

Honey for Healthy Living and Wound Healing for All? - A Concise Human Function Discourse

Charles Odilichukwu R Okpala*

Independent Academic Research Practice Consultant, Umuahia, Abia State, Nigeria

***Corresponding Author:** Charles Odilichukwu R Okpala, Independent Academic Research Practice Consultant, Umuahia, Abia State, Nigeria.

Received: July 12, 2019; **Published:** September 04, 2019

Abstract

Honey - found in almost every country/nation worldwide, remains a natural complex bioactive food item/stuff. Broadly, the health potential of honey emanates from naturally enriched/nutritive constituents that deliver considerable functional support to human metabolic system. Conversely, many around the world still have doubts particularly about honey's role in enhancing healthy living and wound healing despite its ancient nature and increasing scientific evidence. To help clear such doubts, some healthy living and wound healing aspects of honey via human function context is articulated in this concise discourse, hereby constructed as follows: some basics about honey and its processing, its function/role for healthy living and for wound healing. Personal opinions as well as reflections author included were based on experience/expertise, knowledge and understanding. Indeed, honey is relevant for across ages, from infancy, teens, adults, to elderly and invalid/sickly. Some physiological aspects of honey's wound-healing activity sanitizing wound location and surrounding, its efficacy in both healing and repair process, as well as scar formation/reduction are also highlighted.

Keywords: *Honey; Healthy Living; Wound Healing; Honey Efficacy; Human Immune System; Nutritional Significance*

Abbreviations

GI: Glycemic Index; ORS: Oral Rehydration Solution; MMP-9: Matrix Metalloproteinase-9; MRJP1: Major Royal Jelly Protein1; ROS: Reactive Oxygen Species; MG: Methylglyoxal; UMF: Unique Manuka Factor

Introduction

Honey is considered among the oldest global food items. Since ancient times, honey has been shown as a God gifted prestigious product [1]. For over 5000 years, it has been used in medicine/medical sector. In addition, cave paintings of about 8000 years ago reveal that humans first used honey, although it is only from about 2400 BC that its cultivation via bee colonies was shown [2]. Besides honey serving as traditional medicine since 2100-2000 BC, its availability and patronage based respectively of/for evidence-based data about its benefits as well as diverse ailment treatment have been on the rise [3]. Egyptian papyri recorded of between 1900 and 1250 BC reveal that honey has been among old traditionally prescribed medicines [4]. And applicable to our modern day/time, it can be said that at least one out of every ten infant, teen or adult, at the minimum and across the globe, must have either heard about, seen or used honey (as well as honey-based/constituted products). This would buttress honey as among food items of huge socio-economic importance.

Such factors as geographical floral origin, season and environmental conditions can influence the compositional characteristics of honey [4]. Besides honey having aroma and taste-building compounds as well as polyphenols [5], its grading is largely based on color,

which is to say, the clear golden amber honey often fetch high retail prices compared to darker ones [2]. Moreover, the thermal processing of honey contributes to the elimination of microorganisms that affects quality storage [6]. With respect to human well-being, the authenticity and validity of honey can be substantiated by its relevance in supporting/sustaining healthy living for example, in helping to prevent/reduce stomach upsets that result in diarrhea [7-9]. Notably, the potential of honey's apoptosis on many cancer-affected cells has been reported [10]. Also, the presence of proteins, as well as trace elements that makes honey increasingly relevant for human health and wellbeing has been reported [5]. Whilst honey from ancient times to-date have served as a wound healing resource, the ample amounts of nutrients found within the product would continue to strengthen its role (in wound healing), particularly in reducing (excessive) scar formation [11]. Indeed, there are a number of relevant literatures available that have particularly established/recognized the authenticity and efficacy of honey in wound healing [11-15].

Considering the above knowledge and despite the ancient nature of honey together with its increasing existent scientific evidence, there are many across the globe that still doubt honey's role in enhancing healthy living and wound healing. And in an attempt to clear such (existing/prevaling) doubts, this current concise discourse therefore specifically seeks to reiterate how honey in the context of human function is important for healthy living and wound healing for all. Thus, this concise discourse is structured as follows: (i) some basics about honey and its processing; (ii) honey for healthy living; and (iii) honey for wound healing. Subsequently, discussions/reflections of some key aspects of the synthesized literature were carried out. In addition, there are some highlights of physiological aspects about honey's wound-healing activity.

