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Use of Honey as a Medicinal Product in Wound Dressing (Human and Animal Studies): A Review

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Abstract: Use of honey as a medicinal product dates back to 2000 years ago and ever since, it's been utilized in dressing wounds and healing burns.The honey produced by diverse herbal sources contains various antibacterial substances that lead to increase of antibacterial activity of the natural honey. It has a high Osmolarity and takes the lymph into the wound and causes the tissues of the wound surface to use the nutrients of the lymph. Having pH = 3.6-3.7, honey provides an acid environment for a faster wound healing and moreover, bacteria are not able to grow in PH of honey. In order to prevent the growth of yeasts, the honey being used should be thick and should contain at most 17% of water. Honey stimulates the production of lymphocytes and intensifies the body's reaction against microorganisms. One of the antibacterial elements of honey is hydrogen peroxide. The hydrogen peroxide surface of honey varies based on the kind of honey and the nectar being used in its production. Today, due to its accessibility, antibacterial abilities, high Osmolarity, capability of aromatizing and vast use in traditional medicine, a special attention is devoted to the use of honey in wound dressing and burn healing in modern medicine and veterinary medicine.

Key words: Honey, wound dressing, antibacterial activity, osmolarity, hydrogen proxide, lymphocytes, medicine

INTRODUCTION

In traditional medicine, honey is used for the treatment of upset stomach, coughs, sneezes and ocular diseases (Subrahmanyam *et al*., 2001). In the recent years, physicians, with a great regard to the significance of curative powers of honey, have used it in the management of wounds and the process of their healings. Based on the archeological findings, 2000 years ago, ancient Egyptians used honey in wound healing for the first time (Gelbert, 1999). In the scientific sources concerning the Middle Ages, more than 1000 wound healing using honey have been reported (Nailor, 1999). Later on, honey entered the clinical world and the world of scientific researches. Although honey has been used for wound and burn healing for ages, its scientific reason was not evident until the 20th century. Nowadays, honey is used in treatment of both human and animal wounds (Mathews and Binnington, 2002).

NUTRIENTS EXISTING IN HONEY

Ordinary honey contains; 40% glucose, 40% fructose, 20% water and low level of amino acids, vitamins-Biotin, Nicotinic acid, Folic acid, Pentenoic acid, Proxidine, Tiamin and minerals-Potassium, Iron, Magnesium, Phosphorus and Calcium (Bergman *et al*., 1983). Honey is an energizing nutrition source containing different antioxidants and neutralizes the free radicals produced by H_2O_2 (Frankel *et al*., 1998).

Antibacterial ability of honey: Reproduction of bacteria in the wound causes infection and eventually leads to a severe growth of the wound damage. The ability to absorb moisture and low pH in honey (3.6) results in the formation of a protective layer on the wound, which, to a great extent, prevents penetration and colonization of bacteria (Efem, 1998). Laboratory studies have revealed that honey has an antibacterial effect on different kinds of infectious wounds such as the wounds infected by Staphylococcus Aureus (Cooper *et al*., 1999). The thinner the honey is, the lower Osmolarity and consequently higher pH it has. Hence, thinner honey has a low level of antibacterial power (McCarthy, 1995).

Honey contains a variety of antibacterial combinations such as bioflavonoids, which are produced by plants. One of the antibacterial elements of honey is hydrogen peroxide. The hydrogen peroxide surface of honey varies based on the kind of honey and the nectar being used in its production. It's worth pointing out that the H_2O_2 existing in honey is in a low level and has no harm for human health (Molan, 1992).

Recent research shows that the proliferation of peripheral blood B-lymphocytes and T-lymphocytes in cell culture is stimulated by honey at concentrations as

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low as 0.1% and phagocytes are activated by honey at concentrations as low as 0.1% (Abuharfeil *et al*., 1999).

