International Journal of Nursing Care
Volume 11, No. 1, January-June 2023

Effect of Honey Dressing on Wound Healing among Patients with Diabetic Foot Ulcer at Al-Ahsa, Saudi Arabia

Sahbanathul M. Jalal[1*], Rawabi A. Amloqel[2], Sajedah A. Aljaber[2], Jumanah A. Ali Al-Abdulwahed[2], Rahaf A. Aldossary[2], Maha A. Ali Hakami[2]

[1]Assistant Professor, Department of Nursing, College of Applied Medical Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia, [2]Interns, Department of Nursing, College of Applied Medical Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia.

How to cite this article: Jalal SM, Amloqel RA, Aljaber SA, Al-Abdulwahed JAA, Aldossary RAA, Hakami MAA. Effect of Honey Dressing on Wound Healing among Patients with Diabetic Foot Ulcer at Al-Ahsa, Saudi Arabia. 2023;11(1):33-41.

ABSTRCT

Background: Diabetic foot ulcer (DFU) is a serious infection in people with diabetes mellitus. DFU is caused by vascular disease with diabetic neuropathy, and severe DFU leads to disability or even death. Mostly, povidone iodine dressing (PID) is used for DFU. The honey dressing (HD) may also improve wound healing in DFU as a complementary therapy. **Aim:** The study aimed to determine the effect of HD on the wound-healing process for DFU. **Materials and Methods:** A prospective observational study was conducted in the diabetic centres of selected hospitals in eastern Saudi Arabia. A total of 126 patients with DFU below grade three according to Wagner's classification were selected by randomization and equally divided into HD (n = 63) and control (n = 63) groups. The patients were followed up with regularity, and 60 from each group were analysed, because the remaining patients lost their follow-up. Demographic variables and clinical parameters including random blood sugar and haemoglobin A1C were measured at the initial visit before intervention. The Bates-Jensen wound assessment tool was used before and after the intervention. Intervention group received HD and control group received PID for 6 weeks. The results are presented using frequency, mean, chi-squared test, independent 't' test and Wilcoxon signed-rank test. **Results:** Among 120 patients, the demographic variables, and clinical parameters in the HD and control were homogeneous. The overall mean wound score was 41.07 ± 2.95 and 29.78 ± 2.2 before and after the intervention in the HD group respectively which was significant ($p < 0.0001$). Mean score of control was 41.13 ± 2.43 before intervention and 38.53 ± 3.29 after intervention which was also significant ($p = 0.00062$). **Conclusion:** HD is best alternative cost-effective dressing method that promotes faster healing in DFU. It should be further promoted in healthcare settings.

Key words: Diabetic foot ulcer; Wound healing; Honey dressing; Wound dressing

INTRODUCTION

Diabetic foot ulcer (DFU) is a common and serious infection in people with diabetes mellitus (DM)[1]. DFU is caused by poor glycaemic control, poor circulation in lower extremities, peripheral arterial disease (PAD) with sensory neuropathy, calluses, improper foot care and footwear, dry skin, and many others. It is associated with significant morbidity subsequently leading to disability due to lower limb amputation and even death in severe conditions if not treated on time[2]. Diabetic peripheral neuropathy (DPN) eventually affects approximately 50% of adults

Corresponding author: Dr. Sahbanathul Missiriya Jalal, Ph.D. Assistant Professor, Building No.110, Nursing Department, College of Applied Medical Sciences, King Faisal University, Al-Ahsa 31982, Kingdom of Saudi Arabia. India. Pin code -603103
E-mail: sjalal@kfu.edu.sa.

with DM during their lifetime[3]. According to many longitudinal epidemiological studies, the DFU risk is approximately 25% among diabetic patients, and it accounts for two-thirds of all non-traumatic amputations[4].