Methodology

This concise review considered original and review articles, as well as authentic webpages - all of which the author believed to contain relevant information/literature. Author applied discretion to include only articles deemed most appropriate/relevant, taken into account the specific context as well as objective of this concise discourse/review. All published studies/webpages the author considered were in English Language text. Google Scholar served as the main search engine. Specifically, key words used for the search include: Honey, Health, Healthy Living, Wound, Wound Healing, Research, and Reviews. The search process involved combination of (abovementioned) key words, and emergent articles were scrutinized. Personal opinions as well as reflections author included were based on experience/expertise, knowledge and understanding.

Results

Some basics about honey and its processing

In ancient civilization as well as in almost all religions, honey has been considered as a God-gifted prestigious product. In addition, there exists some relevant literature regarding the ethnological importance of honey [1]. Whilst the consumption of honey varies from country to country, and the major honey exporting countries include Argentina and China, honey consumption appears higher in developed countries with European Union standing as major honey importer and exporter [16]. Specifically, honey is an aromatic, sweet and viscous food consumed and enjoyed around the world [17]. Honey, a natural sweet product emerging of *Apis mellifera* bees from nectar of plants (nectar honey), either from secretions of living parts of plants or excretions of plant - sucking insects of living part of plants (honeydew honey) [18,19]. Largely, it remains a natural complex foodstuff found in almost every country worldwide, also serving as a very useful nutritional reserve. By human nutritional standards however, honey cannot always be considered as a complete food, although it remains great potential as dietary supplement especially for infants, senior citizens/elderly as well as invalids/sickly, owed to its ease of digestibility [18,19].

To know/learn how honey is generally processed as well as the fundamental stages involved is equally very important. This is because honey has high viscosity, which can pose problems in handling and processing [6]. The conventional method of processing honey is presented in figure 1. The two important stages in honey processing include filtration and heating. Particularly at harvest, honey is raw and can ferment in few days of storage because of its high moisture content and yeast count. Therefore, preheating allows for effective straining of honey to remove suspended particles. Whereas filtration allows for further removal of fine(r) particles, further heating reduces

moisture content and yeast count, and its cooling helps to consolidate the honey’s viscosity, thereafter the product gets bottled to make it ready for the consumer shelf [6]. Importantly, crystallization can bring about undesirable characteristics in the handling, marketing as well as processing of various honey types. Moreover, microorganisms known to be responsible for honey’s spoilage can get decreased/eliminated when subject to thermal processing. Also, there are alternatives to conventional heat processing methods (some commercially available), which can include infrared heating, microwave heating as well as membrane processing and ultrasound processing. Infrared heating achieves desirable results in a relatively shorter time period compared to conventional heating, for example, to reduce the yeast count [6]. Membrane processing (which could involve microfiltration and/or ultrafiltration) is athermal and very effective as it achieves not only complete/total removal of yeast cells from honey, but also brings anticipated benefits such as absence of cloudiness, reduced viscosity with consistent quality characteristics. Besides, the membrane method can help achieve enzyme-enriched honey. Microwave heat processing can help increase honey’s resistance to spoilage with storage time given its ability to achieve desired level of yeast reduction with reduced thermal damage [6]. Particularly at storage, honey as food may undergo some changes in its chemical composition that modifies its nutritional constituents, largely owed to activities/reactions underscored in fermentation, oxidation and thermal processing [17]. Moreover, honey is among food items of bioactive importance that can be adulterated, as reported in published literature. Hence, there is continuous need to increase detection strategies to assure the authenticity, quality and trust of product [17,20].

