- Journal List
- Ann Burns Fire Disasters
- v.27(1); 2014 Mar 31
- PMC4158441

Ann Burns Fire Disasters. 2014 Mar 31; 27(1): 22–30.

Published online 2014 Mar 31.

PMCID: PMC4158441

PMID: 25249844

Language: English | French

Up-to-date use of honey for burns treatment

A. Zbuchea*

Author information Article notes Copyright and License information Disclaimer

Associated Data

Data Citations

Summary

Go to:

Introduction

Honey is a viscous concentrated solution of sugars produced by bees (*Apis mellifera*) that collect and process the blossom nectar (flowers or floral honey) or sweet juices on certain plant species (honeydew or forest honey). Honey is one of the most complex and valuable natural biological products used since ancient times, both in nutrition and medicine (through internal and external means). Among other medical uses, honey has served in wound care since ancient times:[1-4]

- Sumerian civilization (fragments of pottery, 2100-2000 BC)
- Ancient Egyptian civilization (The Edwin Smith Papyrus, 2600-2200 BC)
- Ayurveda and Chinese medicine
- Ancient Greek civilization (Dioscorides' "*De Materia Medica*", for treating fistulising wounds; Hippocrates)
- Ancient Rome civilization (Pliny, for treating infected wounds)

- Mentions in the Bible and the Quran.

After having served an important role in the medical tradition of many peoples for millennia, honey was "rediscovered" by modern medicine as a topical agent for treating wounds and burns.[4] Therapeutic properties of honey have been scientifically highlighted by numerous in vitro studies, laboratory experiments and clinical trials performed during the last century. However, the impression that the use of honey in wound treatment would not have scientific support[5] still persists sometimes in the medical community.

Moreover, the current promotion of different types of modern dressings for wounds (for instance, nanocrystalline silver dressings) hides the fact that there is little published evidence to support the use of these products.[5,6] A recent systematic review of publications on the use of advanced dressings in the treatment of pressure ulcers revealed that their widespread use is not supported by good quality studies. [5,7]Thus, the vast amount of evidence that proves the efficiency of honey and supports its use in wound treatment, compared with the existing evidence for other wound care products, allows us to consider the use of honey as a viable option for wounds treatment.[5]

The ideal topical preparation for wounds should meet the following criteria:[8,9]

- Bactericidal and fungicidal action, rapid set up and wide spectrum, even under the unfavorable situations of heavy exudation or wound infection;
- Enhancement and acceleration of the physiologic process of wound healing (granulation, epithelialization, contraction);
- No local or systemic adverse effects (allergy, toxicity etc.), even if applied for prolonged periods;
- Moderate cost, even if applied twice a day;
- Patient comfort, ease of application, pain reduction; and
- Patient and healthcare compliance.

According to performed studies, the topical use of honey for wounds and burn care meets most of the above mentioned features.

Go to:

Material and methods

A plethora of data is available in the literature regarding the use of honey for burn treatment, providing comprehensive analyses. These are accessible from databases, such as Medline, from journals, such as Burns and the Annals of Burns and Fire Disasters, from search engines and from specialized books. No restrictions were applied regarding the source or date of publication, with the most representative and reliable studies being selected. The complex activity of honey in burns lesions was evidenced by its properties and effects (anti-infectious, anti-inflammatory, antiexudative, antioxidant, wound healing, wound debriding and nutritional), as revealed from the studies undertaken. Effectiveness of topical administration of honey was highlighted both by a series of experiments on laboratory animals, and by clinical trials. Risks, application procedures and acceptability of honey in practice were also investigated.

Go to:

Results and discussions

The anti-infectious property of honey, a traditional remedy for the treatment of infected wounds, was confirmed through laboratory research. Honey has proven to have a broad-spectrum anti-infectious action against at least 80 species of micro-organisms including Gram positive and Gram negative bacteria, aerobes and anaerobes,[10,11] some fungal species of Aspergillus and Penicillium[11] and all the common dermatophytes,[12] including types of bacteria multi- resistant to antibiotics, such as Pseudomonas, Acinetobacter, methicillin-resistant (MRSA) and coagulase-negative Staphylococcus aureus, with a minimum inhibitory concentration (MIC) generally below 10%, usually inferior to that present in wounds where the honey was applied. [13-20] The increasing interest in the use of honey in infected wounds is strengthened by the widespread development of bacterial resistance to antibiotics,[21,22] as well as evidence that honey is fully effective against such antibiotic-resistant bacteria.[21] There was no loss of bacterial sensibility to honey over time and no appearance of bacteria resistant mutants.[23] In many cases, honey acted where other antibacterial therapies failed,[24] possibly because honey is effectively including aggregated bacteria in biofilms,[25-28] a situation where antibiotics and silver dressings proved ineffective.[29]

The antibacterial property of honey was first recognized in 1892 by the Dutch scientist van Ketel.[8] Many considered this property to be entirely due to the osmotic effect of high glucidic concentrations.[8,30-35]Honey possesses a level of osmolarity which is able to inhibit microbial growth.[36] But the antibacterial quality of honey is also due to other factors. Honey contains an agent that was called “inhibine” before its identification as hydrogen peroxide. This is a well-known antimicrobial agent that is produced by the enzyme glucose oxidase in honey,[37] secreted by the hypopharyngeal glands of bees. Under the action of glucose oxidase, glucose oxidation makes gluconolactone and hydrogen peroxide.

Hydrogen peroxide produced by honey may also accelerate the healing process observed when honey is applied to wounds.[21,38,39] Hydrogen peroxide has been involved in many cell types in the human body as a stimulus for cell proliferation,[14] for the growth of fibroblasts and epithelial cells to repair damage,[40] for the development of new capillaries in damaged tissue[41] as part of the normal inflammatory response to injury or infection. Low concentrations of hydrogen peroxide have been proposed to stimulate wound healing, instead of recombinant growth factors,[40] but only if the concentration of hydrogen peroxide could be carefully controlled in order to avoid tissue damage[42] by production of oxygen radicals at high concentrations. [43,44]