Few cross-sectional studies from developed countries such as the USA and Europe have estimated the prevalence of DPN to range from 6% to 51% depending on the population studied[5]. This burden is higher in older individuals and among adults with long-standing type 2 DM. The prevalence of diabetes among men and women is 17% and 22% respectively in Saudi Arabia[6]. Among DM patients, 2.05% have a foot ulcer, 0.19% have gangrene, and 1.06% undergo an amputation according to the Saudi National Diabetes Registry[7]. Historically, honey has been used to treat many disease conditions in clinical practices because it has medicinal effects. More recently, honey has been rediscovered by medical researchers for its use in dressing acute and chronic wounds[8]. Honey has anti-oxidant, antimicrobial and anti-inflammatory properties. it prevents the growth of bacteria on the surface of the wound due to its antibacterial effects. Honey reduces oedema and exudates due to its anti-inflammatory effects, and it enhances angiogenesis and collagen synthesis in the wound-healing process. Moreover, honey accelerates granulation tissue formation to produce wound epithelialization. Hence, honey has been used for treating wounds[9,10].

A systematic review has reported that honey is effective in decreasing both wound repair and treatment times as well as in increasing the protection from infection through the bacterial clearance in wounds[11]. Although many reviews have discussed the effects of honey and some researchers have studied the impact of honey dressing (HD) on the treatment of DFUs[12,13], additional studies are needed more accurately to measure the changes in wound healing. Thus, we sought to objectively evaluate the effectiveness of HD in the treatment of DFUs and to provide evidence to select an appropriate intervention for wound healing in patients with DFUs.

The aim of the present study was therefore to evaluate the effect of HD on the treatment of wounds on healing outcomes in DFUs. Furthermore, the effect of HD and its effectiveness compared to povidone iodine dressing on wound-healing outcomes in DFUs were assessed.

METHODOLOGY

Study Design

The quantitative, prospective, randomized controlled trial was conducted to determine the effect of HD on wound healing among patients with DFUs [Figure 1]. The objectives and the procedures of the present study were fully understood by the study participants through proper instructions before the onset of the study. Informed consent was obtained from each participant involved in the study before data collection and they were ensured about the confidentiality, no risk, anonymity, and voluntary participation. This study was conducted in accordance with the Declaration of Helsinki, and it followed all ethical principles.

Study Setting and Participants

The present study was conducted in the diabetic centres of selected hospitals in the eastern region of the Kingdom of Saudi Arabia. The inclusion criteria for the patients

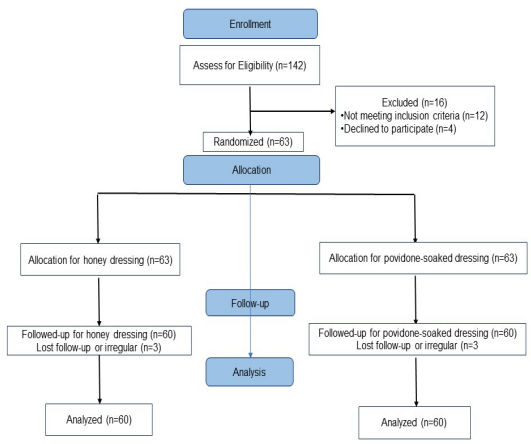

Fig. 1: CONSORT Flow Diagram.

were as follows: Persons with DM, aged 20 years and older, including both males and females, residing in the eastern region of Saudi Arabia; foot ulcers less than grade 3 according to Wagner's classification[14] of any duration; DFU in either one or both legs; uncomplicated conditions; and regularly visited the diabetic clinic for wound dressings (at least two times per week).

The exclusion criteria for the patients were as follows: uncontrolled diabetes (when random blood glucose (RBS) levels are 200 ml/dL or higher or haemoglobin A1C (HbA1C) level is more than 8); septicemia; wound grade 3 or more than 3 according to Wagner's classification; amputated legs; serious illness; complicated diseases, such as end-stage renal failure, cancer and hepatic coma; undergoing immunosuppressive drug treatment; non-cooperative for the regular dressing of DFU; and known allergies to honey.

Study Sampling

The sample size was estimated considering the mean and standard deviation of a similar, previous study[15] with an α error of 0.05 and β error of 0.20. Accounting for 10% dropouts, the total sample size was calculated as 142. After exclusion, 126 participants based on the inclusion criteria were selected and they were assigned to HD (63) and control group (63) equally by simple randomization using through computer-generated random numbers. A total of 126 patients with DFU were assessed to determine the effect of HD on wound healing. However, only 60 patients from the HD group and 60 patients from the control group were able to follow up and those data were analysed in the study.

