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Exploring the Role of Honey Dressing in Post-Cesarean Surgical Site Wound Care

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Abstract: Delivery via cesarean section (C-section) heightens the likelihood of surgical site infection (SSI). Expensive medications and dressings are employed to manage the healing of C-section wounds, which may lead to a delayed healing process and an extended hospital stay. Consequently, complementary therapies and alternative medicines have recently become more popular. In this context, various studies indicate that the topical application of honey dressing is beneficial for the rapid recovery of C-section wounds in mothers. This paper aims to explore the potential roles of honey in the healing of C-section wounds. Studies were selected by searching for keywords such as honey, cesarean section, C-section, surgical site infection (SSI), wound healing, and tissue remodelling. Research articles, case studies, clinical trials, and reviews were obtained from databases including PubMed, Web of Science, Google Scholar, Embase, Medline, and Scopus. Only full articles published in English up to June 2025 were included in this study. Data gathered from various sources indicates that honey is an easily accessible, cost-effective natural product, abundant in a wide range of nutritional components. Honey possesses numerous medicinal properties. It reduces inflammation, oxidative stress, microbial infections, and scar formation. Nutritionally rich honey promotes wound healing by enhancing cell proliferation and migration, angiogenesis through the elevation of growth factors, as well as tissue remodelling via collagen degradation. Moreover, the viscosity and hygroscopic characteristics of honey safeguard wounds against infection and dehydration. The use of honey dressing leads to a faster recovery from post-cesarean wound and SSI when compared to the conventional treatment strategies.

Keywords: *Cesarean Section; C-section; Honey; Surgical Site Infection (SSI), Wound Healing.*

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I. INTRODUCTION

Caesarean section (C-section) is recognized as one of the most significant surgical procedures globally. The World Health Organization reports a notable increase in childbirth via cesarean surgery, rising from 7% in 1990 to 21% in 2021, with projections indicating that Eastern Asia will have the highest rate at 63%, followed by Latin America at 54%. When it comes to childbirth, cesarean surgery carries a heightened risk of complications such as infection, sepsis, pain, bleeding, and extended hospitalization compared to vaginal delivery [1]. Recent epidemiological studies, systematic reviews, and meta-analyses indicate that the incidence of surgical site infection (SSI) following C-sections is 34.1% in Tanzania, 15% in Uganda, and 3% in Saudi Arabia [2, 3]. *Staphylococcus aureus* is the most common pathogen in post-cesarean SSI, with 9.8% of these infections exhibiting methicillin resistance. Additionally, *Klebsiella pneumoniae*,

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Escherichia coli, and *Enterococcus faecalis* have also been implicated in the pathogenesis of post-cesarean SSI [4]. Complete recovery of wound closure and the fading of scars after a C-section may take as long as 12 months [5]. Nevertheless, the use of antibiotics and the implementation of advanced surgical techniques are currently essential for managing post-cesarean wound healing, which can be prohibitively expensive for many families [6, 7]. Complementary medicine and alternative therapies have garnered significant interest due to their cost-effectiveness, minimal side effects, and potential for optimal recovery in post-cesarean wound healing. Various complementary treatments are employed to alleviate pain and promote healing in post-cesarean sections, including medicinal herbs, massage, reflexology, and acupressure [8]. In this context, honey has been identified as beneficial for the recovery of post-cesarean wounds [4]. It has been documented that honey possesses numerous medicinal properties, including anti-inflammatory, analgesic, debridement, and deodorizing effects [9]. The aim of this article is to examine and evaluate various therapeutic properties and the effectiveness of honey in the healing process of post-cesarean wounds.

II. TYPES AND PROPERTIES OF HONEY

Honey can be categorized into two types based on its source of formation: monofloral and multifloral. Monofloral honey is derived from the nectar of a single type of plant, whereas multifloral honey is produced from the nectar of various origins that are blended together by honey bees. Additionally, honey may be designated by its geographical origin if it is exclusively produced in a specific region [10].

➢ *Chemical Composition of Honey:*

Honey comprises over 200 substances, including vitamins, minerals, enzymes, amino acids, sugars, and water. Between 85% and 95% of the carbohydrates present in honey are fructose and glucose (Table 1). In addition, honey contains calcium, magnesium, potassium, phosphorus, sodium, zinc, and iron. It also includes vitamins such as B2, B3, B5, B6, B9, and vitamin C [11].

➢ *Physical Properties of Honey:*

Honey possesses several significant physical characteristics in addition to its chemical composition and flavour, including physical parameters, colour, pH, ash content, enzyme activity, and electrical conductivity (Table 1). The flavour of honey is characterized by its sweetness. The hue of honey ranges from light yellow to deep red, depending on its botanical source. Viscosity is a crucial attribute of honey, influenced by the variety of substances and the water content it contains. At a temperature of 24^0C, the viscosity of honey measures 9.9 psa with a moisture content of 18.9%. The pH level of honey generally falls between 2.4 and 4.7, which can vary based on the geographical area of its production. The moisture content in honey ranges from 13% to 20%. Due to its high sucrose concentration, honey exhibits resistance to spoilage, which can serve as a preservative [12].

