FALTUS, Anita Maria, PAWŁUSZKIEWICZ, Karolina, MIKOŁAJCZAK, Michał, KORGIEL, Matylda, and GAWEŁ-DĄBROWSKA, Dagmara. Benefits of Honey Supplementation for Enhancing Health and Athlete Performance. Quality in Sport. 2025;40:59354. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.40.59354
https://apcz.umk.pl/QS/article/view/59354

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 11.03.2025. Revised: 21.03.2025. Accepted: 03.04.2025 Published: 03.04.2025.

Benefits of Honey Supplementation for Enhancing Health and Athlete Performance

Anita Maria Faltus
Faculty of Medicine at the Wrocław Medical University
Wybrzeże L. Pasteura 1, 50-367 Wrocław, Poland
anita.faltus@gmail.com
https://orcid.org/0009-0007-2881-6553

Karolina Pawłuszkiewicz
Faculty of Medicine at the Wrocław Medical University
Wybrzeże L. Pasteura 1, 50-367 Wrocław, Poland
karolina.pawluszkiewicz@student.umw.edu.pl
https://orcid.org/0009-0006-1297-5958

Michał Mikołajczak
Faculty of Medicine at the Wrocław Medical University
Wybrzeże L. Pasteura 1, 50-367 Wrocław, Poland
mikolajczak-michal@o2.pl
https://orcid.org/0009-0000-7280-9405

Matylda Korgiel
Faculty of Medicine at the Wrocław Medical University
Wybrzeże L. Pasteura 1, 50-367 Wrocław, Poland
korgielmatylda@gmail.com
https://orcid.org/0009-0009-8265-406X

Dagmara Gaweł- Dąbrowska
Department of Population Research and Prevention of Civilization Diseases
Facualty of Health Sciences, Wroclaw Medical University
dagmara.gawel-dabrowska@umw.edu.pl
https://orcid.org/0000-0001-9076-4247

ABSTRACT

Introduction: Honey may be one of the oldest substances known to man. Throughout history, it has been used not only as a healthy sweetener, but also as a medical remedy for wound care, digestive disturbances, skin conditions, cough and many others. Contemporary research has focused on broadening our understanding of its mechanisms of action and exploring additional potential benefits of honey for both health and physical performance enhancement.

Purpose of the work: The aim of this study is to evaluate existing research on the influence of honey supplementation on health, in both a protective and therapeutic capacity, as well as its potential in enhancing athlete physical performance and recovery.

Materials and methods: A comprehensive literature search and analysis was conducted on PubMed, Scopus, Google Scholar and Science Direct databases, encompasing both clinical trials and studies on animal models.

Results: This review establishes honey as a natural therapeutic agent not only for skin conditions, wound healing and cough relief, but also as a potential aid in managing various cardiovascular disorders. Nevertheless, further research is needed. Furthermore, we recognize

honey as a cost-effective and reliable alternative to sports supplements, such as carbohydrate gels and sports drinks.

Keywords: honey, antioxidants, phytochemicals, health benefits, physical performance

INTRODUCTION

A golden, sweet, sticky liquid - with this description we most often associate honey, but its characteristics, properties and applications in the modern world are much more diverse.

Honey is a natural substance produced by honey bees (Apis Mellifera). The bees gather either flower nectar, plant secretions or excretions of sap-feeding insects, which they then transform and store in honeycombs to ripen and mature into honey [1]. With evidence of its use dating back to the Stone Age, honey may be one of the oldest substances known to mankind [2,3].

Honey exhibits numerous unique medicinal properties, therefore supplying various health benefits for the human body. Many of these have been discovered and employed by our ancestors without knowing the scientific framework of honey or the active compounds present [2]. Used throughout the ages as both food and medicine, the sweet liquid has become a great interest of contemporary research, which aims to understand the exact mechanisms of its action and fully harness honey's therapeutic and ergogenic potential [4].

Honey is a complex mixture that on average comprises 80-85% carbohydrates, primarily simple sugars: glucose and fructose, 15-17% water and 0,1- 0,5% proteins. Additionally, it contains vitamins (including B vitamins and vitamin C) and minerals (such as calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium and zinc), enzymes, organic acids and phenolic compounds [4,5,6]. Researchers have paid special attention to flavonoids and phenolic acids, which are the reason for honey’s antioxidant and anti-inflammatory features and therefore, most of its health qualities [7].

Though honey is primarily valued for its sweet taste and nutritional properties, it exhibits many protective effects of the body. It is used in reducing inflammation and the treatment of wounds, as an antimicrobial, antifungal and antiviral agent, as well as in broadly understood improvement of the general health of the body [8]. It also supports tissue regeneration, enhances hyaluronic acid production for skin health, and aids in ophthalmological and gastrointestinal

treatments [9]. What's more, in recent years, honey has been more closely investigated in view of enhancing physical performance, whether as a natural alternative to commercially available carbohydrate-rich gels and sports drinks, or as recovery aid [10,11,12,13].

The following literature review focuses on examining the potential benefits of honey supplementation, with special attention to athletes. It examines the effects of honey as a source of carbohydrates, considering the effects on recovery, endurance and overall physical performance, in comparison with other carbohydrate-based supplements. In addition, we wanted to highlight its anti-inflammatory and anti-oxidant properties, as well as a number of health benefits resulting from its use.