Data Collection

A structured questionnaire with an observational tool was used to collect the data. This questionnaire is an original tool, and it has been evaluated by a panel of experts to validate the tool. A pilot study has also been conducted to improve the tool. The structured questionnaires consisted of the following three parts: 1) demographic variables, 2) clinical parameters and 3) Bates-Jensen wound assessment[16]. The reliability of the questionnaire was tested (r = 0.946) using Cronbach's alpha. The time to fill in the questionnaire ranged from 15 to 20 minutes. Information was included in the tool with an introduction, explaining the objectives of the study and ensuring privacy and confidentiality before distribution. Participants were informed that their participation in the study was voluntary without any financial support. Informed consent was obtained from all the participants before the data collection.

Tool

The demographic variables included age, gender, highest educational qualification, occupation, smoking habit, body mass index (BMI), duration of DM and treatment type of DM. This information was collected for both the intervention and control groups during the initial data collection. The clinical parameters included random blood sugar (RBS) level and haemoglobin A1C (HbA1C) test result. These tests were performed before initiating intervention of the study. The Bates-Jensen wound assessment included data, such as size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudate type, exudate amount, skin colour surrounding the wound, peripheral tissue oedema, peripheral tissue induration, granulation tissue and epithelialization. The wound assessment was graded from 1 to 5 according to the characteristics of the wound. The total score ranged from 13 to 65, and this score was plotted on a wound status continuum to determine progress. Pre-test wound assessment was done before the start of intervention (1st week) and post-test was done after the intervention period (6th week).

Intervention

The patients with DFU were randomized into two groups as HD and control groups by using simple randomization through computer-generated random numbers. HD group received dressing with medical-grade honey; and the control group, which received povidone-soaked dressing. Participants were

advised to visit the diabetic clinic twice a week for dressing their wounds. On the first and sixth week of the study, the Bates-Jensen wound assessment was performed. All patients received appropriate antibiotics, and the ulcers were debrided by the surgeon if needed as per the standard protocols. Wound dressing was performed by a trained nurse. In the HD group, the wound was initially cleansed with normal saline, and the wound was then covered with sterile HD and bandaged. In the control group, the wound was first cleansed with normal saline, which was followed by covering it with povidone-soaked gauze. The wound dressing was continued and observed for 6 weeks regularly. However, the first and sixth weeks of the observation were taken for analysis purposes. The outcome measures were calculated in terms of the proportion of wounds completely healed (primary outcome), wound-healing time and deterioration of wounds based on the wound assessment tool. Patients were followed up for 6 weeks.

Data Analysis

Statistical analysis was performed with Statistical Package for Social Sciences (SPSS) for Windows (version 21.0; International Business Machines (IBM) Corporation, Armonk, NY, USA). The statistical significance level was set at $p < 0.05$. Descriptive statistics, such as frequency and percentages, were used for categorical variables, and the mean and standard deviation (SD) were used for continuous variables. The demographic characteristics of the subjects were compared between the intervention group and control group using an independent t-test for the quantitative variables and the chi-squared test for categorical variables. The paired t-test was used to compare the pre-intervention and post-intervention results within the groups. The overall wound assessment score was tested for both the HD and control groups by Wilcoxon signed-rank test.

RESULTS

Demographic Variables

The demographic characteristics of the study participants were analyzed [Table 1]. The chi-squared test was performed to evaluate the homogeneity of the 60 participants in each group, and all demographic characteristics of patients (including age, gender, highest educational qualification, occupation,

Table 1: Demographic variables of the patients with DFU

Variables	*Category*	*HD group (n=60) n (%)*	*Control group (n=60) n (%)*	*p Value*
Age (years)	21-40 years	7 (11.7)	5 (8.3)	p = 0.673
	41-60 years	35 (58.3)	33 (55)	
	More than 60 years	18 (30)	22 (36.7)	
Gender	Male	47 (78.3)	44 (73.3)	p = 0.522
	Female	13 (21.7)	16 (26.7)	
Educational Qualification (Highest)	Primary level	8 (13.3)	12 (20)	p = 0.580
	High school level	24 (40)	19 (31.7)	
	Graduate level	13 (21.7)	9 (15)	
	Post graduate level	4 (6.7)	6 (10)	