III. TOXICITY ASSESSMENT OF HONEY

Recently, honey has come under scrutiny due to the detection of pesticide residues and various beekeeping practices along with honey bee management. Pesticide residues of boscalid and pyraclostrobin have already been identified using the LCMS/MS technique in honey produced through conventional methods. Studies indicate that pesticide stress is present in honey derived from apple blossom, raspberry, and sunflower. In contrast, organic honey farming does not show any signs of pesticide stress [13]. Similar to pesticides, antibiotics are also utilized in honeybee keeping and farming. Research has revealed the presence of 35 antibiotic residues in commercial blossom honey samples [14]. Antibiotics such as tetracycline, quinolone, aminoglycoside, chloramphenicol, cephalosporin, sulfonamide, macrolide, anthelmintic, and nitrofuran groups have been reported in honey. Additionally, honey may contain plant toxins including pyrrolizidine alkaloids, triptolides, tutin, and grayanotoxins [15]. During the heating and preservation processes, honey may develop 5-hydroxymethylfurfural (HMF), a mutagenic and cytotoxic component typically absent in natural and unprocessed honey [16]. In this context, organic farming for honey production may be beneficial, as beekeeping standards are devoid of antibiotics and pesticides [17]. Furthermore, honey may harbor bacterial spores contaminated with *Clostridium botulinum* or *Bacillus subtilis*, which can be sterilized through gamma irradiation [18]. Therefore, the application of medical grade honey (MGH) may prove advantageous for therapeutic purposes [19].

➢ *Wound Healing Properties of Honey:*

The process of wound healing is highly intricate, involving a variety of interrelated factors that regulate immunological and pathophysiological mechanisms to restore tissue integrity and cellular functions. Honey has proven effective in the treatment of numerous wound types, including septic and surgical wounds, diabetic ulcers, malignancies, boils, trauma, amputation sites, burns, leg ulcers, cervical varicose ulcers, gastric ulcers, ruptured abdominal wounds, fistulas, leprosy, wounds on the abdominal wall, cracked nipples, and scratches [20]. Recently, MGH has been utilized to enhance wound recovery due to its absence of toxic contaminants and microorganisms. MGH plays a crucial role in promoting angiogenesis, re-epithelialization, and the formation of granulation tissue by reducing oxidative stress and supplying essential nutrients [21].

➢ *Honey in Cesarean Wound Healing:*

The prompt recovery of the cesarean site wound is essential for the mother. The management of post-cesarean wound healing poses challenges for clinicians, particularly in cases of impaired host immune response, diabetic wounds, and surgical site infections (SSI). It has been reported that the application of honey leads to faster healing of the wound site, primarily due to enhanced angiogenesis, fibroblast activity, epithelialization, granulation, and closure [22]. An in vivo study indicates that recovery from post-cesarean wounds using honey occurs more rapidly than typical wound healing

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[4]. A list of studies highlighting the use of honey in the recovery of post-cesarean wound healing is presented in Table 2. Furthermore, in vivo research demonstrates that honey-based healing is even more effective than wound healing with turmeric extract [4]. A study involving 70 women reveals that the healing of post-cesarean wound infections is expedited (mean: 18 days) when honey is applied in conjunction with povidone-iodine, compared to povidone-iodine alone (mean: 21.43 days) [23]. Another study conducted on 25 women indicates that an I-dress made from a combination of honey and olive oil is effective in treating cesarean wounds, likely due to the various biological properties of honey, including its antimicrobial, antioxidant, and anti-inflammatory activities. Additionally, the hydrogen peroxide (H_2O_2) present in honey plays a vital role in wound recovery by facilitating cellular repair and tissue regeneration [24]. The topical application of a honey and ghee combination has been found to be advantageous for recovery from post-cesarean wound infections [25]. Moreover, the healing of infected cesarean wounds using crude honey is significantly faster (10.73 ± 2.5 days) than with antiseptic treatment (22.04 ± 7.33 days) [26]. This suggests that honey, due to its viscous and hygroscopic properties, nutritional enrichment, and various biological characteristics, accelerates post-cesarean wound healing in comparison to conventional treatments [27]. MGH is considered superior for cesarean wound care as it is processed to eliminate impurities and toxins. A study involving 383 patients indicates that the average healing time for MGH-treated cesarean wounds is shorter (19.12 ± 7.760 days) compared to conventional treatments that utilize antibiotics and povidone-iodine (24.54 ± 8.168 days) [28]. Furthermore, the application of Tetragonula sapiens honey dressing facilitates rapid wound recovery within 1-6 days, normal recovery within 7-14 days, and prolonged healing beyond 14 days [29].