The production rate of hydrogen peroxide by glucose oxidase largely depends on the degree of honey dilution,[37] and it is minimal in concentrated honey.[37,45] The fact that the antibacterial properties of honey are amplified when it is diluted has been clearly observed and reported since 1919.[11,46] The maximum accumulated hydrogen peroxide (1-2 mmol/L)[16] is found in diluted honey solutions at concentrations between 30% and 50% (v/v), at least 50% of the maximum level at concentrations between 15-67% (v/v). Variation of glucose oxidase activity by diluting honey can be explained by enzyme inactivation due to the low pH of concentrated honey[47] and the availability of free water required to activate the enzyme in honey (water in concentrated honey is almost entirely

bound by carbohydrates). [48] This variation suggests that honey enhances its antimicrobial activity when applied to the wound, as it dilutes and neutralizes the exudate at this level. The amount of hydrogen peroxide found inside the wound depends on the balance between its production rate (honey glucose oxidase) and the rate of destruction (plasma enzymes such as catalase and glutathione peroxidase).[49,50]

Additional non-peroxide antibacterial factors were identified in some honeys treated with catalase to remove the hydrogen peroxide activity,[51,52] for example methylglyoxal[53] (in Manuka honey from New Zealand), bee-defensin-1[54] and melanoidins.[55] Honey is produced from various floral sources and its antibacterial potency varies widely (up to 100 times)[56] depending on its origin and processing. Therefore, it was proposed that honey should be selected for clinical use according to the antibacterial activity levels determined by bacteriological tests.[45] However, in clinical trials[57] of honey of floral origin and antibacterial potency there was found to be no correlation in the difference in effectiveness of treating burns. It was noted that applying honey causes a reduction in inflammation and scar contractures, and that the antioxidant effect of honey in neutralizing free radicals, together with antibacterial action, low pH, high viscosity and hygroscopic effect, all contribute to the efficiency of honey in burns treatment.[57] The anti-infectious activity of honey on the wound reflects more than just intrinsic antibacterial properties.[11]Laboratory studies have shown that, at concentrations of only 0.1%, honey activates phagocytes and stimulates proliferation of peripheral blood B lymphocytes and T lymphocytes in cell cultures.[58] Honey (at a concentration of 1%) also stimulates monocytes in cell culture to release cytokines: tumor necrosis factor alpha (TNFa) and interleukin (IL: IL1 and IL6), which activates immune response to infection [59,60] and initiates tissue repair processes.[5] It has also been shown that honey stimulates the production of antibodies in mice in response to antigens of Escherichia coli.[61] These findings suggest that part of the effectiveness of honey in eliminating and preventing infection in the wound may be due to the strengthening of the body's own immune system, as well as the antibacterial activity of honey.[5] In addition, the glucose content in honey and acidic pH (usually pH between 3 and 4) can support the macrophages to destroy the bacteria.[62]

As well as the antibiotic activity of honey, a number of studies have shown its anti-inflammatory, anti-edematous and anti-exudative activities. This is evidenced by assessment of local wound evolution,[32,63-70]biochemical tests of indicators of inflammation (decreased malondialdehyde and lipid peroxide values)[71-73] and histopathology exams (decrease of inflammatory cells).[64] Possible mechanisms of inflammatory activity are: inhibition of complement,[74] inhibition of nitric oxide production by macrophages,[75]inactivation and suppression of reactive oxygen species (ROS) by phagocytes,[59,74,76-78] decrease of thermal injuryinduced oxidative stress by controlling free radicals that are formed in the burn wound[72] and an anti-inflammatory factor identified as apalbumina-1, a protein secreted by bees.[78] The anti-inflammatory effect and suppression of ROS, which overstimulate fibroblasts, lead to a reduction of fibrosis and hypertrophic scarring.[67,80] In contrast, synthetic anti-inflammatory drugs do not promote wound healing (non-steroidal anti-inflammatory substances are cytotoxic drugs, and corticosteroids inhibit the growth of epithelium).[24]

In some experimentally induced burns, there was no obvious infection, but honey continued to cause a decrease in inflammation. This shows that the anti-inflammatory

activity of honey is a direct action and not a side effect of eliminating infection by antibacterial activity.[5] The direct anti-inflammatory activity of honey is also highlighted by the finding that honey is as effective as prednisolone in a trial on induced colitis in rats,[81] and a statistically significant ($p < 0.001$) reduction of postoperative peritoneal adhesions on the cecum and ileum in another trial on rats.[82] Also, a laboratory experiment demonstrated the direct anti-inflammatory activity of honey, by a significant ($p<0.001$) reduction of ROS released from monocytes in culture that had been stimulated with Escherichia coli lipopolysaccharide.[5,59]

Studies have also revealed an intrinsic antioxidant activity of honey, by controlling free radicals[72] and ROS.[83] The ROS act as messengers that amplify the inflammatory response[84] and this process can be blocked by antioxidant substances[85] present in honey at a high level.[83,86] Also, ROS produced by phagocytes in inflamed tissues activate proteases that are normally inactive.[87-89] and their activated forms digest extracellular matrix and cell growth factors that are essential for tissue repair.[24,90]

Besides its own anti-infectious, anti-inflammatory and antioxidant actions, honey creates a physical barrier and moist local environment, due to its high viscosity and to the drawing of fluids by osmosis. This promotes healing of burn wounds because wounds heal faster when kept moist as opposed to when they are left to dry out and form a scab.[24,91,92] A moist environment ensures the growth of epithelial cells, the contraction of fibroblasts to approach the wound edges, as well as non-adherence of dressings to the wound, leading to easy and painless dressing changes, without the risk of breaking newly formed epithelium.[24] Also, a local environment allows the protein-digesting enzymes in the wound tissues to work and loosen any scab and dead tissue.[24]

Honey is further known to have a wound debriding action, as found in clinical trials.[64-70,93-99] Honey activates plasminogen and increases plasmin enzyme activity, which lyses fibrin attaching slough, by suppression of the macrophage plasminogen activation inhibitor. Plasmin digests fibrin, which attaches debris on wound surface, but does not digest collagen extracellular matrix, which is necessary for tissue repair.[24]

Honey also has a nutritional action in the wound, indirectly through osmotic flow of lymph, which brings nutrients needed for healing, but also directly through an intake of easily metabolized carbohydrates, amino acids, vitamins and minerals.[24,38,64] Studies have shown that wounds heal faster if they are supplied with a mixture of nutrients. [100-102] Honey provides glucose support for epithelial cells, leukocytes and for the process of glycolysis. The epithelial cells require a reserve of carbohydrates for energy migration over the wound surface to restore epithelial sheath.[103] Leukocytes create the respiratory (oxidative) burst that produces hydrogen peroxide, which is the dominant component of macrophages antibacterial activity. Finally, glycolysis is the major mechanism of energy production by macrophages, allowing them to function in damaged tissues and exudates where oxygen is often limited.[62]