HONEY CHARACTERISTICS

Types of Honeys

Honey as a natural product shows great diversity in terms of tastes, colors and aromas, as well as a wide range of health benefits resulting from its rich composition. The final product and its properties depend on factors such as: the geographical origin and the source of honey, the type of bees and the processes it undergoes [14,15,16]. Specific honeys have their own unique properties. For example, pine honey lowers the levels of unfavorable oxidative markers in the kidneys, heart, and liver. Malicia honey reduces the level of low-density lipoproteins (LDL). The use of Clover, gelam, and acacia honeys can improve the lipid profile by lowering the level of triglycerides, and Kelulut honey can be a prevention against the development of colon cancer [15,16]. Honey is a unique product that in recent years has been gaining popularity both among researchers who want to discover its hidden properties and among people who, in addition to its taste values, are increasingly noticing its health promoting properties [14,15,16,17].

Currently, we differentiate and classify over 300 types of honey. Their division is made not only based on origin but also on the content of specific nutrients and health benefits that go hand in hand with them [6,17].

Nutritional and Phytochemical Composition of Honey

The main components of honey are carbohydrates (~80%), mostly fructose and glucose, which constitute 38% and 31% of the composition, respectively. Disaccharides such as maltose, sucrose, maltulose, turanose, isomaltose, laminaribiose, nigerose, kojibiose, gentiobiose, and B-trehalose are also present. Trisaccharides include maltotriose, erlose, melezitose, centose 3-a5, isomaltosylglucose, l-kestose, isomaltotriose, panose, isopanose, and theanderose.

Diastase, invertases, glucose oxidase, catalase and acid phosphatase are enzymes that constitute the main protein component (0,1-0,4%) of honey. Amino acids are also present, the most important of which is proline [14,17]. The low pH of honey, which oscillates around 3.2-4.5, is the result of the presence of gluconic acid, which is formed by the oxidation of glucose and is the main organic acid of honey [17].

The vitamins found in honey are primarily Vitamin C and vitamins from group B, especially vitamin B6, thiamine, niacin, riboflavin and pantothenic acid. Honey is also rich in minerals, such as sodium, potassium, calcium, phosphorus, sulfur, magnesium and chlorine, which are the basic minerals necessary for the functioning of the body. Interestingly, some amounts of heavy metals such as arsenic, lead or cadmium have also been confirmed in honey [14,17].

Honey's antioxidant properties are associated with the phytochemicals such as flavonoids and phenolic acids present. The content of phytochemicals may vary between individual varieties of honey [18]. Flavonoids such as quercetin, myrcetin, hesperidin, apigenin and cinnamic acids "cooperate" with other antioxidant compounds, for example with vitamin C. By inhibiting its oxidation, they additionally enhance vitamin C's abilities. Moreover, they participate together with vitamin C in the formation of collagen, which is necessary for maintaining the elasticity of blood vessels, therefore enhancing the condition of the cardiovascular system [19]. Research indicates that flavonoids also reduce LDL level and stimulate the synthesis of prostacyclins, thus providing anti-aggregating, chelating effects [18,19].

The content of flavonoids and phenolic acids in honey is several times lower than in vegetables or fruits, however, an appropriate supply of honey in the diet can be a supplement to antioxidants [19]. The correlation between the darker color of honey and its increased content of flavonoids and phenolic acids is very accurate [20]. Using Polish honeys as an example, it has been shown that in light honeys, such as acacia, rapeseed and lime honey, the content of flavonoids and phenolic acids was lower (267-390 mg/kg) compared to dark honeys such as buckwheat and deciduous honeydew (645-1260 mg/kg). It is also worth emphasizing that compared to other European, American and African honeys, Polish honeys are distinguished by a higher content of phenolic compounds [19,20].

PROTECTIVE EFFECTS OF HONEY ON THE BODY

Honey and the Cardio-Vascular System

Table 1. Overview of Honey's Effects on the Cardiovascular System

Mechanism of Honey's Action	Research Findings
The Impact of Honey on CRP, Glucose, Total Cholesterol, LDL-C, TG, and HDL-C Levels	Reduction in Glucose Levels [21] Reduction in Total Cholesterol Levels [21,22,23] Reduction in C Reactive Proteins Levels [21,22] Reduction in Low-Density Lipoprotein Cholesterol (LDL-C) Levels [21,22,23] Reduction [21,22] / Increase [23] in Triglycerides (TG) Levels Increase in High-Density Lipoprotein Cholesterol (HDL-C) Levels [21,23] Decrease in Lipid Peroxidation in Rats [24]
The Effect of Honey on Blood Pressure	A 12-month consumption of Tualang honey and its mixture with other bee products (95% honey, 4% bee bread, 1% royal jelly) led to a reduction in diastolic blood pressure [25].
Honey Inhibits ROS Production	The production of reactive oxygen species (ROS) in thrombin-induced neutrophils was significantly suppressed compared to the control group [26].
Honey Exhibits Antioxidant Properties	Honey feeding in rats resulted in increased levels of nitric oxide and α-tocopherol. [25] Honey supplementation in isoproterenol 4-[1-hydroxy-2-(isopropylamino)ethyl]benzene-1,2-diol hydrochloride-induced (ISO-induced) myocardial injury restored glutathione reductase (GRx) activity and enhanced the impaired scavenging activities of superoxide dismutase (SOD) and glutathione peroxidase (GPx) caused by ISO induction [27].
Honey Reduces Myocardial Damage	Reduction in Serum Levels of cardiac troponin I (cTn I), creatine kinase-MB (CK-MB), lactate dehydrogenase (LDH), aspartate