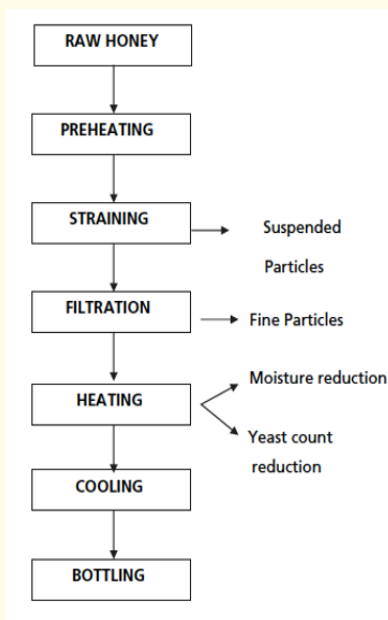


Figure 1: Conventional method of processing honey (Source: Subramanian., et al. 2007 [6]).

Honey for healthy living

Honey, given its nutritional value and rapid carbohydrate absorption, serves as a food item very suitable for across human ages. It digests much effortlessly and gets easily transported via the circulatory system to meet body energy requirements. This makes it widely recommended for children and sportsmen. And also, it improves the efficiency of (metabolic) system of elderly and invalids [8,21]. Honey contains a number of trace elements (manganese (Mn), selenium (Se) for example) very useful for children of ages between 1 and 15 years [5]. Honey also contains some choline (vital for cardiovascular and brain function, cellular membrane composition and repair) and acetylcholine (that acts as a neurotransmitter). Besides aroma and taste-building compounds, the physiological action of honey to increase

heart frequency and blood glucose level (with better tolerance as an effective carbohydrate source) contributes to improve athletic and overall body metabolic activity/performance [5].

As glycemic index (GI) helps to establish obesity, foods with low GI are recommended to control/reduce coronary heart disease/diabetes. Thus, honeys with low GI might present beneficial physiological effects on diabetes (2) patients [5]. Replacing sugar in meals, and providing a healthier alternative, honey can help add browning and moisture to a dish [2]. As author reflects, although honey is an energy resource for life processes within the body cells, it would physiologically help in facilitating the transport of oxygen, hormones, etc., via prioritization of blood supply (pathways). Although details of nutritional fact labels across (now commercially available) honey products might as well have (some) slight content variations, and where such specific (nutritional) contents are identified (as itself reported in these labels) to be somewhat consistent, for example, sodium, potassium, (total) carbohydrates, proteins, vitamins (B6), iron and so on - there could still be (some) trivial differences (probably) owed to the degree/levels in honey grade(s)/type(s) (COR Okpala, personal communication).

There are a number of natural advantages of honey according to Ayurvedic experts. Notably, the ancient *vedic* civilization considered honey among nature's most remarkable gifts to mankind. From the traditional viewpoint and according to the texts of Ayurveda, honey serves as a boon to those with weak digestion. Honey could help keep the teeth and gums, as well as the skin healthy, help in alleviating cardiac pain and palpitation, anemia and lung imbalances as well as various eye ailments, e.g. prevention of cataract. Ancient Greek Hippocrates used honey to tackle baldness, contraception, and antisepsis, to name a few. The Holy Qu'ran illustrates the therapeutic value of honey as Muslim prophet Mohammed (SA) recommended its use for treating diarrhea. Avicenna, the great Iranian scientist and physician, almost 1000 years ago, recommended honey as one of the best remedies in treatment of tuberculosis [22].

Honey has the potential to remedy inflammation that could occur within gastrointestinal tract, which may arise as a result of increased incidence/load of bacteria, viruses and parasites. Besides, pure honey has been reported with bactericidal activity against many enteropathogenic organisms including *Salmonella* spp. and *Shigella* spp., as well as entero-pathogenic *Escherichia coli* [23,24]. Specifically, honey was found to also prevent/reduce the attachment of *Salmonella* spp. bacteria onto mucosal epithelial cells, which has been understood to be the initial stage in the development of bacterial infections within the gastrointestinal tract [25]. In addition, Nzeako and Al-Namaani [9] presented honey with potential of antibacterial activity against *Helicobacter pylori*, especially when combined with triple therapy antibiotics. Further, Ndip., *et al.* [26] utilized different honey concentrations in-vitro to test anti- *H. pylori* activity, and successfully obtained variations in antibacterial activity, all of which were based on different honey concentrations obtained from different countries/regions.