IV. REGULATION OF BIOLOGICAL PROCESSES DURING WOUND HEALING BY HONEY

Honey derived from various sources has been demonstrated to be effective in promoting wound healing in both humans and experimental animal models, including rats and rabbits. Various therapeutic applications of honey have been documented, including topical, oral, intra-incisional, and submucosal methods. Research indicates that honey is beneficial in preventing intra-abdominal adhesions following laparoscopic surgery and aids in recovery after serosal trauma [15]. The topical application of honey for wound recovery leads to the modulation of various cellular, molecular, and biochemical processes. Key biological mechanisms underlying honey's wound healing properties involve the reduction of inflammation and oxidative stress within the wound environment (Figure 1). Honey reduces inflammation by lowering levels of IL-6, IL-1β, TNFα, iNOS, Cox-2, granulocytes, and macrophages [33]. It is capable of inhibiting pro-inflammatory cytokines by attenuating the NF-κβ and MAPK signaling pathways. Additionally, honey contributes to the reduction of oxidative stress by decreasing the activity of nitric oxide, malondialdehyde, heme oxygenase-1 (HO-1), catalase, and superoxide dismutase, while simultaneously increasing glutathione levels [34]. Furthermore, honey plays a crucial role in enhancing angiogenesis, cytoprotection, cell proliferation and migration, as well as tissue remodelling. Honey promotes the proliferation of endothelial cells, vascular endothelial growth factor, angioprotein-1, and angioprotein-2, thereby enhancing angiogenesis in wound tissue. Furthermore, honey increases levels of peroxiredoxin, NRF2, and HO-1, which serve to prevent cellular damage. Research conducted on fibroblasts and keratinocytes indicates that honey can enhance cell proliferation by elevating protein markers such as Ki67 and p63, as well as promoting cell migration. Ki67 serves as a marker for cell proliferation, while p63 functions as a transcription factor that maintains the integrity of epithelial cells. Keratinocytes treated with honey stimulate the production of matrix metalloproteinases, including MMP-9, and lead to the degradation of collagen-IV, which is crucial for tissue remodelling and results in reduced scar formation [35]. In addition to collagen-IV, honey also facilitates various stages of the wound healing process, including wound closure, re-epithelialization, and the deposition of collagens (collagen I and collagen II). Another significant characteristic of honey is its broad-spectrum antimicrobial activity against wound-related pathogens, such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* [36]. Another repost shows that Manuka honey and MGH are potential to inhibit multi drug resistance bacteria [37].

V. CONCLUSION

Complications related to post-cesarean wounds include infection and delayed recovery, which often pose significant challenges for clinicians. Additionally, the availability of expensive medications and wound dressings is limited in rural healthcare settings, making it difficult to provide adequate care for mothers. In this context, honey has been widely utilized for the healing of various wounds. Recently, it has also been employed in the recovery process of post-cesarean wounds and associated infections. A thorough review of the literature and data analysis indicates that honey is an easily accessible, cost-effective natural product, rich in a diverse array of nutritional components. This nutritional richness, along with growth factors such as VEGF, promotes angiogenesis and aids in the repair of wound tissue. The antimicrobial, anti-inflammatory, and antioxidant properties of honey may play a vital role in the healing of post-cesarean wounds. Furthermore, honey encourages cell proliferation, migration, tissue remodelling, cytoprotection, and minimizes scar formation, potentially accelerating the healing process of post-cesarean wounds. The presence of H_2O_2 in honey is beneficial for eliminating wound microbes. However, it is essential to dilute honey to prevent any toxic effects of H_2O_2 on human skin fibroblasts. Additionally, the viscosity and hygroscopic properties of honey help safeguard the wound environment from pathogens and dehydration. Future research is advised to explore the use of honey in conjunction with or without conventional therapies for managing post-cesarean wound healing. Moreover, it is crucial to investigate the molecular mechanisms and biological targets associated with honey-based post-cesarean wound healing in greater detail.

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➢ *Authors' Contribution:*

SS and JCS were involved in the conceptualization, data curation, study design, data compilation, interpretation, original draft writing, formatting, editing and review. SS, JCS, RC, MSD, AD, and VS were performed original draft editing and review.

➢ *Statements and Declarations:*

No potential conflict of interest was reported by the authors.

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Table 1. Physical and Chemical Properties of Honey.