In addition, the high osmolarity of honey causes interstitial fluid drainage, thus providing nutritional support for tissue regeneration which can otherwise only occur around points of angiogenesis (seen as granulation).[38] Inducing the osmotic flow will also contribute to lifting and removing waste and debris from the wound, which may even eliminate the need for surgical debridement.[38] It also contributes to the lack of adherence of the dressing to the wound. A fluid layer of honey is in contact with the surface of the wound and it

may be slightly raised to allow removal of any residue by rinsing. Thus, dressing changes are painless with no risk of damage or tearing of newly formed tissue.[38]

The acidity of honey (usually pH less than 4)[1] may contribute to the antibacterial action of macrophages, since an acidic pH inside the vacuole is involved in destroying the ingested bacteria.[104] Also, local acidification promotes healing of the wound by preventing the appearance of the non-ionized histotoxic form of ammonia, resulting from the action of urease (from urease-producing microorganisms) on urea in the extracellular fluid.[105] In an acidic medium, ammonia (NH_3) is converted to ionized, nontoxic, ammonium ion (NH_4^+).[106] In addition, the acidification of the wound increases oxygen intake and pO_2 on wound surface by increasing oxyhemoglobin-hemoglobin dissociation, due to an appropriate shift in the oxyhemoglobin-hemoglobin dissociation curve (Bohr effect)[106] and thus improves the rate of healing.[107]High carbohydrate levels conferred by honey can be used by bacteria in preference to amino acids108 in the serum and dead cells, thus creating lactic acid instead of ammonia, various amines and sulfur compounds, that are the cause of malodour in burns.[38]

Honey also increases the rate of healing[24,109,110] by stimulating leukocytes to release cytokines and growth factors that activate tissue repair[58] and by stimulating the keratinocytes transcription of genes for TNF-a, IL-1ß and TGF-ß.[111]

Evidence from experiments on laboratory animals

Experimentation on animals has enabled analysis of the action of honey in standard wounds produced by dermal burns (intermediate or full thickness) or by skin excision (excision models). These experiments with standard wounds allowed better comparison of results and histopathological examinations of wounds, as well as the usual measurements of decreasing wound size (their contraction) and the healing time.[5] Also, animal experiments with honey allow objectivity of results by eliminating the placebo effect, which would occur in clinical trials.

Experimental research on animals has shown the effectiveness of topical administration of honey in wound healing compared to the control, to sugar or to silver sulphadiazine. [5,38,91,104,112-116] In addition, they suggested the importance of using only floral honeys, properly processed[91,114] and the synergistic effect of concomitant oral administration of honey in promoting wound epithelialization.[115,116]

Evidence from clinical studies

Many controlled clinical trials have been performed, some being randomized, which compared honey with different products (silver sulphadiazine, Betadine, saline compresses, paraffin dressings, hydrogel etc.) for treatment of wounds of various etiologies, including burns of various depths.[5,24] An article published in December 2011[24] recorded 33 randomized controlled trials (RCTs), with a total number of 3,556 participants. A meta-analysis of Cochrane systematic reviews of local and systemic interventions for wounds, published in 2012, found robust evidence for the use of topical honey to reduce healing times in burns.[117]

Various trials reported that honey is effective in cleaning infected wounds.[31,37,38,65,93,94,118,119] Honey acted as a barrier, preventing wounds from becoming infected[65,67,95,104,120] and cross infection.[96]Gangrenous and necrotic tissues were debrided

easily and were replaced quickly with granulation tissue and advancing, progressive epithelialization.[65,66,121] Studies highlighted fast cleansing[68,93,96,97,122,123]and enzymatic or chemical debridement of wounds after application of honey,[66,67,69,70,95,98] with the absence of eschar forming on burns.[64] Honey was also found to deodorize very smelly wounds.[65-67,70,95,118,120] Several studies have shown that honey caused the formation of clean and healthy granulation tissue,[27,38,64-66,68,94,96,119,121,123] which allowed early grafting on a clean, adequate bed,[97]with prompt graft taking.[96,122] It has also been reported38 that honey promotes wounds epithelialization[64-66,70,80,91] and accelerates healing,[68,104,123,124] with minimal scar formation.66 Honey was further observed to improve wound nutrition,[65] blood circulation,[68] and lymph flow,[93] and to reduce inflammation,[64] edema[65,66,68,69] and exudate.[65,66,70]

Honey has been reported to be calming and soothing when applied to wounds[32,38,67] and to reduce pain from burns.[67] Other studies showed that honey either did not cause any local pain on dressing[93,120] or caused only a momentary stinging sensation.[93] It was also shown not to cause irritation,[69,93,94] or allergic reactions,[65,80,96,118] and to have no harmful effects on tissues.[65,69,93,96,118] Honey dressings were observed to be easily applied and removed,[96,122,123] without adhesions[62,93,120] or bleeding,[67] with any residual honey being easily removed by simply rinsing.[31] However, a prospective clinical trial showed that deep dermal burns heal more slowly with honey than with early surgery (tangential excision and grafting).[125] Other uses for honey included skin grafts storage [50,124] or even a novel method of fixation of split skin grafts with sterilized honey.[4] Overall, honey application has proven economic benefits by having lower direct costs compared to conventional treatments,96, 126 and by reducing the use of antibiotics,[119]as well as the healing and hospitalization time.[94,96,118,119]

Regarding the risks of topical administration of honey, a remedy used with confidence since ancient times, there was no adverse effect in animal experiments, including histopathological examinations.[50,91,104,113-116] Moreover, clinical studies have shown no allergies or other adverse reactions,[65,80,96,118]except for a transient stinging sensation in some patients,[93,97,126]due to the acidity of honey, [127] when wounds are inflamed. The nociceptive nerve endings that detect acidity are sensitized by inflammation, which explains the clinical observation that honey reduces sensitivity within several days, if a sufficient amount of honey is held on the wound to allow remission of inflammation through the anti-inflammatory activity of honey.[24] Generally, topical application of honey on wounds relieved pain,[95] was not irritating69, 93, 94 and did not cause pain during dressing changes.[120]

There is also a hypothetical risk of wound botulism by applying honey, because it sometimes contains spores of Clostridium.[33,38] However, no local infections have been reported in the numerous published trials which used unsterilized and unprocessed honey.[38] If the spores would germinate, any Clostridia vegetative cells, being anaerobic, could not survive in the presence of hydrogen peroxide generated in diluted honey. In any case, concerns about a hypothetical risk of wound botulism, considered unacceptable by some,[33] can be overcome by using honey that has been sterilized by gamma irradiation, which kills Clostridium spores in honey,[129,130] without affecting its antibacterial activity.[128]