Honey has long been used to treat both cough and fever. Other honey-based treatments include helping to reduce asthma-related symptoms, chronic bronchitis and bronchial asthma. Honey can effectively inhibit ovalbumin-induced airway inflammation and reduce airway's asthma related histopathological changes, which would eventually inhibit the induction of asthma [10,27,28]. In addition, honey added to WHO recommended oral rehydration solution (ORS) to treat gastroenteritis in infants and children reduced frequency of both bacterial and non-bacterial diarrhea. Adding honey not only appeared technically easier, and less expensive, but also, it's sweetening the resultant ORS outcome increased the acceptability by those infants/children. In this case, the presence of honey would help to promote $\text{Na}^{2+}/\text{H}_2\text{O}$ absorption from bowel and also help to repair damaged intestinal mucosa, as well as stimulate the growth of new tissues [7,8].

Honey for wound healing

Within the human body, honey has the ability to reduce oxidative reactions, considering the significant antioxidant content characterized by its capacity to scavenge free radicals [8,29]. In addition, flavonoids and other polyphenols in honey are able to impound metal ions in the form of complexes in the view to prevent the formation of free radicals. Hence, honey would exert its antioxidant properties to inhibit the formation of free radicals catalyzed by such metal ions as Fe^{3+} (Iron) and Cu^{2+} (Copper) [8]. Honey can equally stimulate body immune system to fight infection. Specifically, it is able to stimulate the multiplication of β -lymphocytes and T-lymphocytes in cells as well as activation of neutrophils [8,30]. Honey's provision of glucose supply is considered very essential for 'respiratory burst' within macro-

phage-producing hydrogen peroxide (H_2O_2), which is a dominant component of their bacteria destroying activity [23]. Also, the mechanisms of action of honey cuts across antimicrobial, antioxidant and peroxide generator, which makes it is able to induce pro-inflammatory cytokine production, and bring about decreases in biofilm formation, inhibit bacterial cell cycle progression, together with its capacity to decrease wound pH and modulate pain perception [13].

Wounds do occur at one time or another to humans. Regardless of its severity, honey is believed/understood to have high promise in occupying a convincing position especially in the wound healing process. Ingle, *et al.* [12] conducted a randomized controlled trial on wound healing with honey. Honey - among ancient wound treatment substances, was shown to create moist healing environs, particularly harmless to (human) body (internal/external) tissues yet stimulating both healing processes and epithelialization. Increasingly gaining acceptance as mainline wound care, there still remains some concerns about honey's potency, stability and contamination from natural sources, all of which have brought about some increases in products' licensing, regulation and standardization. How honey gets applied to a wound, and how it gets supplemented in wound dressing, is believed to influence its healing efficacy. This is because wound exudates can either activate or dilute its healing properties [12]. Indeed, advances continue to increase about honey's wound healing properties, how it is used, its product availability and development around the globe.

Yaghoobi, *et al.* [14] reviewed the evidence of clinical use of honey in wound healing as an antibacterial, anti-inflammatory, antioxidant and antiviral agent. In its traditional perspective/sense, honey was found to remain very promising in treating, not only burns, infected and non-healing wounds, but also ulcers, boils, pilonidal sinus, as well as venous/diabetic foot ulcers. Honey was further shown to be efficacious in treating venous ulcers and malignant wounds as it would improve wound cleanliness/hygiene, especially when it is used in coating the dressing. Oryan, *et al.* [11] conducted both narrative review and meta-analysis of biological properties and therapeutics activities of honey in wound healing. Their study revealed that good amounts of carbohydrates, lipids, amino acids, proteins, minerals and vitamins in honey help in wound healing, as it provides minimum trauma during redressing. Also, medicinal values and wound-healing properties can differ across honey types and can improve the outcome of wound healing by reducing incidence/excessive scar formation [11].

Honey not only helps in both limiting and preventing bacterial infection, but also, reduces the bioburden of (emerging/existing) wound(s). This function is derived from its biochemical properties associated with peroxide generation via intrinsic glucose oxidase activity. Honey possesses both hygroscopic and mechano-physical properties, by hampering biofilm development to limit the degree/extent of wound edema. Besides, honey's wound healing potential prevails via mechanisms of antimicrobial action, immunologic modulation and physiological mediation [13]. Nonetheless, modulatory effects of honey have classical phases, i.e., clinical and proposed mechanisms, as depicted in figure 2. Primarily, an injury must have happened/occurred before the processes of wound hypoxia can then begin/start to take place, which subsequently gets followed by bacterial colonization specifically around the wound itself. After honey is applied, both clinical and (proposed) mechanisms can take place, through inflammatory, proliferations and remodeling phases, after which the wound healing itself would subsequently target to become accomplished/realized. Besides, the clinical uses of honey would cut across acute (burns, surgical/traumatic wounds), chronic (infected surgical wounds, pressure ulcers, lower extremity ulcers) and mixed acute/chronic wounds [13].

