

## Comparative Research

## Using complementary and alternative medicines to prevent and treat pressure ulcers: a systematic review

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## Competing interests

The authors declare no conflicts of interest.

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## Abbreviations

CAM, complementary and alternative medicines.

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## Abstract

**Background:** Pressure ulcers are skin lesions generated by ischemic conditions caused by pressure on soft tissues. Several studies have investigated complementary and alternative medicine (CAM) as preventative and treatment measures for pressure ulcers. Therefore, we systematically reviewed the CAM literature in preventing and treating pressure ulcers. **Methods:** All clinical trial studies which used CAM were included. We searched different databases, including Scientific Information Database, Irandoc, Google Scholar, PubMed, Medline, Scopus, Cochrane Library, Embase, and Science Direct. The following keywords were used: “complementary and alternative medicine-CAM”, “integrative medicine”, “traditional medicine”, “pressure ulcer”, “bedsore”, “pressure sore healing”, and “prevention”. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2015 checklist was used to perform analyses. **Results:** After screening, 35 studies were selected. Our investigations suggested that honey, medicinal plants, such as resin salve, *Angelica dahurica*, *Aloe vera*, fruits, herbal oils, a combination of several traditional medicine methods, sheepskin, maggot therapy, massage, charcoal, and acupuncture were the most common CAM methods. **Conclusion:** CAM strategies can prevent and treat pressure ulcers. They reduce wound size, exudate and necrotic tissue levels, inflammation, pain, bleeding, and infections.

**Keywords:** complementary therapies; traditional medicines; prevention; healing; pressure ulcer; systematic review

## Complementary and alternative medicines to prevent and treat pressure ulcers.

**Medicinal plants:** *Aloe vera*, resin salve, *Angelica dahurica*, henna, *Plantago major* L.



**Medicinal plant combinations:** aloe vera + olive oil, poppy + plant cellulose, honey + aloe vera, sesame + honey + camphor.

**Fruits:** kiwifruit, mango.



**Other methods:** maggot therapy, acupuncture, charcoal, and mummy solution.

**Herbal oils:** tea tree, coconut oil, olive oil, sun flower seed oil, sweet almonds oil, henna oil.



**Sheepskin**



**Honey**

### Tradition

Complementary and alternative medicine has been used for thousands of years to prevent and treat pressure ulcers in Egypt, China, Greece, India, and Iran. One of the oldest medical manuscripts, *the Sumerian clay tablet of Mesopotamia*, dates back to 2200 B.C.E., describes healing process methods, i.e., washing wounds, wound dressing, and wound bandaging. According to some sources, in Mesopotamian cultures, including the Sumerians and Akkadians, wounds were washed with beer or wine. They also used sesame infusions, which were first purified and pulverized before being applied with beer. Thus, probably one of the oldest known complementary and alternative medicine applications is beer. According to Majno, in 1911, in Mesopotamia, wounds were washed in water or milk and dressed with honey or resin. Similarly, conifer, myrrh and frankincense may also have been used for wound bandaging.

### Background

Pressure ulcers are skin lesions that arise from ischemic conditions caused by pressure applied to soft tissues. This pressure results from the soft tissue being pressed between hard tissue and bone tissue [1, 2]. Globally, pressure ulcers occur in more than 1.3 million adults annually [3]. Its prevalence in hospitals is 8.3% in Spain, 8.9% in France, 10.2% in Germany, 12.5% in Portugal, 12% in Jordan, 18.5% in Ireland, 21.1% in Belgium, 22.7% in Denmark, 23% in Sudan, and 1.58% in China. The condition is reported at 5% in general in Iran and 10.1%–21% in specialized wards [4–6]. When a pressure ulcer diagnosis is delayed, the patient's health deteriorates, and costs related to controlling possible infections increase. Approximately 2.5 million patients contract pressure ulcers annually in the USA, which translates to an estimated 9–11.5 million dollars in treatment costs. Approximately 60,000 patients die annually from pressure ulcer complications. In Europe, this equates to almost 18% of total hospitalized patients in public and private hospitals. Treatment costs for these patients are approximately 15,000–17,000 euros [7].

