kg bodyweight. Results showed that 80% of rats consuming floral honey wereclassed as healed, compared to only 47% of rats consuming sugar honey[27].

f. **Antimicrobial Activity:** Agar diffusion technique for antimicrobial activity of honey

was used against *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *Klebsiella pneumonia,* and *Candida albicans*. Five honey samples were diluted in two-fold dilutions to have 100, 50, 25, and 12.5% concentrations, respectively, and tested against the test organisms. Chloramphenicol at 30 µg/mL was used as a controlled drug against the bacterial isolates. Honey has an antimicrobial effect on certain microorganisms and inhibited all the organisms at 100% concentration[28].In an another study, using agar well diffusion assay,honeys were tested against *Staphylococcus aureus* with reference to phenol as a standard. Antibacterial activity ranged from < 2% (w/v) phenol to 58% (w/v) phenol[3]. Antibacterial activity of the honeys was assayed using standard well diffusion methods. All honeys were tested at four concentrations (10%, 5%, 2.5%, and 1% w/v) against *E. coli and P. aeruginosa.* Theinhibition zonewas measured, which showed a significant inhibitory effect on the growth of *E. coli* and *P. aeruginosa*[29]. Somal*et. al.,*(1994) found that the growth of a range of isolates of *H. pylori* was inhibited by a 5% v/v concentration of manuka honey in an agar well diffusion assay[30]. The antibacterial effect of some Sudanese honey was studied by Farouk *et. al.,* (1988) and compared to that of five antibiotics (30g/ml) ampicillin, cephradine, chloramphenicol, gentamicin, and oxytetracycline. Undiluted honey (0.2 ml) was tested against the pathogens *Bacillus subtilis, S. aureus, E. coli, Klebsiella aerogenes, and Pseudomonas aeruginosa.* All tested honey showed inhibitory against all these bacteria, but gentamicin was the only antibiotic effective against *P.aeruginosa*. The other antibiotics were more effective at inhibiting bacterial growth than the honey, measured in the inhibition zoneon agar plates[31]. Obi *et. al.,*(1994) conducted an*in-vitro* study in which Enteropathogens common in Nigeria were tested for sensitivity to honey by Filter paper disks impregnated with honey of varying concentrations placed on agar plate's inoculated with clinically isolated strains of a range of pathogens including *Salmonella typhi, Vibrio cholera,* and *Yersinia enterocolitica.* After measuringthe zone of inhibition, honey concentrations of 40% and above reduced bacterialgrowth, with undiluted honeyhaving the greatest effect[32]. In another study,the antimicrobial activities of raw honey against various human isolates *E. coli, S. aureus, C. Albicans, S. dysenteriae, P. aeruginosa, S. hemolyticus group B, Klebsiella sp., Proteus sp., E. cloacae, and H. influenza* were tested. The growth of all the species was completely inhibited by honey at various concentrations,

ranging from 30% to 100%. The most sensitive microorganisms are *E. coli, P. aeruginosa,* and *H. influenza*[33].

g. **Analgesic and anti-inflammatory effects of honey**:Zakaria *et. al.,*(2015)conducted studies on analgesic activity of honey using hotplate and formalin-induced paw licking models and anti-inflammatory activity by using the carrageenan paw edema method. The animals were divided into six groups, each with five animals. They were administered saline, honey (600 mg/kg), autonomic blockers (3 µg/kg of tamsulosin), 20 mg/kg (intraperitoneally) of propranolol, indomethacin (5 mg/kg), 2 ml/kg of atropine, or 10 mg/kg (intramuscularly) of hexamethonium or honey (200 and 600 mg/kg) with one of the blockers. According to the findings, Honey reduced pain perception, particularly inflammatory pain, while propranolol and tamsulosin administration neutralised honey's effect. Honey's effects were likewise spared by hexamethonium in both the early and late phases of the test, whereas atropine only inhibited the early stage. Atropine and hexamethonium spared honey's anti-inflammatory properties, but tamsulosin destroyed them, and propranolol only removed them at the peak of the inflammation. The results suggest the involvement of autonomic receptors in the anti-nociceptive and anti-inflammatory effects of honey. However, the level of involvement depends on the different types of receptors[34].