Majtan [15] reported various honey samples and their biological functions, which are able to induce wound-healing capacities. And specific factor(s) associated with honey and immunomodulatory activity would include arabinogalactans (Kanuka honey for monocytes activation), 261 molecular weight component (Jungle honey for neutrophils activation), 5.8 kDa component (Manuka honey for monocytes activation), major royal jelly protein1 {MRJP1} (Acacia honey for macrophages and keratinocytes activation) and apigerin/kaempferol (Honeydew honey for matrix metalloproteinase-9 {MMP-9} inhibition). Further, Majtan [15] also reported that the immunomodulatory action of honey on immune/cutaneous cells takes place during the process of wound healing, as depicted in figure 3. Upon its application to any given wound, honey basically begins to either stimulate or inhibit the release of certain factors as cytokines, MMP-9 and Reactive Oxygen Species (ROS), from immune and cutaneous cells and this is very much dependent on condition of wound. Moreover, honey can

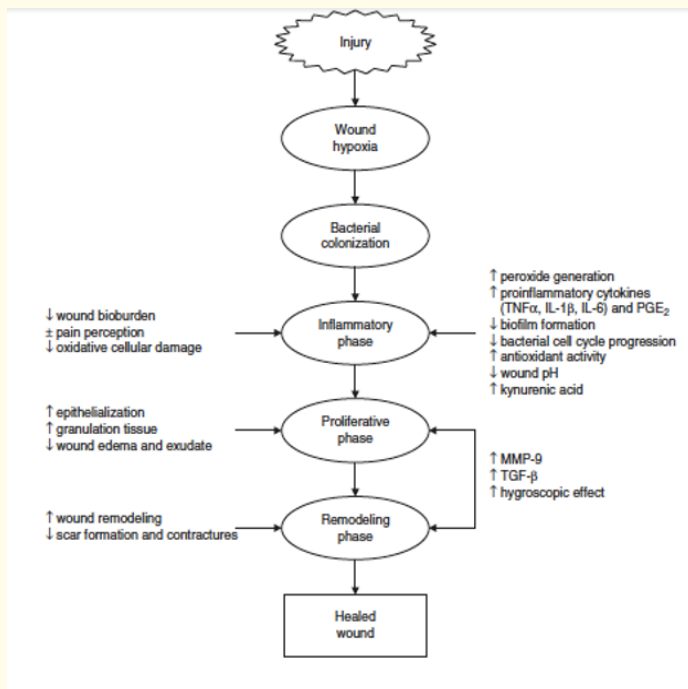


Figure 2: Modulatory effects of honey on classical phases of wound healing. Clinical effects (left) and proposed mechanisms (right) are listed. IL: Interleukin; MMP-9: Matrix Metalloproteinase-9; PGE $_2$: Prostaglandin E $_2$; TGF- β : Transforming Growth Factor- β ; TNF α : Tumor Necrosis Factor- α (Source: Lee, et al. 2011 [13]).