Pressure ulcers arising from cancer and cardiovascular disease are the third most expensive condition. Physical, financial, and social consequences of pressure ulcers can also affect different individuals and groups, including patients, caregivers, families, and medical personnel. Similarly, pain and dependency on caregivers are also inevitable complications. Evidence from the USA has suggested that developing pressure ulcers is associated with an increased hospitalization rate of more than four days, a 25% increased risk of hospital-acquired infection, and a 55% increase in mortality rates [8, 9].

Pressure ulcers typically occur in prominent bony areas such as the sacrum, anterior superior iliac spine bumps, trochanter, heel, shoulder area, and occipital. Lesions have also been reported in the lips, nose, and ears [10]. Despite improvements in ameliorating pressure ulcers, patient numbers with these lesions are increasing [2]. In addition to the high financial costs of addressing the condition, healthcare institutions must endure other consequences, including loss of clinical credibility, staff training, increased nurse workloads of up to 50%, increased hospitalization days, pain, infection, stress, recovery delays, and impaired mental image in patients [10]. Therefore, preventing and treating this complication is essential [9].

There are many suggested treatments for pressure ulcers; however, most are ineffective. Machado et al. reported that lasers were ineffective for the condition [11]. Similarly, another study reported no pharmacological effects on pressure ulcers [12]. In terms of treatment costs, complementary and alternative medicines (CAM) may be reasonable and effective and become increasingly popular treatments [8, 9]. A study reported that approximately half of Europe's

population were interested in CAM methods [8]. In Iran, CAM is deep-rooted in ancient beliefs and traditions, contributing to the success of different treatments. CAM prevalence across different countries is 33% in the UK, 46% in Australia, 34% in the USA, 75% in Belgium, 49% in France, and 18%–30% in Germany [13–15].

There are two types of CAM treatments for pressure ulcers: (1) treatments applied locally to wounds, and/or (2) treatments such as massage, acupuncture, and larval therapies. Local treatments comprise dressings or layers of materials placed directly or indirectly on wounds for specified periods [16, 17]. Local CAM treatments include herbal compounds and their products (e.g., henna, *Aloe vera*, olive oil, or combinations of two or more different ingredients, e.g., *Aloe vera* and honey used as gels, creams, and ointments [8–20].

Wound management is an art and as old as humanity, with CAM used for thousands of years to prevent and treat pressure ulcers in Egypt, China, Greece, India, and Iran. One of the oldest medical manuscripts is *the Sumerian clay tablet of Mesopotamia*, which dates back to 2200 B.C.E. This tablet describes healing process strategies, i.e., washing, dressing, and bandaging wounds. In Mesopotamian cultures, including Sumerians and Akkadians, wounds were washed with beer or wine. They also used sesame infusions which were first purified and pulverized before being applied with beer. Therefore, and quite possibly, the oldest known CAM could be beer [21]. In the ancient Greek epic poem from 800 B.C.E., *Song of Ilium* or *Song of Ilium*, believed the oldest extant work in Western literature, Homer documented the management of various battle wounds at Troy where bitter healing herbs were used [21–23]. In Mesopotamia, according to Majno, wounds were washed with water or milk and dressed with honey or resin. Similarly, conifer, myrrh, and frankincense were also used for wound bandaging [23].

In this research, we systematically reviewed studies using CAM methodologies to prevent and treat pressure ulcers.

### Methods

#### Inclusion and exclusion criteria

**Inclusion criteria.** The review included all CAM clinical trials using control groups with a placebo arm or comparing other treatments.

**Exclusion criteria.** The Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2015 checklist was used in this study. Studies using animal models, articles with more than one intervention, articles using native Chinese plants, articles not in English, repeated articles, articles with obscure statistical results, incomplete articles, and studies with small sample numbers were excluded.

#### Document retrieval

Study sources were chosen according to published articles in Iranian and foreign journals. Studies were chosen from the following databases: Scientific Information Database, Irandoc, Google Scholar, PubMed, Medline, Scopus, Cochrane Library, Embase, and Science Direct. Bibliographies from identified papers were scanned to identify more sources. Keywords were “complementary and alternative medicine-CAM”, “integrative medicine”, “traditional medicine”, “pressure ulcer”, “bedsore”, “pressure sore”, “healing”, and “prevention”. No time limitations were set for electronic searches.