Variables	*Category*	*HD group (n=60) n (%)*	*Control group (n=60) n (%)*	*p Value*
	Others (diploma)	11 (18.3)	14 (23.3)	
Occupation	Employed	39 (65)	36 (60)	p = 0.572
	Unemployed	21 (35)	24 (40)	
Smoke habit	Non-smokers	26 (43.3)	23 (38.3)	p = 0.577
	Smokers	34 (56.7)	37 (61.7)	
BMI	Normal (18.5-24.9)	11 (18.3)	13 (21.7)	p = 0.759
	Overweight (25-29.9)	30 (50)	26 (43.3)	
	Obese (>30)	19 (31.7)	21 (35)	
Duration of DM	< 1 year	2 (3.3)	1 (1.7)	p = 0.932
	1-3 years	5 (8.3)	6 (10)	
	4-6 years	7 (11.7)	8 (13.3)	
	6-9 years	29 (48.4)	31 (51.7)	
	10 & above years	17 (28.3)	14 (23.3)	
Treatment type of DM	Oral drugs	37 (61.7)	42 (70)	p = 0.530
	Parenteral drugs	16 (26.7)	14 (23.3)	
	None	7 (18.4)	4 (6.7)	

N: Number; %: Percentage

smoking habit, and BMI), duration of DM and treatment type of DM were homogeneous in both groups ($p > 0.05$).

Clinical parameters

In the clinical parameters, RBS and HbA1C tests were done before initiation of intervention and the results were analysed [Table 2]. The independent t-test was used to evaluate the homogeneity of the HD and control groups, and all the parameters were similar in both groups ($p > 0.05$).

Wound assessment

The wound assessment was graded from 1 to 5 according to the Bates-Jensen wound assessment tool and the mean score obtained for each characteristic. The results showed that there were significant changes in the size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudate type, exudate amount, skin colour surrounding the wound, peripheral tissue oedema, peripheral tissue induration, granulation tissue and epithelialization ($p = 0.0001$) in the HD group when we compared pre and post intervention assessment {Table 3].

The patients were followed up with regularity, and only 60 from each group were analysed because others lost their continuity of follow-up. The overall wound assessment score was analysed by Wilcoxon signed-rank test. The results showed that the mean wound score in DFU patients before and after the intervention was 41.07 and 29.78 in the HD group, respectively which showed a significant difference ($p < 0.0001$). In the control group, the mean wound score before

Table 2: Clinical parameters of the patients with DFU

Clinical parameters	HD group (n=60) Mean (SD)	Control group (n=60) Mean (SD)	p Value
RBS	191.5 ± 55.5	181.81 ± 41.69	p = 0.448
HbA1C	7.72 ± 0.53	7.75 ± 0.48	p = 0.780

N: Number; %: Percentage

Table 3: Wound assessment characteristics of patients with DFU

	HD group (n=60)		
Characteristics	*Pre-test Mean (SD)*	*Post-test Mean (SD)*	*Paired 't' test*
Size (sq cm)	3.07 ± 0.52	1.93 ± 0.63	t = 7.215 p = 0.0001*
Depth	2.87 ± 0.63	2.03 ± 0.61	t = 7.215 p =0.0001*
Edges	3.2 ± 0.48	2.36 ± 0.49	t = 9.898 p = 0.0001*
Undermining (cm)	3.13 ± 0.35	2.33 ± 0.48	t = 10.77 p = 0.0001*
Necrotic tissue type	3.4 ± 0.5	2.63 ± 0.49	t = 7.389 p = 0.0001*
Necrotic tissue amount (%)	3.5 ± 0.51	2.16 ± 0.65	t = 8.651 p = 0.0001*
Exudate type	3.36 ± 0.61	2.53 ± 0.51	t = 5.221 p = 0.0001*
Exudate amount	3.3 ± 0.6	2.37 ± 0.61	t = 5.635 p = 0.0001*
Skin color surrounding wound	2.77 ± 0.77	1.97 ± 0.56	t = 5.757 p = 0.0001*
Peripheral tissue edema (cm)	3 ± 0.69	2.03 ± 0.6	t = 6.922 p = 0.0001*
Peripheral tissue induration (cm)	3.17 ± 0.59	2.47 ± 0.57	t = 4.826 p = 0.0001*
Granulation tissue (%)	3.43 ± 0.57	2.7 ± 0.47	t = 5.809 p = 0.0001*
Epithelialization (%)	2.87 ± 0.57	2.23 ± 0.68	t = 4.289 p = 0.0001*