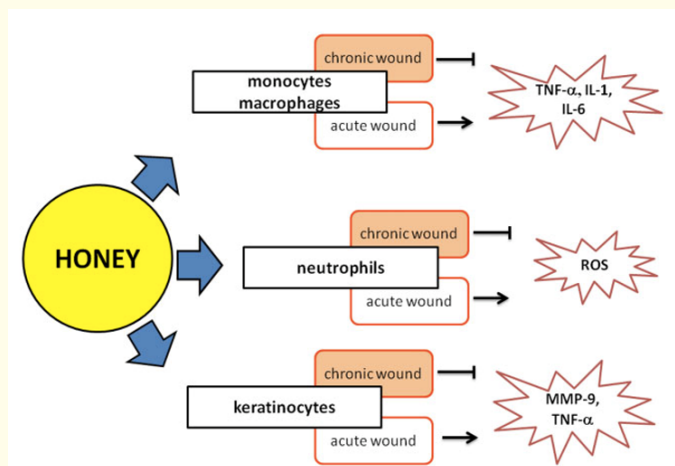


Figure 3: The immunomodulatory action of honey on immune and cutaneous cells involved in wound healing. ROS: Reactive Oxygen Species; IL: Interleukin; MMP-9: Matrix Metalloproteinase-9; TNF α : Tumor Necrosis Factor- α (Source: Majtan, 2014 [15]).

equally induce (some) secretion of proinflammatory cytokines and MMP-9, which is believed to take place during the inflammatory and proliferative wound-healing phases, respectively. And by controlling inflammation of wounds, honey has shown great promise to bring an end to any of such prolonged inflammation (of wounds), in the view to reduce the elevated levels of proinflammatory cytokines, ROS as well as MMP-9 [15]. From all abovementioned (in this wound healing sub-section), we can see that honey's wound healing activity/potential involves a great deal of processes, from sanitizing the surrounding of wound location and indeed, the capacity to remain very efficacious in both healing and repair processes, so as to eventually reduce the scar formation. More promisingly, honey demonstrates great potential to help heal wounds that may seem (rather) medically complex to solve.

Discussions/Reflections

Not only used as a traditional medicine as far back as 2100 - 2000 BC, the increased patronage of honey has been associated with availability of evidence-based data especially with regards to its health advantages/merits [3]. Further, the enriched nature of honey coupled with the complexity of its bioactive compounds/constituents has made this commercially available bee-generated product to become increasingly attractive to various scientific investigators/researchers [5,8,10-19,21-31]. In addition, the fact that honey is consumed in across nations/continents worldwide makes research into its constituent nutritive components very paramount. Besides, the conventional method of processing honey (Refer to figure 1) may be considered as the widely used method [6]. Nonetheless, care is needed/warranted particularly within the pathway/route of honey manufacturing/processing in order to limit/prevent (any) potential errors/mistakes, which if the latter do occur, can actually result in a rapid decrease/dilute of both authenticity and efficacy of product/quality outcome(s).

Many consumers do not actually know how nutritionally important as well as vital honey can (turn out to) be, for example, from its contributing to the healthy development of the pregnant girl/lady and her unborn child, and subsequently an infant, to sustaining the health and wellbeing of elderly/invalid/sickly. For many, it is obviously difficult to fully comprehend what actually takes place within the human circulatory, digestive and respiratory system. And that is why quite a number of *in vitro* studies have used (and would continue to use) rats to test the efficacy and potency of honey [3,8,10]. Besides, there is evidence about the suitability of honey across ages given the ease of its digestibility as well as presence of varied nutritional constituents [8,21]. And this has been clearly observed by individuals (that use honey products) across various communities/nations in many parts of the globe. For emphasis and as already (above) mentioned in this paper, the choline/acetylcholine in honey is vital for brain function and neurotransmission [5]. So, whilst honey is very relevant for healthy living for across ages, care should be taken to ensure that the appropriate/prescribed quantity required is administered/taken by any given consumer as well as at every given time. Nonetheless, a large number of shops/supermarkets that market honey quite/most often (depending on the shop size) do have different product types/varieties displayed on the(ir) shelves. Thus, this would allow for consumers/customers at the place as well as point of purchase to feel free and express/relay their choice/preference (specific) to one honey product/type over another. An example of honey product/type is the Manuka - increasingly captured global attention/interest considering the antibacterial properties/qualities. Particularly, Manuka honey is believed/understood to contain methylglyoxal (MG) - a compound although generally in most other honey types but interestingly, in small amounts. In Manuka honey however, the MG is of a high(er) concentration, which makes it to demonstrate a higher/stronger antibiotic effect. And because of this, producers of Manuka honey have ascribed a rating scale for its efficacy/potency, which is termed 'Unique Manuka Factor (UMF)' - expressive of the concentration of MG, where the rating of 10 UMF is usually considered as minimum [31].