As described in most clinical trials, the following points provide the generalities of the procedure for applying honey:[38]

- First the wound is cleansed with saline[64,65,67,69,80,95,97,130] (possibly also hydrogen peroxide, Dakin solution, Betadine or chlorhexidine).[68] Sometimes it is necessary to make an initial surgical toilet, by opening abscesses, purulent drainage collection[68,96,119] and necrotic tissue removal[68,70,96,122]

- Honey is then spread on the wound before being covered with a dry sterile gauze dressing. The amount of honey used varied from a thin layer (applied 2-3 times per day),[118] to a thick layer or, more often, pouring the honey over the wound.[64,69,93-95,97] Others used bandages soaked in honey,[67,80,93] honey spread on gauze[26,106] or "honey pads".[70] Alginate dressings impregnated with honey are a good alternative to cotton/cellulose dressings, as the alginate converts into a honey-containing soft gel.[11] Wound cavities were either filled with honey-impregnated dressings[66] or filled directly with honey and then covered with gauze.[93,96]

- Dressing changes, mostly daily,[65,93,95-97,122,126] varied from 2-3 times per day[70,94,118,119,131] to once every 2-3 days,[64,67,69,80,123] depending also on the appearance and evolution of the wounds (clean wounds with reduced exudate require less frequent dressing changes).

- Liquid honey can be used on large areas[93] (be it naturally fluid or made so through vigorous stirring or by heating below 40°C). Crystallized honey can easily be made fluid through careful heating. Overheating of honey should be avoided, since the enzyme glucose oxidase in honey that produces hydrogen peroxide, a major component of honey's antibacterial activity, is easily inactivated by heat.[36]

All of the aforementioned experiments, research and innovations, as well as clinical utilization, highlight the increasing interest and confidence in honey as an effective remedy for wound care. Honey, "the oldest wound dressing material known to medicine,"[5] was used systematically for wound treatment, as well as for its benefits as a food and form of medication. In the early 1940s, however, when antibiotics came onto the scene, honey was no longer used to the same degree in wound therapy.[132] Just as with colloidal silver, honey is now being reconsidered for wound healing due to the rising problem of bacteria with multiple resistance to antibiotics.[24,25] Unlike with antibiotics, studies have shown no development of bacterial resistance and no emergence of mutants resistant to honey,[25,133] whose remarkable therapeutic properties are recommended in wound care, as well as modern pharmaceuticals.[24]

Studies have also shown high patient acceptability to honey therapy,[134] due to the favorable effects observed in practice: decreased pain, reduced wound size, and deodorizing effects.[132,35,136] Any reservations or even opposition to the use of honey in wound treatment, due to lack of standardization and to its sticky and fluid nature, are now overcome by the manufacture and marketing of honey-based products. Such products have been licensed and approved for topical treatment of wounds (available in Australia since 1999, in Europe since 2004 and in North America since 2007).[23,137] There are currently several trademarks (Activon, HoneySoft, Manuka Health, Medihoney, MelMax, MelDra, L-Mesitran etc.) and a wide range of sterilized products containing honey, registered as medical devices and commercially available for the treatment of wounds.[24,138]

Go to:

Conclusions

In vitro and in vivo studies have highlighted a broad range of activities provided by honey in burn treatment. These include anti-infectious, anti-inflammatory, antiexudative, antioxidant, wound healing, wound debriding and nutritional properties. In evidence-based medicine, research and clinical studies have shown the efficiency of honey in superficial and partial thickness burns therapy, when compared to other dressing products, making it a viable option as a valuable topical agent in clinical practice. However, as honey also appears to delay healing of partial and full thickness burns when compared to surgical treatment (early excision and grafting), its use requires further exploration. More detailed controlled trials are required to establish the best indications, methods and modalities of honey administration for each type and stage of burn. It is also necessary to have criteria for honey selection over other forms of treatment in burn management, which, of course, will also depend on the preferences and experience of those involved.

Go to:

Acknowledgments

Conflict of interest. The author of this paper has no conflict of interest.

Funding. None.

Go to:

References

1. Beekeepers Association of Romania, Institute for Beekeeping Research and Development (eds): “Beekeeping –student handbook”. Ploiesti, Romania: LVS Crepuscul; 2012. Quality of bee products; pp. 248–56. [Google Scholar]
2. Beekeepers Association of Romania, Institute for Beekeeping Research and Development (eds): “Beekeeping –student handbook”. Ploiesti, Romania: LVS Crepuscul; 2012. Bee products in nutrition and health; pp. 279–82. [Google Scholar]
3. Jull AB, Walker N, Deshpande S, Honey as a topical treatment for wounds. Cochrane Database. Feb 28, 2013. [PubMed]
4. Emsen IM. A different and safe method of split thickness skin graft fixation: Medical honey application. Burns. 2007;33:782–7. [PubMed] [Google Scholar]
5. Molan PC. The evidence supporting the use of honey as a wound dressing. International Journal of Lower Extremity Wounds. 2006;5:40–54. [PubMed] [Google Scholar]
6. Vermeulen H, Ubbink DT, Goossens A, et al. Systematic review of dressings and topical agents for surgical wounds healing by secondary intention. Br J Surg. 2005;92:665–72. [PubMed] [Google Scholar]
7. Bouza C, Saz Z, Muñoz A, et al. Efficacy of advanced dressings in the treatment of pressure ulcers: A systematic review. J Wound Care. 2005;14:193–9. [PubMed] [Google Scholar]
8. Sami AN, Mehmood N, Qureshi MA, et al. Honey compared with silver sulfadiazine as burn wound dressing. Ann. Pak. Inst. Med. Sci. 2011;7:22–5. [Google Scholar]
9. Kramer A, Daeschlein G, Kammerlander G, et al. Consensus recommendation for the choice of antiseptic agent in wound care (KonsensusempfehlungzurAuswahl von Wirkstoffenfür die Wundantiseptik). Hyg Med. 2004;5:147–57. [Google Scholar]
10. Lu J, Carter DA, Turnbull L, et al. The Effect of New Zealand Kanuka, Manuka and Clover Honeys on Bacterial Growth Dynamics and Cellular Morphology Varies