	transaminase (AST) and alanine transaminase (ALT), which are elevated due to ISO induction, was observed following pretreatment with Sundarban honey [27] and Tualang honey [28].
Honey Reduces Myocardial Infarction Size	A decrease in infarct size was also noted, with results varying depending on the concentration of honey, as compared to the control group [29].
Honey Alleviates Cardiac Arrhythmia	Isolated Rat Heart Model: 2011: Reperfusion with honey (1% and 2%) post-ischemia demonstrated reductions in Ventricular tachycardia (VT), Ventricular ectopic beats (VEB), VT occurrence, Total ventricular fibrillation (VF) episodes [30]. 2008 vs 2012: Honey concentrations of 0.25%, 0.5%, 1%, and 2% (2008) [31], as well as 0.125%, 0.25%, 0.5%, and 1% (2012) [29], showed reductions in VEB, VT frequency, and VT duration compared to the control group. 2013: Administration of honey at 1%, 2%, and 4% concentrations reduced VT and VEB frequency after 30 minutes of ischemia [32].

Honey and the Respiratory System

Honey alone does not have robust evidence supporting its efficacy in managing asthma. Contemporary research seeks to evaluate the therapeutic potential of honey in asthmatic patients, either as a monotherapy or in combination with other treatments [33]. The most commonly documented combination in the literature involves honey and saline solution. Studies employing this combination consistently reported significant enhancements across all measures of pulmonary function (forced vital capacity (FVC), forced expiratory volume (FEV1), and peak expiratory flow rate (PEFR)), respiratory muscle strength (maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP)), asthma control test scores, and clinical parameters (wheezing and vesicular breath sounds). Additional combinations explored in the literature include honey with celery seeds or Vrisha ghrita, both of which have demonstrated notable improvements in pulmonary function (FEV1 and FVC) and various clinical features [33,34].

The World Health Organization recognizes honey as a potentially effective demulcent for managing cough associated with upper respiratory tract infections (URTIs) in children. [35,36]. Demulcent syrups, characterized by their high sugar content, exert their effects by stimulating saliva production and the swallowing reflex while, owing to their viscosity, coating peripheral sensory receptors. This mechanism interrupts the transmission of irritative stimuli to the cortical neural network. Clinical trials have indicated that honey-based syrups may offer symptomatic relief for nocturnal cough associated with URTIs [35,37]. The available evidence suggests that honey is superior to placebo in reducing cough duration in children with acute cough. Additionally, honey decreases cough severity, alleviates bothersome symptoms, and improves sleep quality for both children and their parents to a greater extent than placebo, as confirmed by a recent meta-analysis [38]. However, the use of honey is contraindicated in children under 12 months of age due to the risk of infantile botulism [39].

Honey and Allergic conditions

Honey appears to be effective only for certain types of allergic conditions, as evidenced by diverse data regarding its impact on allergies. Significant improvements have been particularly observed in cases of allergies such as atopic dermatitis, whereas such effects were not reported for allergic rhinoconjunctivitis [40]. Research indicates that honey reduces the levels of specific IgE [41], which may inhibit allergic fungal rhinosinusitis by lowering IgE levels in affected patients. However, further studies are necessary to fully understand the factors contributing to these positive outcomes in allergic fungal rhinosinusitis patients [40,41].

The topical application of honey has been shown to substantially improve skin conditions such as erythema, abrasions, and swelling [40,42,43]. Additionally, regular honey consumption over a period of four weeks has demonstrated beneficial effects on allergic rhinitis symptoms [44]. Nonetheless, accurately assessing the efficacy of honey in alleviating allergic rhinitis symptoms remains challenging due to variations in administration methods across studies, including oral, nasal, and topical applications, regardless of the type of allergic conditions [40].

Honey and Wound Healing

Honey provides a moist environment conducive to healing, while its antibacterial properties prevent bacterial growth. Its anti-inflammatory and debridement actions, which remove necrotic tissue harboring bacteria, contribute to the effective treatment of chronic wounds. Maintaining honey in direct contact with the wound bed is essential, achieved through honey-impregnated primary dressings [45].

Honey must be sterilized, as bacterial spores, such as *Clostridium*, may survive and could theoretically germinate in necrotic tissue if diluted by wound exudate. However, no cases of wound infections caused by clostridial spores in non-irradiated honey have been reported. Sterilization should use gamma radiation to preserve antibacterial properties [45,46]. Medicinal honey must be free from contaminants, including pesticides, heavy metals, or toxic compounds from plants like rhododendrons and oleanders [46].

Clinically, honey has demonstrated efficacy in wound care, though the lack of high-quality randomized controlled trials remains a limitation. [47,48]. Based on three small studies (two involving toenail removal and one on minor traumatic wounds), it remains inconclusive whether honey accelerates the healing of minor acute wounds compared to conventional dressings. Low-quality evidence suggests honey may reduce burn healing time by 0.73–9.51 days (mean: 5.12 days) compared to silver sulfadiazine, with fewer adverse events and better wound swab results by day 7. No significant differences were found in complete healing rates after 4–6 weeks [49]. Overall, honey shows potential to accelerate wound healing compared to silver sulfadiazine or sugar dressings, but evidence remains limited [50,51].