p <0.05 – Significance; p >0.05 – Non-significance

Table 4: Overall wound assessment of patients with DFU

Groups		*Mean (SD)*	*Mean Difference*	*z score*
HD group (n=60)	Pre-test	41.07 ± 2.95	10.07	z = 4.7821
	Post-test	29.78 ± 2.2		p = 0.00001*
Control group (n=60)	Pre-test	41.13 ± 2.43	2.87	z = 3.4246
	Post-test	38.53 ± 3.29		p = 0.00062*

p <0.05 – Significance; p >0.05 – Non-significance

and after the intervention was 41.13 and 38.53 (p < 0.00062), respectively [Table 4].

DISCUSSION

DFU is a serious issue and a major challenge for patients with DM, and it may result in a lengthy hospitalization and lead to lower limb amputation in severe cases[17]. The present study aimed to assess the effectiveness of wound dressing using honey, which may provide a clean wound with a reduction of wound size as it was measured by the Bates-Jensen wound assessment tool and enhance the optimal environment for the promotion of healing. The depth and colour of the wound showed faster healing in HD which proved the safe wound dressing. Many researchers have studied the role of honey as a dressing material for wound healing and indicated its physicochemical and antioxidant

properties[18]. In this study, we used dressing with honey for HD group, and povidone-soaked dressing for control group. Honey has more active compounds such as flavonoids, phenolic acid, organic acids, enzymes, and vitamins, which enhance wound healing[19]. As the antibacterial activity of honey has been well documented[20]. It reduces the ulcer of extremities and prevents the risk of limb amputation[21]. Some studies have reported that the usage of honey in dressing different types of diabetic wounds, such as DFUs, has different characteristics, but these studies did not quantitatively measure the differences. In the present study, strict inclusion criteria were adhered to standardized factors to reduce bias in the assessment of wound healing, and the wound assessment was performed using a standardized tool.

Few studies have assessed the parameters of wound healing qualitatively which might cause bias in the assessment. Also, the number of patients (n=30) involved the study was low[22,23]. In the present study, the wound assessment was done quantitatively by using Bates-Jensen wound assessment tool. Each characteristic of the wound was compared in the HD group before and after the intervention, resulting in statistically significant ($p < 0.001$) differences which proved the faster wound healing.

A randomized controlled trial was conducted to investigate the effect of Beri-honey-impregnated dressing on diabetic foot ulcer and compare it with normal saline dressing, in which the percentage of wound healing was higher in HD than normal saline dressing[24]. In the present study, there were significant differences observed in the size of the wound at 6 weeks ($p = 0.0001$) in the HD group. The depth of the wound was significantly different in the HD group before and after treatment ($p = 0.0001$). A previous study investigated the effectiveness in the treatment of DFU than other dressing. The meta-analysis showed that HD effectively shorten wound debridement time, wound healing time, and bacterial clearance time[25].

In the current study, there was a significant decrease in necrotic tissue and exudate formation in the HD group ($p = 0.0001$). A case report on honey-based therapy in the successful management of diabetic foot ulcer, in which HD was changed daily and by week 16 the ulcer completely healed[26]. A review was done to summarize the therapeutic properties of honey and its possible favourable effects on diabetic wound healing which evidenced that there was increased re-epithelialization and collagen production, higher wound contraction in HD[27.] Similarly in the present study, granulation tissue and epithelialization were observed faster significantly ($p = 0.0001$) in HD.

The dressing procedure was generally less painful due to the ability of the honey to maintain the moisture of the wounds without adhesion to the granulating surface. In agreement, other studies have reported that DFUs generally require a longer time to heal, indicating that the cost of the dressing may be an issue. In general, the moisture-retaining dressing materials available in the market are expensive. Therefore, the overall cost for wound dressing with honey is relatively cheaper which was supported by a study[28,29] suggesting that HD provides an economical and practical option for the management of wound ulcers in diabetic patients.