In a recent survey carried out by Efem in 1992, the antibacterial effect of natural honey was compared to that of artificial honey and the sugar solution. In this study, the natural honey destroyed the bacteria-Pseudomonas aeruginosa and clostridium oedematiens-existing on the surface of the wound while the strong sugar solution had no effect on them (Efem and Iwara, 1992).

Aromatizing ability of honey: Scent and the special smell of honey have an effect on the pace of the wound healing, i.e. fragrant honey boosts the healing of the wounds (Molan, 1999). Besides, scent of the honey eradicates the unpleasant odors made by the clostridiums, gram-negative bacteria like Pseudomonas aeruginosa and different types of Proteus and the metabolism of the amino acids (Dunford *et al*., 2000). The bacteria existing in the wounds use the amino acids of the body as a source of energy. In case there is honey on the wound surface, bacteria would prefer glucose to the amino acids and would use the glucose of the honey as an energy source and would produce lactic acid. As a result, the unpleasant smells brought about by the decomposition of the amino acids fade away (Molan, 1999).

Sterilized honey: Although honey is not a suitable environment for the growth of microorganisms, a limited number of bacteria can grow in it under certain circumstances. Thus, in some parts of Europe (e.g. Medihoney in Germany) and Australia, honey is sterilized using gamma ray and the medical honey for wound treatment is available at drugstores (Dunford *et al*., 2000; Ahmed *et al*., 2003).

ANIMAL STUDIES OF HONEY AND SURFACE WOUND HEALING

In a recent study conducted on dogs, a part of their skin tissue was burned. In the ones that were dressed by honey, full recovery was observed after 21 days and the number of wound bacteria in this group was in a lower level in comparison with the other group (Sabetjalali *et al*., 2007). Twenty-four male mice underwent skin excision (10×10 mm) from the nape of the neck, to the depth immediately above the first layer of muscle, in a study by Bergman *et al*. (1983). Half the animals had pure honey applied in a thin layer to the wounds, twice daily, while the control group had saline applied at the same frequency and time of day. Four animals from 10 each group were killed at 3, 6 and 9 days after wounding and the damaged tissue excised completely. Depth and quality of granulation tissue was determined microscopically and the degree of epithelisation measured as the distance from the skin border to the wound centre.

The honey-treated tissue underwent more rapid and more extensive epithelisation than did the saline-treated control. After 3 days, the honey-treated tissue had 58% more skin growth ($p<0.001$), after 6 days it had 114% more ($p<0.001$) and after 9 days, 12% more ($p<0.01$) than the controls. Honey-treated mice had a greater thickness of granulation tissue in the centre of the wounds ($p<0.001$) compared to the control mice. No bacterial infections were detected in any of the wounds, which may reflect hygienic standards in the original surgical procedure. This experimental model therefore may not be representative of wound healing in infected tissue. Several papers by Egyptian and Indian researchers, have claimed that orally-administered honey was more effective in treating surface wounds than was topically-applied honey (Suguna *et al*., 1992, 1993; El-Banby, 1989; Kandil, 1987). These studies all used rats given surgical wounds. The studies suffer from several major defects in design, reducing their worth. Nevertheless they are mentioned for the sake of completeness due to the consistent outcomes reported, although these outcomes would appear to be unexpected. Wounds applied were either excision of a 4 cm^2 area of skin (Suguna, 1992, 1993) or by making a 10 mm incision (Kandil, 1987 and El-Banby *et al*., 1989). None of these studies reported the depth of the wounds although the studies of excised skin reported the excision to be "full thickness of skin". The excised skin studies used only 6 rat per group. Kandil *et al.* (1987) did not report the number of rats in each group and did not present a statistical analysis of the results. El-Banb *et al.* (1989) used a slightly larger group of rats (10) and presented some statistical analyses of results. The amount of honey administered orally was small in each study (0.5-1.0 mL^{-1} day, to rats weighing 125-150 g) and concurrent feeding practices were not described. The sameamount of honey was used for topical treatment.