h. **Anti-viral activity:**Anti-viral activity of honey samples was evaluated using MDCK (Madin-Darby canine kidney cells) to test the synergistic effects of honey with known anti-influenza virus drug zanamivir or oseltamivir. Manuka honey efficiently inhibited influenza virus replication, which is related to its virucidal products. The IC_{50} of zanamivir or oseltamivir was lowered to about 1/1000th of their single-use value in the presence of 3.13 mg/mL manuka honey[35].

i. **Anti-allergic activity:** A study demonstrated that manuka honey could inhibit allergic disease by modulating mast cell response. The LAD-2 human mast cell line induced by calcium ionophore was utilized as an *in vitro* model of allergicreaction to evaluate histamine release inhibition, a key indicator of mast cell degranulation.And found that pretreatment of honey (0.5, 1, and 2%) was able to inhibit histamine release in a concentration-dependent manner[36]. Another study conducted by Duddukuriet. al., (1997) showed that intraperitoneal (i.p.) administration of 100 µl Rock bee honey (*Apisdorsata*) inhibited antibody responses in C57BL/6, BALB/c, and SWR/J mice induced by 10µg OVA. Specifically, its anti-passive cutaneous anaphylaxis was

indicated by suppressing antigen-specificIgE levels (IgE titer <4)[37].

Clinical Study

a. **Vernal keratoconjunctivitis:** The efficacy and safety of topical honey eye drops in patients with diagnosed Vernal keratoconjunctivitis were evaluated in a 60-patient double-blind clinical trial. Patients in the first group received fluorometholone drop (1%) and sodium cromolyn along with honey drops (60% honey in artificial tears), while patients in the second group received fluorometholone and sodium cromolyn along with artificial tear one drop every 6 hours for one month. The use of a honey drop (60%) had a significant impact on the reduction of eye redness, limbal papillae, and in improving the Vernal keratoconjunctivitis[38].

b. **Management of radiation mucositis:** A clinical study was conducted on 60 patients with oral malignancy having radiation mucositis, an early effect of head and neck radiotherapy, to evaluate the impact of natural honey on the onset and severity of radiation mucositis. Mucositis can cause ulcers, and patients may experience dysphagia and pain. The patients were assigned into three groups consisted of 20 patients each. Group 1, group 2, and 3 patients were instructed for topical application of natural honey, topical application of 0.15% benzydamine hydrochloride, and 0.9% normal saline, respectively. The effectiveness of honey in controlling radiation-induced oral mucositis was demonstrated by a significant reduction in mucositis in honey-received patients compared to 0.15 %benzydamine hydrochloride and 0.9 %normal saline-applied individuals[39].

c. **Hemorrhoids and Anal fissure:**A prospective pilot study was conducted to evaluate the therapeutic effect of topical application of the mixture of Honey, Olive Oil, and Beeswax on patients with anal fissure or hemorrhoids. For a maximum of four weeks, fifteen patients were given a 12-hour application of a natural combination combining honey, olive oil, and beeswax in a 1:1:1(v/v/v) ratio.In individuals with hemorrhoids, the honey mixture significantly reduced bleeding and relieving irritation.Aftertreatment, patients with anal fissures experienced considerable reductions in discomfort, bleeding, and itching[40].

d. **Anti-obesity and Anti-hyperlipidemic activity:** A Randomised, Open labeled, Controlled Clinical Study to evaluate the Anti-obesity and Anti-hyperlipidemic activity *Triphala Kashaya Samskaritha Madhu* was conducted. Ninety obese individuals were randomly allocated into three groups consisting of 30 subjects in each group. For the duration of One Mandala Kala (48 days), they were treated with lifestyle management (diet and

activity), unprocessed honey, and processed honey respectively at a dose of One*Pala* (48 g) in two divided doses in the morning and evening hours (on an empty stomach) with *Ushnodaka*(Luke warm water). In terms of all parameters (Body weight, Body Mass Index, Waist circumference, Hip Circumference, lipid profile), there was a significant reduction in the unprocessed and processed honey treatment groups[41].