The strength of the present study was the use of a standardized tool for wound assessment. Importantly, the HD group had faster wound-healing outcomes than the control group. Bias was minimized in the selection of participants and in the outcome evaluation with randomization and single blinded assessment of the wounds. However, the present study had certain limitations. The safety of the dressing needed to be assessed, the sample size in the present study was relatively small, and all participants were not able to follow-up. However, the present study provides information for future RCTs with larger sample sizes of DFU patients, which will increase the strength and frequency of the

assessment to determine the wound-healing process more accurately.

CONCLUSION

HD is an alternative method. HD effectively promoted faster wound healing outcomes in DFU, compared to standard dressing which can reduce health consequences like limb amputations. In addition, HD effectively decreased wound oedema and odour. For the repeated dressing, the gauze removal was easier to perform and was less painful for the patient when using HD. Because HD is a cost-effective dressing method, it should be promoted in healthcare settings.

Source of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest: There is no conflict of interest.

Ethical approval

The study protocol was approved by the Human Ethical Clearance Committee of Deanship of Scientific Research, King Faisal University and King Fahad Hospital Hofuf, Institutional Review Board (H-05-HS-065), reference number 18-E-2020 as it was a clinical study.

REFERENCES

1. Reardon R, Simring D, Kim B, Mortensen J, Williams D, Leslie A. The diabetic foot ulcer. Aust J Gen Pract 2020:49:250-255. 10.31128/AJGP-11-19-5161
2. Chantelau EA. A novel diagnostic test for end-stage sensory failure associated with diabetic foot ulceration: Proof-of-principle study. J Diabetes Sci Technol 2021;15:622-629. 10.1177/1932296819900256
3. Hicks CW, Selvin E. Epidemiology of peripheral neuropathy and lower extremity disease in diabetes. Curr Diab Rep 2019;19:86. 10.1007/s11892-019-1212-8
4. Bus SA, van Deursen RW, Armstrong DG, Lewis JE, Caravaggi CF, Cavanagh PR. International Working Group on the Diabetic Foot. Footwear and offloading interventions to prevent and heal foot ulcers and reduce plantar pressure in patients with diabetes: A systematic review. Diabetes Metab Res Rev 2016;32 :99-118. 10.1002/dmrr.2702.
5. Boulton AJ. Diabetic neuropathy and foot complications. Handb Clin Neurol 2014;126, 97-107. 10.1016/S0140-6736(05)67698-2
6. Alotaibi A, Perry L, Gholizadeh L, Al-Ganmi A. Incidence and prevalence rates of diabetes mellitus in Saudi Arabia: An overview. J Epidemiol Glob Health 2017;7:211-218. 10.1016/j.jegh.2017.10.001
7. Al-Rubeaan K, Al Derwish M, Ouizi S, Youssef AM, Subhani SN, Ibrahim HM, Alamri BN. Diabetic foot complications and their risk factors from a large retrospective cohort study. PLoS One 2015;10:0124446. 10.1371/journal.pone.0124446
8. Al-Waili NS, Salom K, Butler G, Al Ghamdi AA. Honey and microbial infections: a review supporting the use of honey for microbial control. J Med Food 2011;14:1079-96. 10.1089/jmf.2010.0161
9. Saikaly SK, Khachemoune A. Honey and wound healing: An update. Am J Clin Dermatol 2017;18:237-251. 10.1007/s40257-016-0247-8
10. El-Kased RF, Amer RI, Attia D, Elmazar MM. Honey-based hydrogel: In vitro and comparative In vivo evaluation for burn wound healing. Sci Rep 2017;7:9692. 10.1038/s41598-017-08771-8
11. Al-Musawi S, Albukhaty S, Al-Karagoly H, Sulaiman GM, Alwahibi MS, Dewir YH, Soliman DA, Rizwana H. Antibacterial activity of honey/chitosan nanofibers loaded with capsaicin and gold nanoparticles for wound dressing. Molecules 2020;25:4770. 10.3390/molecules25204770
12. Wang C, Guo M, Zhang N, Wang G. Effectiveness of honey dressing in the treatment of diabetic foot ulcers: A systematic review and meta-analysis. Complement Ther Clin Pract 2019;34:123-131. 10.1016/j.ctcp.2018.09.004
13. Chopra H, Bibi S, Kumar S, Khan MS, Kumar P, Singh I. Preparation, and evaluation of chitosan/pva based hydrogel films loaded with honey for wound healing application. Gels 2022;8:111. 10.3390/gels8020111
14. Shah P, Inturi R, Anne D, Jadhav D, Viswambharan V, Khadilkar R, Dnyanmote A, Shahi S. Wagner's classification as a tool for treating diabetic foot ulcers: Our observations at a suburban teaching hospital. Cureus 2022;14:21501. 10.7759/cureus.21501
15. Surahio AR, Khan AA, Farooq M, Fatima I. Role of honey in wound dressing in diabetic foot ulcer. J Ayub Med Coll Abbottabad 2014;26:304-306.