Honey and Photoprotection

Research indicates that honey extracts exhibit strong antioxidant and antimutagenic properties, effectively protecting human immortalized keratinocyte cells from the cytotoxic and oxidative effects of ultraviolet (UV)-radiation. However, no significant correlation was observed between the total flavonoid content and the antioxidant capacity of the extracts, possibly due to their low concentration [52].

Furthermore, the application of manuka honey to whole blood samples from healthy volunteers resulted in substantial protection of blood cells against oxidative damage induced by hydrogen peroxide, as assessed using the comet assay in vitro [53]. To the best of our knowledge, this is the first study to demonstrate the protective effect of honey against UV-induced genotoxicity in human keratinocytes [52].

EFFECTS OF HONEY ON PERFORMANCE

Honey as an Energy Source

Glycemic index (GI) is a measure of the extent to which the available carbohydrates in certain foods raise the glucose levels, compared to consuming the same amount of pure glucose, where the GI equals 100 [54].

Honey has been used by athletes since ancient times as an energizing and restorative agent. It aids in recovery, helps replenish energy quickly, and combats fatigue. It can be used as a natural alternative to pre-training gels, providing a source of carbohydrates for athletes [10,11].

Honey consists mainly of glucose and fructose, each with distinct benefits. Glucose, with high glycemic index (GI), is rapidly absorbed, making it ideal for short bursts of activity or recovery. In contrast, fructose, a low GI monocarbohydrate, is absorbed more slowly, providing sustained energy release during endurance activities [54]. One tablespoon of honey delivers 60 calories and 17 grams of carbohydrates, with a GI ranging from 32 to 85, depending on its origin [9,10]. A lower GI, associated with a high fructose-to-glucose ratio, leads to a gradual rise in blood sugar, while a higher GI, linked to a low fructose-to-glucose ratio, results in a faster and more significant increase [9,10,55].

Honey's affordability and natural composition make it a cost-effective and reliable alternative to synthetic gels, providing a consistent energy source that supports athletic performance [11,12]. A study by Kreider et al. (2002) reported that honey improved performance and power output compared to a placebo, without causing hypoglycemia or gastrointestinal discomfort [11]. While honey provides energy and is absorbed into muscles within 10 minutes- a rate comparable to commercial gels, when compared to a water placebo, it does not consistently outperform them in enhancing performance [10,11,12,56]. Therefore, it serves as an equivalent rather than a superior substitute [12].

Honey as Rehydration and Performance aid

In addition to carbohydrate gels, athletes are increasingly turning to sports drinks, designed to aid hydration and energy replenishment through a balanced composition of sugars and electrolytes. Honey, containing 18-20% water and small amounts of isotonic substances, has also been shown to support water balance, particularly during athletic performance [10].

Samsani et al. (2022), in a study conducted on runners demonstrated that both honey and sports drinks enhanced energy availability, improving performance and rehydration compared to water [13]. However, Mayhew et al. (2007) in their research on cyclists found no significant differences in performance times [56]. Several studies also reported that honey-based drinks not only boost energy availability but also support thermoregulation during exercise, helping athletes maintain high-intensity training and reduce fatigue without altering internal body temperature [9,56,57].

Despite these findings, other studies reported no significant changes in physiological measures such as body weight, oxygen uptake, heart rate, perceived exertion, body temperature,

or urine osmolality in athletes supplementing with honey [10]. Furthermore, honey supplementation before anaerobic sprint tests was found to have no significant impact on performance, showing no effects on power output, fatigue index, or perceived exertion compared to a placebo [58].

The Combined Effects of Honey and Exercise

Honey supplementation with aerobic exercise has been shown to improve bone formation, measured by the rise in serum alkaline phosphatase (ALP) concentration, more significantly than honey or aerobic training alone [59]. Studies conducted on animal models reported that honey alone does not enhance osteogenesis, instead exercises like jumping are required to increase bone density [60,61] and maximum force output [61]. Higher-intensity jumping training combined with honey supplementation was found to cause notable improvements in bone properties [62]. Additionally, this combination caused a reduction of stress hormones while simultaneously increasing progesterone levels in the blood [62]. Furthermore, research indicates that low doses of honey combined with endurance exercises promote the production of antioxidant enzymes [63] and enhance anti-inflammatory properties [64]. However, Yusof et al. (2018) suggest that these effects cannot be conclusively attributed solely to the properties of honey [18].

Effects of Honey on Muscle Regeneration and Recovery

Honey combined with protein post-exercise enhances glycogen replenishment, accelerates energy refueling, and promotes muscle repair and growth by triggering an anabolic hormonal response. Research highlights that consuming carbohydrates and protein within 2 hours post-exercise maximizes these recovery benefits [10]. Moreover, a study conducted on cyclists supplementing honey showed lower levels of inflammatory cytokines and reduced oxidative stress biomarkers in the honey group, compared to participants consuming isotonics [63]. Phenolic acids present in honey were found to help protect endothelial cells from oxidative stress, which is crucial for maintaining vascular health during and after intense exercise. It aids in reducing damage caused by reactive oxygen species produced during strenuous activities [10].