#### Search strategy

Search terms were used individually or in combination with the title, abstract and keywords, such as “complementary and alternative medicine” OR “integrative medicine” OR “traditional medicine” AND “pressure ulcer” OR “pressure sore” OR “bedsore” AND “randomized controlled trial” OR “clinical trial”. The specific search strategy for PubMed is shown (Table 1).

#### Data extraction

Extracted information was classified and aggregated. Information on CAM and pressure ulcers was collated, and the number of selected studies counted. These were divided into several groups: studies using medicinal plants, fruits, herbal oils, a product or combined products

derived from several traditional medicine methods, particular animal compounds, and other traditional medicine methods. Articles for each category were reported separately.

## Results

Of the 75 selected studies, 15 were performed in animals, six were inaccessible or written in non-English, eight used native Chinese herbs, and eight had limited sample numbers with poor statistical quality. These studies were excluded, and the remaining 34 studies assessed (Figure 1).

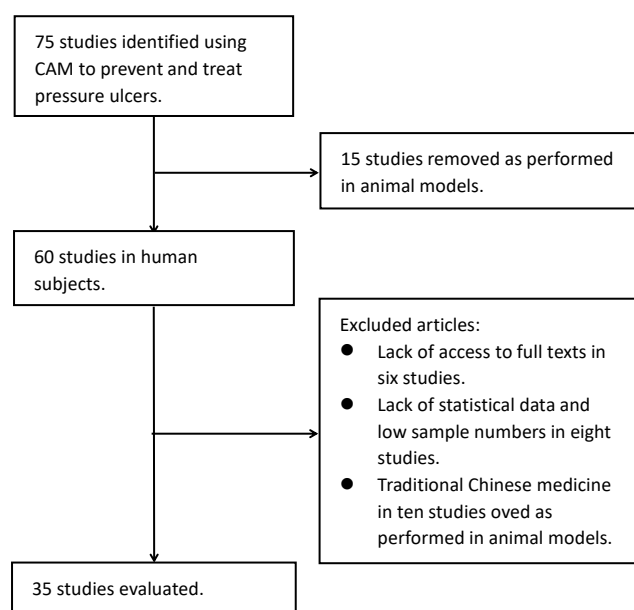
Articles were divided into several groups: medicinal plants, fruits, herbal oils, products or combinations derived from several traditional medicine methods, particular animal compounds, and other traditional medicine methods.

Among the selected 35 studies, seven articles focused on honey and

its comparisons, eight focused on medicinal plants, two studied fruit, eight used herbal oils, three used products or combinations derived from several traditional medicine methods, two focused on sheepskin and five used other traditional medicine methods (Supplementary Table 1–3).

## Honey

Seven studies investigating pressure ulcer treatments used honey as a therapy (Table 2) [24–30]. Honey is an ancient treatment for pressure ulcers and has been used as an ointment to heal wounds and skin inflammation. Moreover, honey acts as a bridge between different active immune cells in response to infection. Honey also activates protein-digesting enzymes, which have important roles during healing processes. Due to its acidic properties, high sugar, and nutrient content, honey promotes new tissue growth by increasing free oxygen compounds at wound sites [31].



**Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist for study selection.** CAM, complementary and alternative medicines.

**Table 1 Retrieval strategy for PubMed**

Number	Search terms
#1	Complementary and alternative medicine [Mesh]
#2	Integrative medicine [Mesh]
#3	Alternative medicine [Mesh]
#4	Alternative therapies [Mesh]
#5	Traditional medicine [Mesh]
#6	#1 OR #2 OR #3 OR #4 OR #5
#7	Pressure ulcer [Mesh]
#8	Bedsore [Mesh]
#9	Pressure sore [Mesh]
#10	#7 OR #8 OR #9
#11	Clinical trial [Mesh]
#12	Trial [Mesh]
#13	Randomized controlled trial [Mesh]
#14	#11 OR #12 OR #13
#15	#6 AND #10 AND #14