16. Bates-Jensen BM, McCreath HE, Harputlu D, Patlan A. Reliability of the Bates-Jensen wound assessment tool for pressure injury assessment: The pressure ulcer detection study. Wound Repair Regen 2019; 27:386-395.: 10.1111/wrr.12714

17. Zhang P, Lu J, Jing Y, Tang S, Zhu D, Bi Y. Global epidemiology of diabetic foot ulceration: A systematic review and meta-analysis (dagger). Ann Med 2017;49:106-16. 10.1080/07853890.2016.1231932

18. Moniruzzaman M, Khalil MI, Sulaiman SA, Gan SH. Physicochemical and antioxidant properties of Malaysian honeys produced by Apis cerana, Apis dorsata and Apis mellifera. BMC Complement Altern Med 2013;13:43. 10.1186/1472-6882-13-43

19. Visavadia BG, Honeysett J, Danford MH. Manuka honey dressing: An effective treatment for chronic wound infections. Br J Oral Maxillofac Surg 2008;46:55-56. 10.1016/j.bjoms.2006.09.013

20. Mandal MD, Mandal S. Honey: Its medicinal property and antibacterial activity. Asian Pac J Trop Biomed. 2011, 1:154-160. 10.1016/S2221-1691(11)60016-6

21. Vandamme L, Heyneman A, Hoeksema H, Verbelen J, Monstrey S. Honey in modern wound care: a systematic review. Burns 2013;39:15141525. 10.1016/j.burns.2013.06.014

22. Alam F, Islam MA, Gan SH, Khalil MI. Honey: A potential therapeutic agent for managing diabetic wounds. Evid Based Complement Alternat Med 2014;2014:169130. 10.1155/2014/169130

23. Shukrimi A, Sulaiman AR, Halim AY, Azril A. A comparative study between honey and povidone iodine as dressing solution for Wagner type II diabetic foot ulcers. Med J Malaysia 2008;63:44-6. PMID: 18935732.

24. Imran M, Hussain MB, Baig M. A randomized, controlled clinical trial of honey-impregnated dressing for treating diabetic foot ulcer. J Coll Physicians Surg Pak 2015;25:721-725. 10.2015/JCPSP.721725

25. Wang C, Guo M, Zhang N, Wang G. Effectiveness of honey dressing in the treatment of diabetic foot ulcers: A systematic review and meta-analysis. Complement Ther Clin Pract 2019;34:123-131. 10.1016/j.ctcp.2018.09.004.

26. Mohamed H, El Lenjawi B, Abu Salma M, Abdi S. Honey based therapy for the management of a recalcitrant diabetic foot ulcer. J Tissue Viability 2014;23:29-33. 10.1016/j.jtv.2013.06.001.

27. Kateel R, Adhikari P, Augustine AJ, Ullal S. Topical honey for the treatment of diabetic foot ulcer: A systematic review. Complement Ther Clin Pract 2016;24:130-133. 10.1016/j.ctcp.2016.06.003.

28. Anastasiou IA, Eleftheriadou I, Tentolouris A, Samakidou G, Papanas N, Tentolouris N. Therapeutic Properties of Honey for the Management of Wounds; Is There a Role in the Armamentarium of Diabetic Foot Ulcer Treatment? Results From In vitro and In vivo Studies. Int J Low Extrem Wounds 2021;20:291-299. 10.1177/15347346211026819.

29. Yilmaz AC, Aygin D. Honey dressing in wound treatment: A systematic review. Complement Ther Med 2020;51:102388. 10.1016/j.ctim.2020.102388