e. Treatment of Burn wounds: Maghsoudi H*, et. al.,* (2011) conducted a clinical trial on burns patients to compare the efficacy of natural honey and mafenide acetate in burn wounds. Of the patients with honey-treated wounds, 84% showed satisfactory epithelialization by day 7 and 100% by day 21. In wounds treated with mafenide acetate, epithelialization occurred by day 7 in 72% of cases and 84% by day 21. In honey-dressed wounds, early subsidence of acute inflammatory changes, better control of infection, and quicker wound healing were observed. In mafenide acetate treated wounds, a sustained inflammatory reaction was noted even on epithelialization[42]. Similililarly, Subrahmanyam, M., (1991) compared the efficacy of honey with silver sulfadiazine (SSD). In Honey treated wound, healthy granulation tissue appeared at an average of 7.4 days, compared to 13.4 days for SSD patients. Wounds healed more rapidly in the honey group patients within ten days and all within 40 days than compared to the SSD group patients within 30 days and all within 60 days.In another study conducted by him, patients had a mean burn area of 15% of the body surface. One group received 16-30 ml, unprocessed honey every two- days along with a topical application of Honey & SSD. Epithelisation was achieved within seven days in 84% for honey-treated patients and within ten days for all, compared to 72% and 84% respectively for SSD. Histological analysis of tissue showed that the honey-treated tissue underwent earlier subsidence of acute inflammation[43]. Subrahmanyam, M., (1994) conducted a similar clinical trial to compare the efficacy of Amniotic membrane (prepared from fresh caesarian or vaginal deliveries) and topical honey to treat partial-thickness burns. The burns treated with honey healed faster compared to those treated with an amniotic membrane (9.4 vs. 17.5 days) with less scarring[44]. Subrahmanyam M., (1996) again conducted a trial comparing honey to boiled potato peel to treat partial-thickness burns. Burns healed more quickly in the honey-treated group (mean 10.4 days vs 16.2 days) and granulation tissue appeared sooner (mean 6.8 days vs. 9.2 days)[45]**.** Efem, 1988 conducted a clinical study in which Unprocessed honey was used to treat 59 individuals with sores and

ulcers, most of whom (80%) had failed to heal with conventional treatment. Following topical application of honey, fifty-eight instances exhibited significant improvement. Honey debrided wounds heal rapidly, replace sloughs with granulation tissue, promote rapid epithelialization, and absorb edema around the ulcer margins[46].

f. Prophylactic Agent Of Endophthalmitis: Cernak *et. al*., (2012) conducted a study to determine if a 25% (w/v) honey solution effectively eradicates bacterial ocular pathogens in patients undergoing cataract surgery or vitrectomy in the perioperative period, and to compare its efficacy to 0.3 % of ofloxacin. In this pilot study, 101 patients were randomized to honey (n = 49) or ofloxacin (n = 52) treatment. Eye drops were given to both groups five times a day for seven days before and after surgery. In the ofloxacin group, 18 isolates and in honey groups 25 isolates, were found before the antibacterial drugs were administered. Each therapeutic group had four isolates (coagulase-negative *Staphylococcus*) after seven days of administration. No significant difference in antibacterial effect was found between groups indicating that honey may act as a prophylactic agent of endophthalmitis[47].

Allergic reactions due to honey: Honey allergy is a very rare, but serious health condition. A case of a 40-year-old female detected with honey allergy confirmed by Skin prick tests (SPT). At the age of 36 she had 2 episodes of generalized urticaria 20 minutes after ingestion of foods with honey and at the age of 37, five minutes after an inadvertent contact with a teaspoon with traces of honey, she got swollen lips and within 10 minutes urticaria, angioedema. The symptoms resolved after oral corticosteroids and antihistamines[48]. In another case a female 19 years old, suffering from summer rhinoconjunctivitis presented with angioedema of the lips and tongue, runny nose, cough, dyspnoea, dizziness, followed by collapse, ten minutes after eating bread and honey. This required hospitalization and treatment with high dose corticosteroids and anti-histamines. After two weeks, the patient underwent to skin prick tests which was positive for Millefiori honey(a variety of honey produced in Italy)[49].

CONCLUSION:

Due to variation of botanical origin honey differs in appearance, sensory perception and composition. The main nutrition- and health relevant components are the carbohydrates, which make it an excellent energy source especially for children and sportsmen. Microbial resistance to honey has never been reported and so makes it a very prom- ising alternative therapeutic. Manuka honey has

been widely researched and its antibacterial potential is re- nowned worldwide. The potency of honeys, such as Tualang honey, against microorganisms suggests its potential to be used as an alternative therapeutic agent incertain medical conditions, particularly wound infection. Honey is highly nutritional with promising properties of antioxidant, anti-inflammatory, anti-bacterial agent as well as cough reducing and wound healing characteristics. Honey also improves the serum testosterone concentration, sperm count and fertility. The foremost concern in the medicinal application of honey in modern medicine is variation in its composition and lack of clinical trials.

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