According to the Species. PLoS ONE. 2013;8:55898. [PMC free article] [PubMed] [Google Scholar]
11. Molan PC. Honey as a topical antibacterial agent for treatment of infected wounds. World Wide Wounds. 2001 ISSN 1369-2607. Available at:http://www.worldwidewounds.com/2001/november/Molan/honey-as-topical-agent.html . [Google Scholar]
12. Brady NF, Molan PC, Harfoot CG. The sensitivity of dermatophytes to the antimicrobial activity of manuka honey and other honey. Pharm Sci. 1997;2:1–3. [Google Scholar]
13. Cooper RA, Molan PC, Harding KG. The effectiveness of the antibacterial activity of honey against strains of Staphylococcus aureus isolated from infected wounds. J R Soc Med. 1999;92:283–5.[PMC free article] [PubMed] [Google Scholar]
14. George NM, Cutting KF. Antibacterial honey (Medihoney ™): Invitro activity against clinical isolates of MRSA, VRE, and other multiresistant gram-negative organisms including Pseudomonas aeruginosa. Wounds. 2007;19:231–6. [PubMed] [Google Scholar]
15. Cooper R. Honey in wound care: antibacterial properties. GMS KrankenhhygInterdiszip. 2007;2:51.[PMC free article] [PubMed] [Google Scholar]
16. Cooper RA, Molan PC. The use of honey as an antiseptic in managing Pseudomonas infection. J Wound Care. 1999;8:161–4. [PubMed] [Google Scholar]
17. Subrahmanyam M. Honey dressing for burns – an appraisal. Ann Burns Fire Disasters. 1996;9:33–35.[Google Scholar]
18. Subrahmanyam M, Hemmady A, Pawar SG. Antibacterial activity of honey on bacteria isolated from wounds. Ann Burns Fire Disasters. 2001;14:100. [Google Scholar]
19. Molan PC. The antibacterial activity of honey. 1. The nature of the antibacterial activity. Bee World. 1992;73:5–28. [Google Scholar]
20. Ahmad, I Aqil, F , editor. New Strategies Combating Bacterial Infection. Weinheim, Germany: Wiley VCH; 2009. Honey: Antimicrobial actions and role in disease management. pp. 229–53. [Google Scholar]
21. Bang L, Buntting C, Molan P, et al. The effect of dilution on the rate of hydrogen peroxide production in honey and its implications for wound healing. J Altern Complement Med. 2003;9:267–73. [PubMed] [Google Scholar]
22. Greenwood D. Sixty years on: Antimicrobial drug resistance comes of age. Lancet. 1995;346:1.[PubMed] [Google Scholar]
23. Cooper RA, Jenkins L, Henriques AFM, et al. Absence of bacterial resistance to medical-grade manuka honey. Eur J Microbiol Infect Dis. 2010;29:1237–41. [PubMed] [Google Scholar]
24. Molan PC. The evidence and the rationale for the use of honey as a wound dressing. Wound Practice and Research. 2011;19:204–20. [Google Scholar]
25. Merckoll P, Jonassen TØ, Vad ME, et al. Bacteria, biofilm and honey: A study of the effects of honey on “planktonic” and biofilmembedded chronic wound bacteria. Scand J Infect Dis. 2009;41:341–7.[PubMed] [Google Scholar]
26. Okhiria OA, Henriques A, Burton NF, et al. Honey modulates biofilms of Pseudomonas aeruginosa in a time and dose dependent manner. J Api Product Api Med Sci. 2009;1:6–10. [Google Scholar]
27. Alandejani T, Marsan J, Ferris W, et al. Effectiveness of honey on Staphylococcus aureus and Pseudomonas aeruginosa biofilms. Otolaryngol Head Neck Surg. 2009;141:114–8. [PubMed] [Google Scholar]

28. Maddocks SE, Lopez MS, Rowlands RS, et al. Manuka honey inhibits the development of Streptococcus pyogenes biofilms and causes reduced expression of two fibronectin binding proteins. Microbiology. 2012;158:781–90. [PubMed] [Google Scholar]
29. Hill KE, Malic S, McKee R. An in vitro model of chronic wound biofilms to test wound dressings and assess antimicrobial susceptibilities. J Antimicrob Chemother. 2010;65:1195–206. [PubMed] [Google Scholar]
30. Condon RE. Curious interaction of bugs and bees. Surgery. 1993;113:234–5. [PubMed] [Google Scholar]
31. Green AE. Wound healing properties of honey. Br J Surg. 1988;75:1278. [Google Scholar]
32. Keast-Butler J. Honey for necrotic malignant breast ulcers. Lancet. 1980;2:809. [PubMed] [Google Scholar]
33. Mossel DA. Honey for necrotic breast ulcers. Lancet. 1980;2:1091. [PubMed] [Google Scholar]
34. Somerfield SD. Honey and healing. J R Soc Med. 1991;84:179. [PMC free article] [PubMed] [Google Scholar]
Tovey FI. Honey and healing. J R Soc Med. 1991;84:447. [PMC free article] [PubMed] [Google Scholar]
36. Chirife J, Herszage L, Joseph A, et al. In vitro study of bacterial growth inhibition in concentrated sugar solutions: microbiological basis for the use of sugar in treating infected wounds. Antimicrob Agents Chemother. 1983;23:766–73. [PMC free article] [PubMed] [Google Scholar]
37. White JW, Subers MH, Schepartz AI. The identification of inhibine, the antibacterial factor in honey, as hydrogen peroxide and its origin in a honey glucose-oxidase system. BiochimBiophys-Acta. 1963;73:57–70. [PubMed] [Google Scholar]
38. Molan PC, et al. A brief review of honey as a clinical dressing. Primary Intention. 1998;6:148–58.[Google Scholar]
39. Molan PC. Potential of honey in the treatment of wounds and burns. Am J ClinDermatol. 2001;1:13–9.[PubMed] [Google Scholar]
40. Burdon RH, et al. Superoxide and hydrogen peroxide in relation to mammalian cell proliferation. Free Rad Biol Med. 1995;18:775–94. [PubMed] [Google Scholar]
41. Tur E, Bolton L, Constantine BE. Topical hydrogen peroxide treatment of ischemic ulcers in the guinea pig: Blood recruitment in multiple skin sites. J Am Acad Dermatol. 1995;33:217–21. [PubMed] [Google Scholar]
42. Chung LY, Schmidt RJ, Andrews AM, et al. A study of hydrogen peroxide generation by, and antioxidant activity of, Granuflex ™ (DuoDERM™) Hydrocolloid Granules and some other hydrogel/hydrocolloid wound management materials. Br J Dermatol. 1993;129:145–53. [PubMed] [Google Scholar]
43. Cochrane CG. Cellular injury by oxidants. Am J Med. 1991;91:23–30. [PubMed] [Google Scholar]
44. Simon RH, Scoggin CH, Patterson D. Hydrogen peroxide causes the fatal injury to human fibroblasts exposed to oxygen radicals. J Biol Chem. 1981;256:7181–6. [PubMed] [Google Scholar]
45. Radwan SS, El-Essawy A, Sarhan M. Experimental evidence for the occurrence in honey of specific substances active against microorganisms. ZentralblattfürMikrobiologie. 1984;139:249–55. [PubMed] [Google Scholar]