Published reviews that evaluated the wound healing properties of honey (as used in this current work) were found to involve a number of (honey) types/varieties [7,8,10,13,14]. Besides, figures 2 and 3 show wound healing processes that would take place after honey is applied, which include, the modulatory effects of honey on classical phases of wound healing (Refer to figure 2) and immunomodulatory action on immune and cutaneous cells involved in wound healing (Refer to figure 3) [13,15]. When a wound occurs, to comprehend what actually happens with visible eyes, specifically the micro-changes that take place, is obviously very challenging. Furthermore, the various wound healing properties of honey, from stimulating body immune system to fighting infection [8,30], decreasing biofilm forma-

tion, decreasing wound pH to modulating pain perception [13] provides high assurance/promise especially to those who are unable to afford modern day medical wound treatment and therefore have no alternative/option but to seek for the traditional medicine approach, wherein the use of honey has been a very useful candidate to heal wounds and increasingly gaining greater grounds than ever to occupy its strong niche.

Clearly, this concise review has attempted to reiterate honey's role in enhancing healthy living and wound healing, via human function context. Before concluding this concise review, it is important to highlight that readers who seek to know/learn more about wound healing properties of honey, available literatures used in this current work recommended include: Bansal, *et al.* [7], Manyi-Loh, *et al.* [8], Samarghandian, *et al.* [10], Ingle, *et al.* [12], Lee, *et al.* [13], Yaghoobi, *et al.* [14] and Majtan [15]. This equally applies to those who seek to know/learn more about healthy living capacities of honey, available literature also used in this current work recommended include: Khan, *et al.* [1], Bansal, *et al.* [7], Bogdanov, *et al.* [16], da Silva, *et al.* [17], Olaitan, *et al.* [18], Alvarez-Saurez, *et al.* [21], Eteraf-Oskouei and Nagafi [22], Molan [23], Ndip, *et al.* [26], Ghashm, *et al.* [27], Kamaruzaman, *et al.* [28], Gheldof, *et al.* [29] and Tonks, *et al.* [30].

Concluding Remarks

In this paper, honey's role in enhancing healthy living and wound healing via concise human function discourse was performed. Some basics about honey and its processing, its function for healthy living and wound healing were presented. Some physiology that underscores wound-healing activity was also highlighted. The health potential of honey (when consumed) via its naturally nutritive constituents is shown as it delivers considerable functional support to human metabolism/physiology. Honey is indeed very relevant across ages, from infancy to teens, adults, elderly as well as invalid/sickly. And whilst advances continue to intensify/strengthen with regards to honey's wound healing properties, its utilization as well as product availability/development across many parts of the globe, the pursuance of its great potential to help tackle wounds that may well seem (rather) medically complex to solve should be the direction of future (experimental/field) studies, as such would help to supplement existing information.

Conflict of Interest

Author declares no conflict of interest.

Bibliography

1. Khan SU, *et al.* "Honey: Single foodstuff comprises many drugs". *Saudi Journal of Biological Sciences* 25.2 (2018): 320-325.
2. Nordqvist J. "Everything you need to know about honey". *Medical News Today* (2018).
3. Erejuwa OO, *et al.* "Effect of Honey on Body Weight, Body Mass Index and Adiposity in High-Fat Diet Fed Wistar Rats". *EC Pharmacology and Toxicology* 3.1 (2017): 3-12.
4. Hegazi AG, *et al.* "Physiochemical Analysis of Some Saudi Arabia Honey". *International Journal of Current Microbiology and Applied Sciences* 7.2 (2018): 1441-1448.
5. Bogdanov S. "Honey as Nutrient and Functional Food". *Book of Honey. Chapter 8: Bee Product Science* (2016): 47.
6. Subramanian R, *et al.* "Processing of Honey: A Review". *International Journal of Food Properties* 10.1 (2007): 127-143.
7. Bansal V, *et al.* "Honey - A remedy rediscovered and its therapeutic utility". *Kathmandu University Medical Journal* 3.3 (2005): 305-309.
8. Manyi-Loh CE, *et al.* "An overview of honey: Therapeutic properties and contribution in nutrition and human health". *African Journal of Microbiological Research* 5.8 (2011): 844-852.
9. Nzeako BC, *et al.* "The antibacterial activity of honey on *Helicobacter pylori*". *Sultan Qaboos University Medical Journal* 6.2 (2006): 71-76.