Physical properties			
Parameter		**Properties/ Range**	
Color		Pale yellow to dark red	
Taste		Sweetened	
pH		2.4 to 4.7	
viscosity		9.9 psa at 24^0C temperature and 18.9% moister	
Moister		13% to 20%	
Chemical compositions			
Fructose	Aluminium	Copper	Fluoride
Glucose	Lead	Iron	Vanadium
Sucrose	Lithium	Selenium	Iodide
Calcium	Molybdenum	Vitamin B2	Zirconium
Magnesium	Cadmium	Vitamin B3	Vitamin B9
Potassium	Silicon	Vitamin B5	Vitamin C
Phosporus	Strontium	Vitamin B6	Vitamin K
Sodium	Cobalt	Amino acids	Proteins
Zinc	Sulphur	oligosaccharides	Water

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Table 2: List of Studies to Use Honey as a Therapeutic Agent to Treat Post-Cesarean Wound Recovery.

Name/Source of Honey/Combination	Wound Type	Application of Honey	Human/ Animal Models	Number (N)	Dose/days of Application	Wound Healing (Days)	References
Trigona honey	Caesarean sections	Topical (gel)	Rats	56	Twice daily (0.13 mg) (morning and evening) or once daily (0.064 mg) in the morning	Granulation tissue formation: Day-9	[4]
Hamdard Shifa Khana and Marhaba (Hamdard Laboratories, India) and povidone-iodine combination	Cesarean wound infection	Topical (gauze piece dressing)	Human	70	Once in a day	Complete wound heling: Day-16 to 20	[23]
Honey and olive oil combination	Caesarean sections	Topical (I-dress)	Human	25	I-dress was removed on day-3	Mean wound healing: Day-2.2 ± 0.7	[24]
Australian honey (nectar of eucalypt and ground flora) and Amul Ghee combination	Post-caesarean wound infection	Topical (dressing)	Human	11	Dressing changed when exudate formation is profuse.	Complete wound healing: 2 to 3 weeks	[25]
Crude honey	Cesarean wound infection	Topical	Human	26	Every 12 hours	Complete wound heling: 10. 73 +/- 2.5	[26]
Honey gel made by mixing honey (25 Gr), glycerin (5 Gr), carbopol (0.55 Gr), triethanolamine (0.5 Gr), methyl paraben (0.18 Gr), propyl paraben (0.02 Gr), and distilled water (69.3 Gr)	Cesarean section	Topical	Human	37	Twice a day for 14 days	Complete wound heling: 10.37 ± 2.5	[27]
L-Mesitran Soft containing 40% MGH (BV, Maastricht, Netherlands)	Caesarean sections	Topical	Human	383	Once a day	Complete wound heling: 19.12 ± 7.760 days	[28]
Tetragonula sapiens honey	Caesarean sections	Topical (honey on sterile gauze)	Human	28	Twice a day at 12 hours intervals for 7 days	Fast healing: 1-6 days Normal healing: 7-14 days Long healing: >14 days	[29]
Honey cream (containing 35% of honey) (Babol University of Medical Sciences, Babol, Iran)	Caesarean sections	Topical	Human	40	Twice a day for 10 days	Complete wound healing and pain relief: Day-10	[30]

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Medical grade honey (MGH)	Caesarean sections	Topical	Human	1	Twice a day	Granulation tissue formation: Day-10 Complete wound heling: Day-15	[31]
Honey (Madu Nusantara)	Caesarean sections	Topical (wound dressing)	Human	1	Not reported	Post-primary re-closure: Day 10	[32]

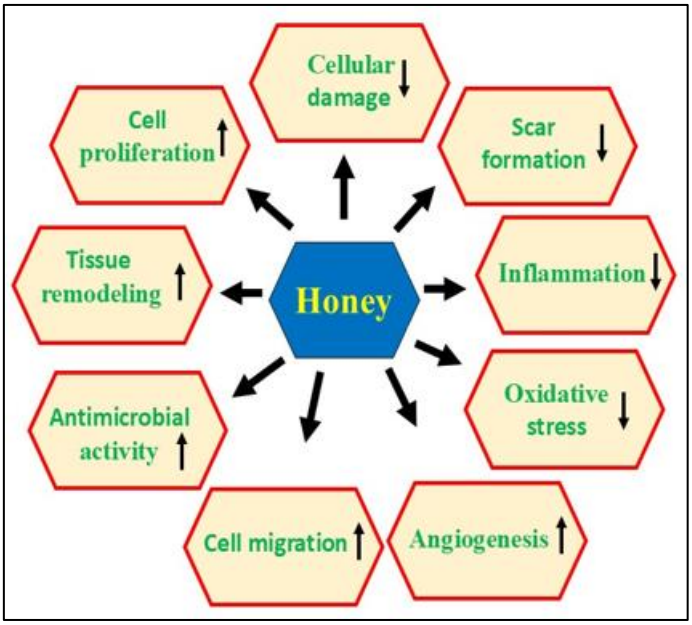

Fig 1: Different Medicinal Properties of Honey, Which are Significantly Contribute to the Recovery of Wound Healing and Prevention of Surgical Site Infection. The Symbols "↓" and "↑" Represent "Low" and "High" Respectively.