Table 2 Analysis of studies using honey for PU

Authors	Year	Sample size	Methods	Results
Ülkü Yapucu Günes et al. [24]	2007	36 patients with pressure ulcers grade II and III.	15 patients with 25 pressure ulcer were treated with honey (intervention group) and 11 patients with 25 pressure ulcer were treated with autotaxamine dihydroacridine with nitrofurazone (control group) for 5 weeks, then the wound was examined based on PUSH tools.	Patients treated with honey had better scores than the control group ( $P < 0.001$ ).
Gethin et al. [27]	2008	37 patients with PU.	Intervention group: honey dressing and calcium alginate fibers. Control group: routine dressing.	There was a reduction in the size and PH of the PU.
Biglari et al. [28]	2012	20 spinal cord injury patients with chronic pressure ulcers.	Intervention group: 3 mm honey dressing on a sterile layer. Control group: routine dressing.	After 4 weeks, 90% of patients had a complete wound healing. Dressing with honey is very effective in reducing the bacterial load, size and healing process of wounds.
Mehrabani et al. [25]	2013	15 patients with 20 PU grade II and III in the intervention group, and 14 patients with 20 PU Grade II and III 3 in the control group.	15 patients with 20 PU grade II and III in the intervention group, and 14 patients with 20 PU Grade II and III 3 in the control group.	Statistically, there was no significant difference between the two groups in the rate of healing in PU ( $P < 0.15$ ).
Choudhary et al. [29]	2015	30 patients with PU.	Intervention group: honey dressing with 15 to 30 mL of honey - once a day.	The wounds of 12 patients from the honey group and 5 patients from the betadine group healed ( $P < 0.001$ ).
Maharaul et al. [30]	2015	60 patients with PU.	Group A: washed the wound with normal saline + dressing with 5 human actrapid insulin units for 10 cm square wounds. Group B: washed the wound with normal saline + dressing with honey. Intervention period: once a week for up to 12 weeks.	Wound healing time: $40.0 \pm 18.8$ days in group A and $30.5 \pm 13.0$ days in group B, which was statistically significant.
Gilligan et al. [26]	2016	787 patients with PU.	Clostridial collagen ointment was used in 446 patients and honey in 341 patients.	The granulation and epithelialization of patients receiving clostridial collagen ointment was greater than that of honey.

PU, pressure ulcer; PH, potential of hydrogen; PUSH, pressure ulcer scale healing; CCO, clostridial collagen ointment.

In the seven selected studies, honey's antibacterial effects were greater than insulin, betadine, nitrofurantoin, and silver sulfadiazine dressings. It reduced healing and hospitalization times and resolved infections at wound sites [24–29, 31]. Honey was also used to treat grade 2 and 3 wounds. However, no differences were observed between honey and a hydrocolloid dressing [25].

#### Medical plants

Medicinal plants have also been exploited as CAM treatment methods used for biological treatments. For centuries, herbal medicines were the only available cures for pain and other complications [32]. CAM plants used to prevent and treat pressure ulcers including *Aloe vera*, henna, *Angelica dahurica*, resin salve from spruce trees, and *Plantago major* L. (Table 3).

***Aloe vera*.** *Aloe vera* belongs to the liliaceous family and is similar in appearance to cacti. It is a perennial herbaceous plant with thick,

fleshy, long leaves [33]. There are 75 compounds identified in *Aloe vera* plants, including 20 minerals, 20 amino acids, vitamins, and water [33–35]. In laboratory studies and studies in living organisms, *Aloe vera* inhibited thromboxane (wound healing inhibitor), promoted healing, and decreased inflammation [36]. In addition, magnesium lactate in the gel from *Aloe vera* inhibited histamine reactions and prevented itching and skin irritation. Moreover, it also improved immune system activity and cytokine synthesis. *Aloe vera* also inhibited inflammatory reactions by inhibiting interleukin-6 and interleukin-8, reducing leukocyte adhesion and tumor necrosis factor- $\alpha$  levels, and increasing interleukin-10 levels [17].