46. Sackett WG. Honey as a carrier of intestinal diseases. Bull Colorado State Univ Agric Exp Stn. 1919;252:1–18. [Google Scholar]
47. Schepartz AI, Subers MH. The glucose-oxidase of honey. I. Purification and some general properties of the enzyme. Biochimica et Biophysica Acta. 1964;85:228–37. [PubMed] [Google Scholar]
48. Alston MJ, Freedman RB. The water-dependence of the catalytic activity of bilirubin oxidase suspensions in low-water systems. Biotechnology and Bioengineering. 2002;77:651–7. [PubMed] [Google Scholar]
49. Cooper RA, Molan PC. Honey in wound care. J Wound Care. 1999;8:340. [PubMed] [Google Scholar]
50. Postmes T, van den Bogaard AE, Hazen M. Honey for wounds, ulcers, and skin graft preservation. Lancet. 1993;341:756–7. [PubMed] [Google Scholar]
51. Allen KL, Molan PC, Reid GM. A survey of the antibacterial activity of some New Zealand honeys. J Pharm Pharmacol. 1991;43:817–22. [PubMed] [Google Scholar]
52. Adcock D. The effect of catalase on the inhibine and peroxide values of various honeys. J Apic Res. 1962;1:38–40. [Google Scholar]
53. Mavric E, Wittmann S, Barth G, et al. Identification and quantification of methylglyoxal as the dominant antibacterial constituent of Manuka (Leptospermum scoparium) honeys from New Zealand. Mol. Nutr. Food Res. 2008;52:483–9. [PubMed] [Google Scholar]
54. Kwakman PHS, teVelde AA, de Boer L, et al. How honey kills bacteria. The FASEB Journal. 2010;24:2576–82. [PubMed] [Google Scholar]
55. Rufian-Henares JA, Morales FJ. Functional properties of melanoidins: In vitro antioxidant, antimicrobial and antihypertensive activities. Food Research International. 2007;40:995–1002.[Google Scholar]
56. d'Agostino Barbaro A, La Rosa C, Zanelli C. Atttività antibatterica di mieli Siciliani. Quad Nutr. 1961;21:30–44. [Google Scholar]
57. Subrahmanyam M, Hemmady A, Pawar SG. The sensitivity to honey of multidrug-resistant Pseudomonas Aeruginosa from infected burns. Ann Burns Fire Disasters. 2003;16:84–6. [Google Scholar]
58. Abuharfeil N, Al-Oran R, Abo-Shehada M. The effect of bee honey on the proliferative activity of human B- and T-lymphocytes and the activity of phagocytes. Food Agric Immunol. 1999;11:169–77.[Google Scholar]
59. Tonks A, Cooper RA, Price AJ, et al. Stimulation of TNF-alpha release in monocytes by honey. Cytokine. 2001;14:240–2. [PubMed] [Google Scholar]
60. Tonks AJ, Cooper RA, Jones KP, et al. Honey stimulates inflammatory cytokine production from monocytes. Cytokine. 2003;21:242–7. [PubMed] [Google Scholar]
61. Al-Waili NS, Haq A. Effect of honey on antibody production against thymus-dependent and thymus-independent antigens in primary and secondary immuneresponses. J Med Food. 2004;7:491–4. [PubMed] [Google Scholar]
62. Inflammation. Michigan: Upjohn; 1977. [Google Scholar]
63. Molan PC, Betts J. Using honey dressings: The practical considerations. Nurs Times. 2000;96:36–7.[PubMed] [Google Scholar]
64. Subrahmanyam M. A prospective randomised clinical and histopathological study of superficial burn wound healing with honey and silver sulfadiazine. Burns. 1998;24:157–61. [PubMed] [Google Scholar]
65. Efem SEE. Clinical observations on the wound healing properties of honey. Br J Surg. 1988;75:679–81. [PubMed] [Google Scholar]

66. Efem SEE. Recent advances in the management of Fournier's gangrene: Preliminary observations. Surgery. 1993;113:200–4. [PubMed] [Google Scholar]
67. Subrahmanyam M. Honey impregnated gauze versus polyurethane film (OpSiteR) in the treatment of burns – a prospective randomised study. Br J Plast Surg. 1993;46:322–3. [PubMed] [Google Scholar]
68. Dumronglert E. A follow-up study of chronic wound healing dressing with pure natural honey. J Nat Res Counc Thail. 1983;15:39–66. [Google Scholar]
69. Subrahmanyam M. Honey dressing versus boiled potato peel in the treatment of burns: A prospective randomised study. Burns. 1996;22:491–3. [PubMed] [Google Scholar]
70. Hejase MJ, Simonin JE, Bihrle R, et al. Genital Fournier's gangrene: Experience with 38 patients. Urology. 1996;47:734–9. [PubMed] [Google Scholar]
71. Subrahmanyam M, Sahapure AG, Nagane NS, et al. Effects of topical application of honey on burn wound healing. Ann Burns Fire Disasters. 2001;14:143–5. [Google Scholar]
72. Subrahmanyam M, Sahapure AG, Nagane NS, et al. Free radical control – the main mechanism of the action of honey in burns. Ann Burns Fire Disasters. 2003;16:135–7. [Google Scholar]
73. Nagane NS, Ganu JV, Bhagwat VR, et al. Efficacy of topical honey therapy against silver sulphadiazine treatment in burns: A biochemical study. Indian J Clin Biochem. 2004;19:173–6. [PMC free article][PubMed] [Google Scholar]
74. van den Berg AJ, van den Worm E, van Ufford HC, et al. An in vitro examination of the antioxidant and anti-inflammatory properties of buckwheat honey. J Wound Care. 2008;17:172–8. [PubMed] [Google Scholar]
75. Kassim M, Achoui M, Mustafa MR, et al. Ellagic acid, phenolic acids, and flavonoids in Malaysian honey extracts demonstrate in vitro anti-inflammatory activity. Nutr Res. 2010;30:650–9. [PubMed] [Google Scholar]
76. Henriques A, Jackson S, Cooper R, et al. N. Free radical production and quenching in honeys with wound healing potential. J Antimicrob Chemother. 2006;58:773–7. [PubMed] [Google Scholar]
77. Mesaik MA, Azim MK, Mohiuddin S. Honey modulates oxidative burst of professional phagocytes. Phytother Res. 2008;22:1404–8. [PubMed] [Google Scholar]
78. Ahmad A, Khan RA, Mesaik MA, et al. Anti inflammatory effect of natural honey on bovine thrombin-induced oxidative burst in phagocytes. Phytother Res. 2009;23:801–8. [PubMed] [Google Scholar]
79. Molan P. Honey anti-inflammatory factor identified. New Zealand Beekeeper. 2012 Sep 6;[Google Scholar]
80. Subrahmanyam M. Honey impregnated gauze versus amniotic membrane in the treatment of burns. Burns. 1994;20:331–3. [PubMed] [Google Scholar]
81. Bilsel Y, Bugra D, Yamaner S. Could honey have a place in colitis therapy? Effects of honey, prednisolone and disulfiram on inflammation, nitric oxide, and free radical formation. Dig Surg. 2002;19:306–12. [PubMed] [Google Scholar]
82. Aysan E, Ayar E, Aren A. The role of intra-peritoneal honey administration in preventing post-operative peritoneal adhesions. Eur J Obstet Gynecol Reprod Biol. 2002;104:152–5. [PubMed] [Google Scholar]
83. Inoue K, Murayama S, Seshimo F, et al. Identification of phenolic compound in manuka honey as specific superoxide anion radical scavenger using electron spin resonance (ESR) and liquid chromatography with colorimetric array detection. J Sci Food Agric. 2005;85:872–8. [Google Scholar]