Gupta *et al.* (1992) studied the effect of topical natural honey on the healing of infected skin wounds in buffalo calves and compared this effectiveness to that of ampicillin ointment and ampicillin mixed with honey. Although this study was of a superior design to those of Suguna *et al.* (1992, 1993), El-Banby *et al.* (1989) and Kandil *et al.* (1987) with wound production being well-defined, a large number of wounds being studied (90) and histological observation being undertaken, the suffers from a major defect in that no tabulated results are provided. The authors present only three photographs as evidence in support of their conclusions. The authors claim that honey was significantly more effective than ampicillin (2.5% ampicillin sodium in petroleum jelly) or 2.5% ampicillin sodium in honey in accelerating wound

healing. The amount of ointments applied was not stated. The authors report that honey-treated wounds showed less neutrophilic infiltration and more formation of angioblasts and fibroblasts. Without presentation of numerical results it is difficult to assign much weight to this study, beyond the anecdotal.

Deep skin burns were applied in twelve places on the flanks of three pigs in a study by Postmes *et al.* (1996) that compared the efficacy of honey to sugar solutions, both of very similar carbohydrate composition and concentration and silver sulfadiazine (1% cream) in healing burn tissue. Burn tissue was examined histologically on days 7, 14, 21, 28, 35 and 42 post-burn. Honey and sugar both produced more rapid healing than did silver sulfadiazine, with wounds closing within 21 days for honey and sugar, but requiring 28-35 days for silver sulfadiazine. Burns treated with sugar solution produced thicker new skin (mean 7.1 mm 11 after 28 days), with evidence of inflammation, than was found on the burns treated with honey, whichshowed little inflammation (mean dermal thickness after 28 days: 5.1 mm).

The mechanism by which honey produced a more rapid and effective healing than either sugar or silver sulfadiazine was not identified, although tissue treated with sugar showed more myofibroblasts than did the honey-treated tissue.

In a survey carried out in Uludag University of Turkey, in a group of dogs, they applied honey on the wounds and dressed them, while the other group were dressed using SSD (Silver Sulfadiazine). In other words, honey was compared to SSD. In the dogs dressed using honey, the infection of the wound disappeared rapidly and the healing pace increased and proved that honey works better than some other medications used in wound dressing (Celimli, 2005) (Fig. 1).

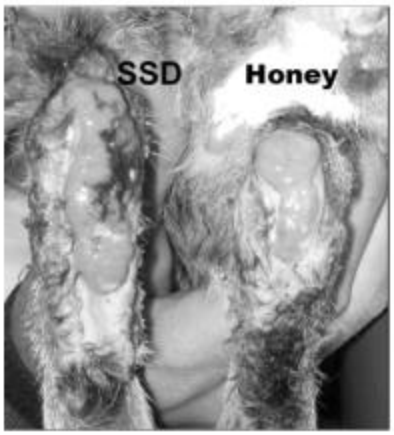

Fig. 1: SSD and honey in burn wounds, a faster healing can be observed on the honey applied wound

HONEY AND WOUND HEALING

In order to treat some diseases, traditional medicine has recommended gathering honey from different regions, which today, is revealed it's been due to the variety of herbal sources. The honey produced by diverse herbal sources includes various antibacterial substances that accelerate its antibacterial efficiency (Cooper *et al*., 1999). The suitable temperature for honey in wound dressing is 37°C.

Honey has a high Osmolarity and takes the lymph into the wound and causes the tissues of the wound surface to use the nutrients of the lymph (Molan, 1999). It makes the wound swelling go down, annihilates and scatters microorganisms and subsequently cleans the wound surface and in addition to its important role in wound recovery, it's considered as an energy source for the surrounding cells and a protection for the protein layer of the wound surface (Subrahmanyam, 1999).

Having pH = 3.6-3.7, honey provides an acid environment which revs up the wound healing (Cooper *et al*., 1999). Thin honey, due to having more water, can be a suitable environment for the growth of some yeasts; therefore, in order to prevent the yeast growth, the honey being used should be thick and should include at most 17% of water (Molan, 1996).