A more recent study, Hemmati et al. (2024), carried out on 16 women at a sports camp found that the group consuming a honey-sweetened beverage experienced lower levels of muscle soreness (DOMS) and better recovery performance compared to the placebo group. These results suggest that honey may help reduce muscle damage and aid recovery after intense exercise [65].

ADVERSE EFFECTS OF HONEY

One of the key advantages of honey consumption for athletes is the low possibility of side effects, especially when compared to other sports supplements or energy drinks, which may contain artificial additives, high sugar concentrations, or stimulants like caffeine [57]. When consumed in appropriate amounts, honey typically does not cause gastrointestinal distress, a common issue with other supplements like sports drinks or gels [57]. One study, however, reported minimal gastrointestinal issues following honey supplementation, though mild enough not to detract from performance [58]. Honey provides sustained energy and hydration without significantly affecting blood sugar levels, making it a safe option during prolonged activity. Its combination with water enhances fluid retention and electrolyte balance [11,12,57,66].

Nevertheless, as a sugar-based product, honey can cause blood glucose increases, potentially leading to insulin sensitivity issues over time, especially for those at risk of diabetes [13]. Overconsumption can damage tooth enamel, cause cavities, and lead to bloating, diarrhea, or cramps [13].

SUMMARY AND CONCLUSSIONS

Honey is a natural product with a long history of use as both food and medicine. Recent research explores its potential in enhancing physical performance, positioning honey as a natural alternative to commercial sports supplements [10,11,13].

Honey benefits the body by lowering glucose, LDL-C and inflammation while boosting HDL-C and heart health [21,22,23]. It aids cough relief in children, though not infants, and may contribute to allergy relief by reducing IgE levels [41]. Its antibacterial and moisturizing properties support wound healing, however medicinal honey must be sterilized prior to use [50,51]. Furthermore, it offers some UV protection by reducing oxidative stress in skin and blood cells [52].

Honey also acts a natural alternative to sports gels and drinks, providing quick and sustained energy through glucose and fructose components. It aids performance, recovery, hydration, and thermoregulation, though studies report inconclusive results regarding its superiority over commercial products [9,55,56,57]. Honey helps maintain blood glucose levels, delays fatigue and supports endurance, while its isotonic properties promote hydration. It also aids post-exercise recovery by replenishing glycogen and reducing inflammation [10, 56].

Though generally well-tolerated and safe, honey has few reported adverse effects, including blood sugar spikes or digestive discomfort, if overconsumed [9]. While it does not

significantly enhance performance beyond other carbohydrate sources, it remains a reliable and cost-effective energy option for athletes. Despite its centuries-old tradition of use, further research is still needed to explore its maximal therapeutic potential as well as the long-term effects on athletic health and performance [12,54,58].

Author's contribution: Conceptualization, MK; methodology, MM, KP, AF; check, MK, KP, DGP; investigation, MM, KP, AF; resources, MM, KP, AF; data curation, MK, MM, KP, AF; writing - rough preparation, MM, KP, AF; writing - review and editing, MK; visualization, MK; supervision, MK, DGP; project administration, DGP;
All authors have read and agreed with the published version of the manuscript.

Funding Statement: This study did not receive any external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflict of Interest Statement: Not applicable.

REFERNCES

1. Council Directive 2001/110/EC of 20 December 2001 relating to honey EU Council - Official Journal of the European Communities L, 2002
2. Khan RU, Naz S, Abudabos AM. Towards a better understanding of the therapeutic applications and corresponding mechanisms of action of honey. Environ Sci Pollut Res Int. 2017;24(36):27755-27766. doi:10.1007/s11356-017-0567-0
3. Havsteen BH. The biochemistry and medical significance of the flavonoids. Pharmacol Ther. 2002;96(2-3):67-202. doi:10.1016/s0163-7258(02)00298-x
4. Cortés, M., Vigil, P., & Montenegro, G. The medicinal value of honey: a review on its benefits to human health, with a special focus on its effects on glycemic regulation. International Journal of Agriculture and Natural Resources. 2011;38(2):303-317.
5. Palma-Morales M, Huertas JR, Rodríguez-Pérez C. A Comprehensive Review of the Effect of Honey on Human Health. Nutrients. 2023;15(13):3056. Published 2023 Jul 6. doi:10.3390/nu15133056
6. da Silva PM, Gauche C, Gonzaga LV, Costa ACO, Fett R. Honey: Chemical composition, stability and authenticity. Food Chemistry. 2016;196:309-323. doi:https://doi.org/10.1016/j.fo-odchem.2015.09.051
7. Nikhat S, Fazil M. History, phytochemistry, experimental pharmacology and clinical uses of honey: A comprehensive review with special reference to Unani medicine. Journal of Eth-nopharmacology. 2022;282:114614. doi:https://doi.org/10.1016/j.jep.2021.114614
8. Cianciosi D, Forbes-Hernández TY, Afrin S, et al. Phenolic Compounds in Honey and Their Associated Health Benefits: A Review. Molecules. 2018;23(9):2322. Published 2018 Sep 11. doi:10.3390/molecules23092322
9. Bogdanov S, Jurendic T, Sieber R, Gallmann P. Honey for Nutrition and Health: A Review. Journal of the American College of Nutrition. 2008;27(6):677-689. doi:https://doi.org/10.1080/07315724.2008.10719745
10. Ilia G, Simulescu V, Merghes P, Varan N. The health benefits of honey as an energy source with antioxidant, antibacterial and antiseptic effects. Science & Sports. 2021;36(4):272.e1-272.e10. doi:https://doi.org/10.1016/j.scispo.2020.10.005
11. Kreider, Richard B. PhD, FACSM, EPC; Rasmussen, Christopher J. CSCS; Lancaster, Stacy L. CSCS; Kerksick, Chad CSCS; Greenwood, Michael CSCS*D. Honey: An Alternative Sports Gel. Strength and Conditioning Journal. 2002;24(1):p 50-51.
12. Hills SP, Mitchell P, Wells C, Russell M. Honey Supplementation and Exercise: A Systematic Review. Nutrients. 2019;11(7):1586. https://doi.org/10.3390/nu11071586
13. Mohamad Samsani AN, Foong KO, Chen CK, Ismail MS. Effects of Acacia Honey Drink after Exercise-Induced Dehydration on Selected Physiological Parameters and Subsequent Running