The plants healing properties are primarily related to glucomannan which is rich in polysaccharides, such as mannose. This affects fibroblasts and promotes collagen production. *Aloe vera* gel increases collagen in the wound and changes its composition by increasing cross-linking between collagen fibers, thereby accelerating wound

healing [37]. *Aloe vera* also prevents wound formation due to mucopolysaccharides, amino acids, and zinc, which cause skin cohesion, maintain moisture, reduce erythema, and prevents skin lesion formation [17, 38]. Moreover, *Aloe vera* was also more effective than saline gas dressing, phenytoin, and common treatments [20, 37–43]. However, only one study identified no differences between the two groups, which may have been due to limited sample numbers [38]. Thus, *Aloe vera* reduced pain, bleeding, and healing times [42, 43].

**Henna.** Henna plants (*Lawsonia inermis*) belong to the Lythraceae family and are native to the Mediterranean, Middle Eastern, Indian, and southern Iran regions. The most commonly used parts of the plant are the adult leaves. The plant contains effective ingredients such as colored materials, tannins, resins, volatile oils, and fats. When its leaves are powdered and made into a dough, it is used in cosmetics and remedies for traditional medicine. In some Middle East countries, henna is used to treat burns, wounds, and some fungal infections. It also targets infections caused by Gram-positive bacteria, treats acne and abscesses, and has strong antifungal, antiviral, antiparasite, and anti-inflammation effects [43–46].

In 2008, Khatem et al. investigated the antimicrobial effects of henna and showed its antibacterial effects were similar to common antibiotics [47]. In 2007, Saedabi et al. reported that henna was a source of antimicrobial materials which exhibited high activities against a wide range of microorganisms, including *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and fungi. The plant killed bacterial and fungal pathogens without side effects or bacterial resistance [46, 48].

These studies suggested that when henna was used as a pressure ulcer treatment, it reduced redness, inflammation, and local heat from affected areas ( $P < 0.0001$ ). When preparing henna for wounds, 50 g henna powder should be mixed with 500 mL water, placed on the area for 30 minutes, and then washed. This should be performed for seven days. Moreover, henna also effectively treats first-degree pressure ulcers in the sacrum area [8–16].

**Angelica dahurica.** This plant is native to Siberia, Russia, the Far East, Mongolia, northeast China, Japan, Korea, and Taiwan. The roots are used extensively due to their medicinal properties, and it is known as a furocoumarin and angelicotoxin medication. *A. dahurica* exhibited improved healing effects in treating degree 1 and 2 pressure ulcers after four weeks when compared with clotrimazole. The plant induced wound healing by increasing interleukin-8, epidermal growth factor, transforming growth factor-beta, and vascular endothelial growth factor levels; this increased cells in the G0/G1 phase and cyclin D and cyclin-dependent kinases levels. *A. dahurica* also provided an effective clinical treatment for phase I and II pressure ulcers. The plant also increased angiogenesis, improved wound status, and exerted positive effects on diabetic wounds. A 2–4 mg dose is recommended [49, 50].

**Resin salve.** Resin salve from the Norwegian spruce tree was also used to treat pressure ulcers. The authors reported that the salve reduced the size of degree 4 ulcers after two weeks of treatment. Moreover, after a 6-month treatment regime, ulcers had completely healed [51]. To treat degrees 2, 3, and 4 ulcers, a resin layer of approximately 1 mm diameter under sterile cotton is sufficient. The resin resulted in 73% complete healing, which was significant when compared with the control group ( $P = 0.013$ ). Similarly, ulcer cultures were negative for bacterial infection [52].

**Plantago major L.** *Plantago major* L. is used to treat skin diseases, respiratory diseases, digestive disorders, reproduction issues, blood circulation problems, cancer, pain relief, and infections. The plant contains biologically active compounds such as polysaccharides, lipids, caffeic acid derivatives, flavonoids, iridoid glycosides, and terpenoids. Also, alkaloids and some organic acids have also been characterized. Plant extracts have been used for wound healing, with anti-inflammatory, analgesic, antioxidant, weak antibiotic, immune-modulating, and anti-inflammatory roles reported. Because of these effects, the plant has been successfully used as a suitable medicine for folk remedies [53, 54].