10. Samarghandian S., *et al.* "Honey and Health: A Review of Recent Clinical Research". *Pharmacognosy Research* 9.2 (2017): 121-127.
11. Oryan A., *et al.* "Biological properties and therapeutic activities of honey in wound healing: A narrative review and meta-analysis". *Journal of Tissue Viability* 25.2 (2016): 98-118.
12. Ingle RF, *et al.* "Wound healing with honey - a randomized controlled trial". *South African Medical Journal* 96.9 (2006): 831-835.
13. Lee DS., *et al.* "Honey and Wound Healing: An Overview". *American Journal of Clinical Dermatology* 12.3 (2011): 1-10.
14. Yaghoobi R., *et al.* "Evidence of clinical use of honey in wound healing as an anti-bacterial, anti-inflammatory, anti-oxidant and anti-viral agent: A review". *Jundishapur Journal of Natural Pharmaceutical Products* 8.3 (2013): 100-104.
15. Majtan J. "Honey: An immunomodulator in wound healing". *Wound Repair and Regeneration* 22.2 (2014): 187-192.
16. Bogdanov S., *et al.* "Honey for nutrition and health: A review". *Journal of the American College of Nutrition* 27.6 (2008): 677-689.
17. da Silva PM., *et al.* "Honey: Chemical composition, stability and authenticity". *Food Chemistry* 196 (2016): 309-323.
18. Olaitan PB., *et al.* "Honey: A reservoir for microorganisms and an inhibitory agent for microbes". *African Health Sciences* 7.3 (2007): 159-165.
19. Silva LR., *et al.* "Honey from Luso region (Portugal): Physicochemical characteristics and mineral contents". *Microchemical Journal* 93.1 (2009): 73-77.
20. Okpala COR. "Towards enhancing the detection of adulteration in bioactive food products". *Journal of Food Bioactives* 6 (2019): 6-9.
21. Alvarez-Saurez JM., *et al.* "Contribution of honey in nutrition and human health: A review". *Mediterranean Journal of Nutrition and Metabolism* 3.1 (2010): 15-23.
22. Eteraf-Oskouei, T. and Nagafi M. "Traditional and modern uses of natural honey in human diseases: A review". *Iran Journal of Basic Medical Sciences* 16.6 (2013): 731-742.
23. Molan PC. "Why honey is effective as medicine 2. The scientific explanation of its effects". *Bee World* 82.1 (2001): 22-40.
24. Adebolu TT. "Effect of natural honey on local isolates of diarrhea-causing bacteria in South Western Nigeria". *African Journal of Biotechnology* 4 (2005): 1172-1174.
25. Alnaqdy A., *et al.* "Inhibition effect of honey on the adherence of Salmonella to intestinal epithelial cells in vitro". *International Journal of Food Microbiology* 103.3 (2005): 347-351.
26. Ndir R., *et al.* "In vitro antimicrobial activity of selected honeys on clinical isolates of Helicobacter pylori". *African Health Sciences* 7.4 (2007): 228-231.
27. Ghashm AA., *et al.* "Antiproliferative effect of Tualang honey on oral squamous cell carcinoma and osteosarcoma cell lines". *BMC Complementary and Alternative Medicine* 10 (2010): 49.
28. Kamaruzaman NA., *et al.* "Inhalation of honey reduces airway inflammation and histopathological changes in a rabbit model of ovalbumin-induced chronic asthma". *BMC Complementary and Alternative Medicine* 14 (2014): 176.
29. Gheldof N., *et al.* "Identification and quantification of antioxidant components of honeys from various floral sources". *Journal of Agricultural Food Chemistry* 50.21 (2002): 5870-5877.

30. Tonks AJ, *et al.* "Honey stimulates inflammatory cytokine production from monocytes". *Cytokine* 21.5 (2003): 242-247.
31. Ratini M. "Manuka Honey: Medicinal Uses, Benefits and Side Effects" (2018).

Volume 7 Issue 10 October 2019

©All rights reserved by Charles Odilichukwu R Okpala.