Performance. Sains Malaysiana. 2021;50(8):2293-2308. doi:https://doi.org/10.17576/jsm-2021-5008-13

14. Ahmed S, Sulaiman SA, Baig AA, et al. Honey as a Potential Natural Antioxidant Medicine: An Insight into Its Molecular Mechanisms of Action. Oxid Med Cell Longev. 2018;2018:8367846. Published 2018 Jan 18. doi:10.1155/2018/8367846
15. Al-Kafaween MA, Alwahsh M, Mohd Hilmi AB, Abulebdah DH. Physicochemical Characteristics and Bioactive Compounds of Different Types of Honey and Their Biological and Therapeutic Properties: A Comprehensive Review. Antibiotics (Basel). 2023;12(2):337. Published 2023 Feb 6. doi:10.3390/antibiotics12020337
16. Mărgăoan R, Topal E, Balkanska R, et al. Monofloral Honeys as a Potential Source of Natural Antioxidants, Minerals and Medicine. Antioxidants (Basel). 2021;10(7):1023. Published 2021 Jun 25. doi:10.3390/antiox10071023
17. Samarghandian S, Farkhondeh T, Samini F. Honey and Health: A Review of Recent Clinical Research. Pharmacognosy Res. 2017;9(2):121-127. doi:10.4103/0974-8490.204647
18. Yusof A, Ahmad NS, Hamid M.S. A, Khong TK. Effects of honey on exercise performance and health components: A systematic review. Science & Sports. 2018;33(5):267-281. doi:https://doi.org/10.1016/j.scispo.2018.02.007
19. A. Wilczyńska, P. Przybyłowski. Characteristics of Phenolic Compounds Present in Honey. Scientific Journal of Gdynia Maritime University. 2009;61:33-38. Polish.
20. B. Kędzia, E. Hołderna-Kędzia. Presence of Phenolic Compounds in Bee Honey. Borgis: Postępy Fitoterapii. 2008;4:225-232. Polish.
21. Al-Waili N. Natural Honey Lowers Plasma Glucose, C-Reactive Protein, Homocysteine, and Blood Lipids in Healthy, Diabetic, and Hyperlipidemic Subjects: Comparison with Dextrose and Sucrose. J. Med. Food. 2004;7:100–107. doi: 10.1089/109662004322984789.
22. Yaghoobi N., Al-Waili N., Avan A., Parizadeh S.M.R., Abasalti Z., Yaghoobi Z., Yaghoobi F., Esmaeili H., Kazemi-Bajestani S.M.R., Aghasizadeh R., et al. Natural Honey and Cardiovascular Risk Factors; Effects on Blood Glucose, Cholesterol, Triacylglycerole, CRP, and Body Weight Compared with Sucrose. Sci. World J. 2008;8:463–469. doi: 10.1100/tsw.2008.64.
23. Rasad H., Entezari M.H., Ghadiri E., Mehaki B., Pahlavani N. The effect of honey consumption compared with sucrose on lipid profile in young healthy subjects (randomized clinical trial) Clin. Nutr. ESPEN. 2018;26:8–12. doi: 10.1016/j.clnesp.2018.04.016.
24. Busserolles J., Gueux E., Rock E., Mazur A., Rayssiguier Y. Substituting Honey for Refined Carbohydrates Protects Rats from Hypertriglyceridemic and Prooxidative Effects of Fructose. J. Nutr. 2002;132:3379–3382. doi: 10.1093/jn/132.11.3379.