PRACTICAL CONSIDERATIOS FOR THE CLINICAL USE OF HONEY (MOLAN, 2001)

- The amount of honey required on the wound relates to the amount of fluid exuding from the wound diluting it. The frequency of dressing changes required will depend on how rapidly the honey is being diluted by exudate. If there is no exudate, dressings need to be changed twice-weekly to maintain a 'reservoir' of antibacterial components as they diffuse into the wound tissues.
- To achieve best results the honey should be applied to an absorbent dressing prior to application. If applied directly to the wound, the honey tends to run off before a secondary dressing is applied to hold it in place.
- Honey will not soak readily into absorbent dressings. Soaking is facilitated by warming the honey to body temperature and/or adding 1 part water to 20 parts honey to make the honey more fluid.
- In some situations a 'blister' of honey can be held on a wound using an adhesive film dressing. Honey can be used to treat cavity wounds in this way, although this approach is not suitable for heavily exuding wounds.

- For moderately to heavily exuding wounds, a secondary dressing may be needed to contain seepage of diluted honey from the primary dressing. An occlusive dressing such as polyurethane film is best, as an absorbent secondary dressing tends to draw the honey away from the wound surface.
- A low-adherent dressing helps prevent the honey dressing sticking to the wound in cases where this is a problem. This dressing is placed between the wound and the honey dressing, but must be porous to allow the antibacterial components of honey to diffuse freely into the wound bed.
- Alginate dressings impregnated with honey are a good alternative to cotton/cellulose dressings, as the alginate converts into a honey-containing soft gel.
- Any depressions or cavities in the wound bed need to be filled with honey in addition to using a honey-impregnated dressing. This is to ensure the antibacterial components of the honey diffuse into the wound tissues.
- Honey can safely be inserted into cavities and sinuses. It is water-soluble and easily rinsed out; any residues are bio-degradable (honey filtered in processing does not contain any foreign bodies). For sinuses with small openings a catheter on a syringe filled with honey is an effective way of applying honey.
- Since infection may lie in the tissues underlying the wound margins, honey dressings need to extend beyond the inflamed area surrounding a wound.

CONCLUSION

In regard to its accessibility all around the world, its inexpensive price compared to antibiotics and wound dressing medications and acceleration in wound healing, honey can be used instead of aforementioned medications. Medical and veterinary studies would prefer the use of honey in eradication of infections rather than some other antibiotics. Today, the use of honey in medicine and veterinary medicine is increasing and sterilized honey is available at the drugstores in some countries (Dunford et al., 2000 ; Ahmed *et al*., 2003). In various surveys, medical abilities of honey and the possibility of using it in other branches of medicine is being studied.

REFERENCES

Abuharfeil, N., R. Al-Oran and M. Abo-Shehada, 1999. The effect of bee honey on the proliferative activity of human B and T lymphocytes and the activity of phagocytes. Food Agric. Immunol., 11: 169-177.

Ahmed, A.K., M.J. Hoekstra, J.J. Hage and R.B. Karim, 2003. Honey-Medicated. Dressing: Transformation of an ancient remedyin to modern therapy. Ann. Plast Surg., 50: 143-147.

Bergman, A., J. Yanai, J. Weiss, D. Bell and M.P. David, 1983. Acceleration of wound healing by topical application of honey: An animal model. Am. J. Surg., 145: 374-376.

Çelimi, N., 2005. Kedi ve KöpeklerdeYara Sagaltımında Bal Kullanılması. Veteriner Cerrahi Dergisi., 11: 10-14. (In Turkush).

Cooper, R.A., P.C. Molan and K.G. Harding, 1999. Antibacterial activity of honey against strains of Staphylococcus Aureus from infected wounds. J. Royal. Soc. Med., 92: 283-285.

Cooper, R.A., 1998. The inhibition of bacteria isolated from chronic venous leg ulcers by honey. J. Med. Microbiol., 47: 1140-1146.