84. Iles KE, Forman HJ. Macrophage signaling and respiratory burst. Immunol Res. 2002;26:95–105.[PubMed] [Google Scholar]
85. Ma Q, Kinneer K, Ye JP, et al. Inhibition of nuclear factor kappa B by phenolic antioxidants: Interplay between antioxidant signaling and inflammatory cytokine expression. Mol Pharmacol. 2003;64:211–9.[PubMed] [Google Scholar]
86. Tan ST, Holland PT, Wilkins AL, et al. Extractives from New Zealand honeys. 1. White clover, manuka and kanuka unifloral honeys. J Agric Food Chem. 1988;36:453–60. [Google Scholar]
87. Ossanna PJ, Test ST, Matheson NR, et al. Oxidative regulation of neutrophil elastase-alpha-1-proteinase inhibitor interactions. J Clin Invest. 1986;77:1939–51. [PMC free article] [PubMed] [Google Scholar]
88. Peppin GJ, Weiss SJ. Activation of the endogenous metalloproteinase, gelatinase, by triggered human neutrophils. Proc Nat Acad Sci USA. 1986;83:4322–6. [PMC free article] [PubMed] [Google Scholar]
89. Weiss SJ, Peppin G, Ortiz X, et al. Oxidative autoactivation of latent collagenase by human neutrophils. Science. 1985;227:747–9. [PubMed] [Google Scholar]
90. Toriseva M, Kahari VM. Proteinases in cutaneous wound healing. Cell Mol Life Sci. 2009;66:203–24.[PubMed] [Google Scholar]
91. Kandil A, El-Banby M, Abdel-Wahed K, et al. Healing effect of true floral and false nonfloral honey on medical wounds. J Drug Res (Cairo) 1987;17:71–5. [Google Scholar]
92. Winter GD. Formation of the scab and the rate of epithelialization of superficial wounds in the skin of the young domestic pig. Nature. 1962;193:293–4. [PubMed] [Google Scholar]
93. Bulman MW. Honey as a surgical dressing. Middlesex Hosp J. 1955;55:188–9. [Google Scholar]
94. Cavanagh D, Beazley J, Ostapowicz F. Radical operation for carcinoma of the vulva. A new approach to wound healing. J Obstet Gynaecol Br Commonw. 1970;77:1037–40. [PubMed] [Google Scholar]
95. Subrahmanyam M. Topical application of honey in treatment of burns. Br J Surg. 1991;78:497–8.[PubMed] [Google Scholar]
96. Farouk A, Hassan T, Kashif H, et al. Studies on Sudanese bee honey: Laboratory and clinical evaluation. Int J Crude Drug Res. 1988;26:161–8. [Google Scholar]
97. Ndayisaba G, Bazira L, Habonimana E, et al. Clinical and bacteriological results in wounds treated with honey. J Orthop Surg. 1993;7:202–4. [Google Scholar]
98. Molan PC. Debridement of wounds with honey. Journal of Wound Technology. 2009;5:12–7.[Google Scholar]
99. Gethin G, Cowman S. Manuka honey vs hydrogel – a prospective, open label, multicentre, randomised controlled trial to compare desloughing efficacy and healing outcomes in venous ulcers. J Clin Nurs. 2009;18:466–74. [PubMed] [Google Scholar]
100. Kaufman T, Levin M, Hurwitz DJ. The effect of topical hyperalimentation on wound healing rate and granulation tissue formation of experimental deep second degree burns in guinea-pigs. Burns. 1984;10:252–6. [PubMed] [Google Scholar]
101. Niinikoski J, Kivisaari J, Viljanto J. Local hyperalimentation of experimental granulation tissue. Acta Chir Scand. 1977;143:201–6. [PubMed] [Google Scholar]
102. Silvetti AN. An effective method of treating long-enduring wounds and ulcers by topical applications of solutions of nutrients. J Dermatol Surg Oncol. 1981;7:501–8. [PubMed] [Google Scholar]