## Fruit

Two studies suggested that kiwi and mango were effective for treating pressure ulcers (Table 4). Kiwi healed grade 2 and 3 ulcers in three weeks by increasing granulation and angiogenesis ( $P < 0.02$ ) [55]. Mango was more effective in debriding grade 3 and 4 ulcers with less bleeding, and it had higher success rates when cleaning necrotic tissue [56].

## Herbal oils

Massaging the skin with herbal oils is an important tradition in some countries [55]. Herbal oils used for pressure ulcers include olive, sunflower seed, tea tree, sesame, coconut, almond, and henna [57–64] (Table 5). The most frequently used oil is olive oil, which in most studies, effectively prevented pressure ulcers. Preventing and treating pressure ulcers is clinically beneficial, and because olive oil is easy to access, this approach may be effective in targeting pain and reducing treatment costs [64]. One study used sweet almond oil for pressure ulcers. The oil contains 54% oil and 26% carbohydrates. It is rich in vitamin E (26 mg vitamin per 100 g of oil), group B vitamins, different amino acid types, and minerals, which can be used as skin massage oil [62]. Sunflower seed oil effectively treated grade 1 and 2 pressure ulcers over a 21-day period [58]. In another study, tea tree oil also efficiently reduced ulcer sizes [63]. Coconut and henna were also beneficial in reducing the risk of pressure ulcers.

## Medicinal plant combinations

The most frequent combinations were *Aloe vera* and olive oil, poppy and plant cellulose, honey and *Aloe vera*, and sesame, honey, and camphor.

Poppy and plant cellulose combinations exerted antimicrobial effects toward ulcers, with *P. aeruginosa*, *E. coli*, and *S. aureus* sensitive to preparations [65]. Similarly, *Aloe vera* and olive oil exerted positive effects by decreasing ulcer size and depth and reducing exudate and tissue edema around the ulcer when compared with phenytoin [20]. Ointments containing honey, sesame oil and camphor accelerated the treatment of pressure ulcers in the sacrum, ischium, and heel protrusion in patients with diabetes ( $P < 0.001$ ) [18].

## Sheepskin

Two Australian articles investigated sheepskin to ameliorate pressure ulcers [66, 67]. Preparations were particularly useful in the sacrum area as they reduced the incidence of pressure ulcers by up to 8.9% [66, 67]. Preparations were also used to treat grade 1 and 2 ulcers. The method acted as a pressure-reducing agent to reduce pressure by up to 27 mmHg and absorbed moisture. These characteristics of sheepskin will not disappear until 50–65 washes in a washing machine [66].

## Other methods

Maggot therapy, acupuncture, charcoal, and mummy solution were some of the other CAM methods used for pressure ulcers. Maggot therapy was primarily used to treat diabetic wounds, but some studies have suggested its utility for healing pressure ulcers, debriding, and wound granulation [68, 69]. In the past, charcoal was used to heal chronic wounds. Other studies associated it with decreased exudate from pressure ulcers and effective treatment [70, 71]. The mummy solution reduced ulcer size, discharge rate, and redness in grade 2 and 3 ulcers [72]. Some studies listed acupuncture, but these were excluded because they did not meet our inclusion criteria. A fire needle was used in a randomized controlled trial with positive effects [73, 74].

## Limitations

Our review had some limitations. The most relevant was reduced access to some articles and unpublished reports. Another limitation involved the lack of precise, high-quality, and useful information in some articles, making it difficult to completely and accurately analyze and compare data.