Dunford, C., R. Cooper and P. Molan, 2000. Using Honey as a dressing for infected skin lesions. Nursing Times Plus, 96: 7-9.

Efem, S.E.E., 1998. Clinical observations on the wound healing properties of honey. Br. J. Surg., 75: 679-681.

Efem, S.E.E. and C.I. Iwara, 1992.The antimicrobial spectrum of honey and its clinical significance. Infection, 20: 227-229.

El-Banby, M., A. Kandil, G. Abou-Sehly, M.E. El-Sherif and K. Abdel-Wahed, 1989. Healing effect of floral honey and honey from sugar-fed bees on surgical wounds (animal model). Fourth Int. Conf. Apicul. Tropi. Clim. Cairo, pp: 46-49.

Frankel, S., G.E. Robinson, M.R. and Berenbaum, 1998. Antioxidant capacity andcorrelated characteristics of 14 unifloral honeys. J. Apic. Res., 37: 27-31.

Gelbert, M., 1999. Wounds in time: The History of wound management. In: Miller, M., D. Glover (Eds.). Wound Management. London, NT Press.

Gupta, S.K., H. Singh, A.C. Varshney and P. Prakash, 1992. Therapeutic efficacy of honey in infected wounds of buffaloes. Ind. J. Anim. Sci., 62: 521-523.

Kandil, A., M. El-Banby, K. Abdel-Elwahed, G. Abou Sehly and N. Ezzat, 1987. Healing effect of true floral and false nonfloral honey. J. Drug. Res. Egypt, 17: 1-2.

Mathews, K.A. and A.G. Binnington, 2002. Wound management using honey. Compendium Continuing Edu., 24: 53-60.

McCarthy, J., 1995. The Antibacterial effects of honey, Am. Bee. J., pp: 171-172.

Molan, PC., 2001. Honey as a topical antibacterial agent for treatment of infected wounds, Deptartment of Biology Sciences, University of Waikato Private Bag 3105, Hamilton, New Zealand.

Molan, P.C., 1999. The Role of Honey In the Management of Wounds. J. Wound Care, 8: 415-418.

Molan, P.C., 1996. Antibacterial Properties of Honey, Hivelights, pp: 15-19.

Molan, P.C., 1992. The antibacterian activity of Honey. Variation in the potency of Antibacterial Activity. Bee World, 73: 59-79.

Nailor, I.L., 1999. Ulcer Care in The Middle Ages. J. wound Care, 8: 208-212.

Postmes, T.J., M.M.C. Bosch, R. Dutrieux, J. van Baare and M.J. Hoekstra, 1997. Speeding up the healing of burns with honey. In: Mizrahi, A. and Y. Lensky (Eds.). Bee Products: Properties, applications and apitherapy. New York, Plenum Press, pp: 27-37.

Sabetjalali, F.S., S. Tajik, S. Saifzade and B. Fartash, 2007. Topical Application of Natural Urmia Honey on experimental burn wounds in the Dog : Clinical and microbiological studu, Asian J. Anim. Vet. Adv., 2: 133-139.

Subrahmanyam, M., H. Archan and S.G. Pawar, 2001. Antibacterial Activity of Honey on Bacteria Isolated From Wounds, Annals of Burns and Fire Disasters, 14: 1-22.

Subrahmanyam, M., 1999. Early tangential excision and skin grafting of moderate burns is superior to honey dressing: A prospective randomized trial. Burns., 25: 729-731.

Suguna, L., G. Chandrakasan, U. Ramamoorthy and K.T. Joseph, 1993. Influence of honey on collagen metabolism during wound healing in rats. J. Clin. Biochem. Nutr., 14: 91-99.

Suguna, L., G. Chandrakasan and K.T. Joseph, 1992. Influence of honey on biochemical and biophysical parameters of wounds in rats. J. Clin. Biochem. Nutr., 13: 7-12.