25. Ab Wahab S.Z., Hussain N.H.N., Zakaria R., Kadir A.A., Mohamed N., Tohit N.M., Noor N.M., Hassan I.I., Noor N.M. Long-term effects of honey on cardiovascular parameters and anthropometric measurements of postmenopausal women. Complement. Ther. Med. 2018;41:154–160. doi: 10.1016/j.ctim.2018.08.015.
26. Ahmad A., Alam Khan R., Mesaik M.A. Anti inflammatory effect of natural honey on bovine thrombin-induced oxidative burst in phagocytes. Phytotherapy Res. 2009;23:801–808. doi: 10.1002/ptr.2648.
27. Afroz R., Tanvir E.M., Karim N., Hossain S., Alam N., Gan S.H., Khalil I. Sundarban Honey Confers Protection against Isoproterenol-Induced Myocardial Infarction in Wistar Rats. BioMed Res. Int. 2016;2016:1–10. doi: 10.1155/2016/6437641.
28. Khalil I., Tanvir E.M., Afroz R., Sulaiman S.A., Gan S.H. Cardioprotective Effects of Tualang Honey: Amelioration of Cholesterol and Cardiac Enzymes Levels. BioMed Res. Int. 2015;2015:1–8. doi: 10.1155/2015/286051.
29. Vaez H., Samadzadeh M., Zahednezhad F., Najafi M. Effect of post-ischemic administration of natural honey on ischemia-reperfusion induced infarct size in global ischemia model of isolated rat heart. Res. Pharm. Sci. 2012;7:819.
30. Najafi M., Shaseb E., Ghaffary S., Fakhrju A., Eteraf Oskouei T. Effects of chronic oral administration of natural honey on ischemia/reperfusion-induced arrhythmias in isolated rat heart. Iran. J. Basic Med. Sci. 2011;14:75–81.
31. Miran R., Nabil Z.I., Hussein A. Cardioactive and Vasoactive Effects of Natural Wild Honey against Cardiac Malperformance Induced by Hyperadrenergic Activity. J. Med. Food. 2008;11:91–98. doi: 10.1089/jmf.2006.172.
32. Eteraf-Oskouei T., Shaseb E., Ghaffary S., Najafi M. Prolonged preconditioning with natural honey against myocardial infarction injuries. Pak. J. Pharm. Sci. 2013;26:681–686.
33. Abbas AS, Ghozy S, Minh LHN, et al. Honey in Bronchial Asthma: From Folk Tales to Scientific Facts. J Med Food. 2019;22(6):543-550. doi:10.1089/jmf.2018.4303
34. Kotb FT: Medicinal Plants in Libya. Arab Encyclopedia House, Tripoli-Libya, 1985.
35. Murgia V, Manti S, Licari A, De Filippo M, Ciprandi G, Marseglia GL. Upper Respiratory Tract Infection-Associated Acute Cough and the Urge to Cough: New Insights for Clinical Practice. Pediatr Allergy Immunol Pulmonol. 2020;33(1):3-11. doi:10.1089/ped.2019.1135
36. WHO. Cough and cold remedies for the treatment of acute respiratory infections in young children 2001. Geneva, Switzerland: World Health Organization, 2001. available online: https://www.who.int/publications/i/item/WHO_FCH_CAH_01.02
37. Ayazi P, Mahyar A, Yousef-Zanjani M, et al. . Comparison of the effect of two kinds of iranian honey and diphenhydramine on nocturnal cough and the sleep quality in coughing children and their parents. PLoS One 2017; 12:e0170277.

38. Oduwole O, Udoh EE, Oyo-Ita A, et al. . Honey for acute cough in children. Cochrane Database Syst Rev 2018; CD007094.
39. Cox N, Hinkle R. Infant botulism. Am Fam Physician 2002; 65:1388–1392
40. Aw Yong PY, Islam F, Harith HH, Israf DA, Tan JW, Tham CL. The Potential use of Honey as a Remedy for Allergic Diseases: A Mini Review. Front Pharmacol. 2021;11:599080. Published 2021 Jan 26. doi:10.3389/fphar.2020.599080
41. Duddukuri G. R., Kumar P. S., Kumar V. B., Athota R. R. (1997). Immunosuppressive effect of honey on the induction of allergen-specific humoral antibody response in mice. Int. Arch. Allergy Immunol. 114, 385–388. 10.1159/000237699
42. Al-Waili N. S. (2003). Topical application of natural honey, beeswax and olive oil mixture for atopic dermatitis or psoriasis: partially controlled, single-blinded study. Compl. Ther. Med. 11, 226–234. 10.1016/s0965-2299(03)00120-1
43. Alangari A. A., Morris K., Lwaleed B. A., Lau L., Jones K., Cooper R., et al. (2017). Honey is potentially effective in the treatment of atopic dermatitis: clinical and mechanistic studies. Immun Inflamm Dis. 5, 190–199. 10.1002/iid3.153
44. Asha'Ari Z. A., Ahmad M. Z., Wan Din W. S. J., Che Hussin C. M., Leman I. (2013). Ingestion of honey improves the symptoms of allergic rhinitis: evidence from a randomized placebo-controlled trial in the East Coast of Peninsular Malaysia. Ann. Saudi Med. 33, 469–475. 10.5144/0256-4947.2013.469
45. Molan P, Rhodes T. Honey: A Biologic Wound Dressing. Wounds. 2015;27(6):141-151.
46. Scepankova H, Combarros-Fuertes P, Fresno JM, et al. Role of Honey in Advanced Wound Care. Molecules. 2021;26(16):4784. Published 2021 Aug 7. doi:10.3390/molecules26164784
47. Bowden L.G., Byrne H.M., Maini P.K., Moulton D.E. A Morphoelastic Model for Dermal Wound Closure. Biomech. Model. Mechanobiol. 2016;15:663–681. doi: 10.1007/s10237-015-0716-7.
48. Datta S., Sarkar R., Vyas V., Bhutoria S., Barui A., Roy Chowdhury A., Datta P. Alginate-Honey Bioinks with Improved Cell Responses for Applications as Bioprinted Tissue Engineered Constructs. J. Mater. Res. 2018;33:2029–2039. doi: 10.1557/jmr.2018.202.
49. Jull A.B., Cullum N., Dumville J.C., Westby M.J., Deshpande S., Walker N. Honey as a topical treatment for wounds. Cochrane Database Syst Rev. 2015;2015(3):CD005083. Published 2015 Mar 6. doi:10.1002/14651858.CD005083.pub4
50. Mphande A.N.G., Killow C., Phalira S., Wynn Jones H., Harrison W.J. Effects of honey and sugar dressings on wound healing. Journal of Wound Care 2007;16(7):317-9.
51. Subrahmanyam M. Honey as a surgical dressing for burns and ulcers. Indian Journal of Surgery 1993;55(9):468-73.