Table 3 Analysis of studies using medicinal plants for PU

Authors	Year	Intervention	Sample size	Methods	Results
Sipponen et al. [51]	2008	Resin salve	37 patients.	Intervention group: applied a layer of resin with a diameter of approximately 1 mm — If there was an exudate, it was used daily, otherwise once every three days. Control group: routine care.	All 12 patients in the intervention group and 4 patients in the control group recovered ( $P = 0.003$ ; power 73%). Complete wound healing in the resin group was significantly higher than the control group ( $P = 0.013$ ).
Beygi brojeni et al. [43]	2009	<i>Aloe vera</i>	30 patients.	Intervention group: applied 2 to 3 times a day 2% <i>Aloe vera</i> gel in local form on the wound — for a month.	Among 30 cases, 27 cases, 90% had a complete response to treatment and 10% did not respond. Significant difference was observed in the time required to reduce redness, edema and complete wound healing ( $P = 0.016$ ).
Ahmadian et al. [8]	2016	Henna ( <i>Lawsonia Inermis</i> )	80 patients admitted to the ICU.	Intervention group: in order to prevent wounds, a combination of 50 g of henna leaf powder and 500 mL of distilled water was applied as a 10 cm thick henna layer in the sacrum area. It remained on the skin for 30 minutes, then washed off with warm water and the skin was dried. Control group: routine care.	The use of henna was effective in reducing redness, inflammation and local heat. The results showed that during the seven days of the study, there was a relationship between lowering the Braden scale score and increasing the local heat of sacrum ( $r = -0.409$ , $r = 0.558$ , respectively).
Zanaty et al. [42]	2017	<i>Aloe vera</i>	60 patients with PU grade II.	Intervention group: use of <i>Aloe vera</i> cream twice a day. Control group: use silver sulfadiazine twice daily.	Statistically, there was a significant difference between the control and intervention groups in terms of PU such as size, depth, skin color around the wound, the presence of granular and epithelial tissues ( $P < 0.001$ ).
Gong et al. [50]	2017	<i>Angelica dahurica</i>	98 patients with I and II degree PU.	Intervention group: use of <i>Angelica dahurica</i> for 4 weeks. Control group: use clotrimazole cream.	Patients in the intervention group had higher growth factor and cytokine and higher cell growth ( $P < 0.01$ ).
Hekmatpou et al. [9]	2018	<i>Aloe vera</i>	80 patients in orthopedic susceptible to pressure ulcers.	Intervention group: twice a day dressing with pure <i>Aloe vera</i> gel. Control group: routine care.	Statistical analysis showed that PU were less common in the intervention group than in the control group ( $P = 0.047$ ).
Rafiei et al. [16]	2019	Henna ( <i>Lawsonia Inermis</i> )	76 patients admitted to ICU.	Intervention group: in addition to routine care, a mixture of henna and distilled water was applied topically. Control group: routine care.	In the intervention group, the wound size decreased more than the control group.
Ghiasian et al. [54]	2020	<i>Plantago major</i> L.	130 patients with I degree PU.	Intervention group: use of topical formulation of <i>Plantago major</i> L. for 14 day. Control group: routine care.	The results confirmed the traditional use of <i>P. major</i> in resolution of the damage.

PU, pressure ulcer; ICU, intensive care unit.



Table 4 Analysis of studies using fruits for PU

Authors	Year	Intervention	Sample size	Methods	Results
Mohajeri et al. [55]	2013	Kiwifruit	40 patients with paraplegia, quadriplegia, or hemiplegia with grade II and III PU.	Intervention group: in addition to washing the wounds daily with normal saline, the kiwi was mixed with a mixer and then applied to the wounds to a thickness of 3 mm. Control group: use of Vaseline gas without any substances.	In the intervention group, the decrease in mean wound area ( $P < 0.001$ and increase in collagen ( $P = 0.005$ ), granulation tissue ( $P = 0.02$ ) and angiogenesis ( $P < 0.02$ ) were significantly higher than the control group.
Takumi Yamamoto et al. [56]	2017	Mango	17 patients with grade III and IV PU and necrotic tissue.	Intervention group: 9 patients under debridement using the Mango Cut Incision method was used, followed by silver sulfonyazine cream. Control group: 8 patients underwent conventional debridement followed by silver sulfonazine cream.	In the intervention group, the bleeding rate was lower and the percentage of necrotic tissue clearance was higher ( $P < 0.043$ ).

PU, pressure ulcer.