103. Hunt, TK , editor. Wound Healing and Wound Infection: Theory and Surgical Practice. New York: Appleton-Century-Crofts; 1980. The physiology of wound healing; pp. 11–28. [Google Scholar]
104. Gupta SK, Singh H, Varshney AC, et al. Therapeutic efficacy of honey in infected wounds in buffaloes. Indian J Anim Sci. 1992;62:521–23. [Google Scholar]
105. Kaufman T, Eichenlaub EH, Angel MF, et al. Topical acidification promotes healing of experimental deep partial thickness skin burns: a randomised double-blind preliminary study. Burns. 1985;12:84–90.[PubMed] [Google Scholar]
106. Leveen HH, Falk G, Borek B, et al. Chemical acidification of wounds. An adjuvant to healing and the unfavourable action of alkalinity and ammonia. Ann Surg. 1973;178:745–53. [PMC free article] [PubMed] [Google Scholar]
107. Gethin GT, Cowman S, Conroy RM. The impact of Manuka honey dressings on surface pH of chronic wounds. Int Wound J. 2008;5:185–94. [PubMed] [Google Scholar]
108. Nychas GJ, Dillon VM, Board RG, et al. Glucose, the key substrate in the microbiological changes in meat and certain meat products. Biotechnol Appl Biochem. 1988;10:203–31. [PubMed] [Google Scholar]
109. Boekema BKHL, Pool L, Ulrich MMW. The effect of a honey based gel and silver sulphadiazine on bacterial infections of in vitro burn wounds. Burns. 2012 Available from: http://dx.doi.org/10.1016/j.burns.2012.09.008 . [PubMed] [Google Scholar]
110. Subrahmanyam M. Topical application of honey for burn wound treatment – an overview. Ann Burns Fire Disasters. 2007;20:137–9. [PMC free article] [PubMed] [Google Scholar]
111. Majtan J, Kumar P, Majtan T, et al. Effect of honey and its major royal jelly protein 1 on cytokine and MMP-9 mRNA transcripts in human keratinocytes. Exp Dermatol. 2009;19:73–9. [PubMed] [Google Scholar]
112. Mizrahi, A Lensky, Y , editor. Bee Products: Properties, Applications and Apitherapy. New York: Plenum Press; 1997. Speeding up the healing of burns with honey. An experimental study with histological assessment of wound biopsies. pp. 27–37. [Google Scholar]
113. Bergman A, Yanai J, Weiss J. Acceleration of wound healing by topical application of honey. An animal model. Am J Surg. 1983;145:374–6. [PubMed] [Google Scholar]
114. El-Banby M, Kandil A, Abou-Sehly G. Healing effect of floral honey and honey from sugar-fed bees on surgical wounds (animal model). Fourth International Conference on Apiculture in Tropical Climates. Cairo: International Bee Research Association; London: 1989. pp. 46–9. [Google Scholar]
115. Suguna L, Chandrakasan G, Thomas Joseph K, et al. Influence of honey on collagen metabolism during wound healing in rats. J Clin Biochem Nutr. 1992;13:7–12. [Google Scholar]
116. Suguna L, Chandrakasan G, Ramamoorthy U, et al. Influence of honey on biochemical and biophysical parameters of wounds in rats. J Clin Biochem Nutr. 1993;14:91–9. [Google Scholar]
117. Brölmann FE, Ubbink DT, Nelson EA, et al. Evidence-based decisions for local and systemic wound care. Br J Surg. 2012;99:1172–83. [PubMed] [Google Scholar]
118. Phuapradit W, Saropala N. Topical application of honey in treatment of abdominal wound disruption. Aust N Z J Obstet Gynaecol. 1992;32:381–4. [PubMed] [Google Scholar]
119. Armon PJ. The use of honey in the treatment of infected wounds. Trop Doct. 1980;10:91. [PubMed] [Google Scholar]

120. McInerney RJF. Honey - A remedy rediscovered. J R Soc Med. 1990;83:127. [PMC free article][PubMed] [Google Scholar]
121. Hutton DJ. Treatment of pressure sores. Nurs Times. 1966;62:1533–4. [PubMed] [Google Scholar]
122. Wadi M, Al-Amin H, Farouq A, et al. Sudanese bee honey in the treatment of suppurating wounds. Arab Medico. 1987;3:16–8. [Google Scholar]
123. Blomfield R. Honey for decubitus ulcers. J Am Med Assoc. 1973;224:905. [Google Scholar]
124. Subrahmanyam M. Storage of skin grafts in honey. Lancet. 1993;341:63–4. [PubMed] [Google Scholar]
125. Subrahmanyam M. Early tangential excision and skin grafting of moderate burns is superior to honey dressing: a prospective clinical trial. Burns. 1999;25:729–31. [PubMed] [Google Scholar]
126. Wood B, Rademaker M, Molan PC. Manuka honey, a low cost leg ulcer dressing. N Z Med J. 1997;110:107. [PubMed] [Google Scholar]
127. Betts JA, Molan PC. A pilot trial of honey as a wound dressing has shown the importance of the way that honey is applied to wounds.. 11th Conference of the European Wound Management Association; Dublin, Ireland. 2001. [Google Scholar]
128. Molan PC, Allen KL. The effect of gamma-irradiation on the antibacterial activity of honey. J Pharm Pharmacol. 1996;48:1206–9. [PubMed] [Google Scholar]
129. Postmes T, van den Bogaard AE, Hazen M, et al. The sterilization of honey with cobalt 60 gamma radiation: A study of honey spiked with Clostridium botulinum and Bacillus subtilis. Experentia (Basel) 1995;51:986–9. [PubMed] [Google Scholar]
130. Harris S. Honey for the treatment of superficial wounds: A case report and review. Primary Intention. 1994;2:18–23. [Google Scholar]
131. Bose B. Honey or sugar in treatment of infected wounds? Lancet. 1982;1:963. [PubMed] [Google Scholar]
132. Molan PC. Re-introducing honey in the management of wounds and ulcers - theory and practice. Ostomy Wound Manage. 2002;48:28–40. [PubMed] [Google Scholar]
133. Blair SE, Cokcetin NN, Harry EJ, et al. The unusual antibacterial activity of medical-grade Leptospermum honey: Antibacterial spectrum, resistance and transcriptome analysis. . Eur J Clin Microbiol Infect Dis. 2009;28:1199–208. [PubMed] [Google Scholar]
134. Dunford CE, Hanano R. Acceptability to patients of a honey dressing for non-healing venous leg ulcers. J Wound Care. 2004;13:193–7. [PubMed] [Google Scholar]
135. Lusby PE, Coombes A, Wilkinson J. Honey: A Potent Agent for Wound Healing? Journal of Wound. Ostomy & Continence Nursing. 2002;29:295–300. [PubMed] [Google Scholar]
136. Maghsoudi H, Salehi F, Khosrowshahi MK, et al. Comparison between topical honey and mafenide acetate in treatment of burn wounds. Ann Burns Fire Disasters. 2011;24:132–7. [PMC free article][PubMed] [Google Scholar]
137. Seckam A, Cooper R. Understanding how honey impacts on wounds: An update on recent research findings. Wounds International. 2013;4:20–4. [Google Scholar]
138. Biglari B, Moghaddam A, Santos K, et al. Multicentre prospective observational study on professional wound care using honey (Medihoney™). Int Wound J. 2013;10:252–9. [PubMed] [Google Scholar]