52. Karapetsas A., Voulgaridou G.P., Iliadi D. Honey Extracts Exhibit Cytoprotective Properties against UVB-Induced Photodamage in Human Experimental Skin Models. Antioxidants (Basel). 2020;9(7):566. Doi:doi:10.3390/antiox9070566
53. Živković L., Bajić V., Dekanski D., Čabarkapa-Pirković A., Giampieri F., Gasparrini M., Mazzoni L., Potparević B.S. Manuka honey attenuates oxidative damage induced by H2O2 in human whole blood in vitro. Food Chem. Toxicol. 2018;119:61–65. doi: 10.1016/j.fct.2018.05.034.
54. Monro JA, Shaw M. Glycemic impact, glycemic glucose equivalents, glycemic index, and glycemic load: definitions, distinctions, and implications. The American Journal of Clinical Nutrition. 2008;87(1):237S243S. doi:https://doi.org/10.1093/ajcn/87.1.237s
55. Truswell AS. Glycaemic index of foods. Eur J Clin Nutr. 1992;46 Suppl 2:S91-S101.
56. Mayhew I. Ergogenic efficacy of honey based sports drink during a simulated 56 mile cycling time trial. Handlenet. 2007. doi:http://hdl.handle.net/10034/133872
57. Ehab Sabry, Shalaby MN. Effect of a Nutrition Compound (Honey and Water) on Blood Glucose, Body Temperature and Some Physiological Variables in Wrestlers. 2010;3(3):930-935.
58. Woolfolk, Katelyn G., "Effect of Honey on Anaerobic Performance in Male Collegiate Soccer Players" (2012). Electronic Theses and Dissertations. 1011. https://digitalcommons.georgiasouthern.edu/etd/1011
59. Tavafzadeh SS, Chen CK, Ooi FK, Hamzah NA, Sulaiman SA, Osman JM. Effects of Aerobic Dance Exercise and Honey Supplementation Followed by Their Subsequent Cessation on Bone Metabolism Markers and Antioxidant Status in Young Collegiate Females. Malays J Med Sci. 2023;30(3):151-166. doi:10.21315/mjms2023.30.3.14
60. Tavafzadeh SS, Ooi FK, Krasilshchikov O, Sulaiman SA. Effect of a Combination of Jumping Exercise and Honey Supplementation on Bone Mass, Strength and Physical Dimensions in Young Female Rats. Journal of ApiProduct and ApiMedical Science. 2011;3(1):26-32. doi:https://doi.org/10.3896/IBRA.4.03.1.05
61. Ooi FK, Somayeh Sadat Tavafzadeh, Hung L, Hung W, He Y. Tibial Bone Mineral Density, Geometry and Mechanical Properties in Response to High Impact Exercise and Honey Supplementation in Rats. 2014;11(2):12-24.
62. Mosavat M, Ooi FK, Mohamed M. Effects of honey supplementation combined with different jumping exercise intensities on bone mass, serum bone metabolism markers and gonadotropins in female rats. BMC Complementary and Alternative Medicine. 2014;14(1). doi:https://doi.org/10.1186/1472-6882-14-126
63. Tartibian B, Maleki BH. The Effects of Honey Supplementation on Seminal Plasma Cytokines, Oxidative Stress Biomarkers, and Antioxidants During 8 Weeks of Intensive Cycling Training. Journal of Andrology. 2011;33(3):449-461. doi:https://doi.org/10.2164/jandrol.110.012815

64. Salehian O, Rashidi M, Sedaghat M. Oral supplementation of natural honey and levels of inflammatory and anti-inflammatory plasma cytokines during 10-week of intensive treadmill training in endurance-trained athletes. Biomedical Research - India. 2014;25(4):459-462.
65. Hemmati H, Walaa Jumah Alkasasbeh, Hemmatinafar M, et al. Corrigendum: Effect of a honey-sweetened beverage on muscle soreness and recovery of performance after exercise-induced muscle damage in strength-trained females. Frontiers in Physiology. 2024;15. doi:https://doi.org/10.3389/fphys.2024.1523903
66. Fadzel P. A Short Review of Honey Supplementation on Bone Metabolism Markers and Sports Performance. Transactions on Science and Technology. 2021;8(3-2):184-190.