Table 5 Analysis of studies using herbal oils for PU

Authors	Year	Intervention	Sample size	Methods	Results
Edmondson et al. [61]	2011	Oil solution of tea tree ( <i>Melaleuca alternifolia</i> ) oil solution	12 participants with wounds suspected of being colonised.	Intervention: water-miscible tea tree oil (3.3%) solution was used in 11 patients. The dressing was changed 3 times a week or daily.	After treatment had been implemented, 8 of the 11 treated wounds had begun to heal and reduced in size as measured by computer planimetry.
Dhikhil et al. [63]	2014	Coconut oil	60 patients bed ridden.	In the pretest group: changing position every two hours. In the posttest group: In addition to changing position, olive oil was used in pressure areas to prevent PU.	The risk of PU in the intervention group compared to control was decreased. Mean difference = 0.2.
Abbas Ali Madadi et al. [57]	2015	Olive oil	60 patients admitted to the ICU.	Intervention group: 15 mL olive oil applied topically once a day without massage on different parts of the body including earlobes, shoulders, spine, lower back, buttocks, iliac, sacrum, elbows, heels, ankles. Control group: routine care.	Statistically, there was a significant difference between the two groups in prevalence of PU ( $P = 0.03$ ) and olive oil had preventative effects.
Lupiañez-Perez et al. [58]	2015	Olive oil	831 immobile patients exposed to PU.	Intervention group: olive oil. Control group: use of hyperoxygenated fatty acids. The sites used were heel, trochanter and sacrum.	The use of olive oil formulas can be effective as a low-cost treatment in the treatment of PU in immobile patients.
Behnammoghadam et al. [59]	2015	Olive oil	70 patients admitted to the ICU.	Intervention group: in addition to regular care, applied 15 mL of olive oil daily on the affected areas of the body slowly and without massage. Control group: routine care.	In the intervention group, the incidence of PU was lower than in the control group ( $P < 0.03$ ). The use of topical olive oil is effective in preventing pressure ulcers in patients.

Table 5 Analysis of studies using herbal oils for PU (Continued)

Authors	Year	Intervention	Sample size	Methods	Results
Serio et al. [60]	2017	Sun flower seed oil	22 patients.	Intervention group: use of ozonized sunflower seed oil gel in a thin layer of about 1 to 2 mm. Control group: use of common skin gels.	In the intervention group, the results showed a faster recovery compared to the control group in the second week ( $P < 0.05$ ).
Varaei et al. [62]	2019	Olive oil and sweet almonds oil	90 patients admitted to ICU.	Intervention group: in addition to regular care, patients received a massage in the areas exposed to risk of PU for a week once a day with 1–3 mL of olive oil or sweet almonds. Control group: routine care.	The incidence of PU in the experimental groups was lower than the control group and in the olive oil massage group was lower than the sweet almond oil massage group ( $P < 0.05$ ).
Poursadra et al. [63]	2019	Henna oil and olive oil	108 ICU patients.	Intervention group 1: use of Henna oil. Intervention group 2: use of olive oil. Control group: routine care.	The results showed a significant difference between the two henna and olive groups in the mean score of pressure ulcer measured through the pressure ulcer scale for healing tool ( $P < 0.05$ ). The mean area of the ulcer on days 4 and 7 in the henna oil group was lower than that in the olive oil and control groups ( $P < 0.001$ ).

PU, pressure ulcer; ICU, intensive care unit.

## Conclusion

Different CAM methods preventing and treating pressure ulcers have been widely investigated in the literature. This systematic review demonstrated that various methods were used to prevent and treat pressure ulcers. Of all the CAM approaches, honey, *Aloe vera*, and olive oil were the predominant methods. Importantly, sheepskin as a pressure-reducing agent and moisture-absorbent exhibited major effects on ameliorating pressure ulcers. We also investigated the effects of these methods on different ulcer characteristics, including ulcer depth and size, edema, exudate levels, necrotic tissue [37], inflammation, pain, bleeding, and infection. Critically, in 90% of cases, CAM demonstrated positive effects and reduced complications. Hospitalization times, treatment costs, and redness and itching at wound sites were some of the secondary aims evaluated in several studies, suggesting herbal compounds and CAM methods are often more effective when compared with other treatments.

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