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The Impact of Calcium Alginate Dressings on Wound Healing in Patients with Diabetic Ulcers

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ABSTRACT

Introduction: Diabetic foot ulcers often occur due to a combination of neuropathy (sensory, motor, autonomic) and ischemia. This condition is further exacerbated by infection which generally requires proper care for wound healing. Calcium Alginate Dressing is a group of exudate and odor-absorbent dressings that aim to accelerate the healing process of diabetic mellitus wounds, this support material is made from seaweed with hemostatic properties.
Objective: To determine the effect of using calcium alginate dressings in the healing process of diabetic ulcer wounds.
Method: This study used a literature review method by searching for articles in the Google Scholar, PubMed, and Research Gate databases with a publication range of 2015-2025. Of the 18 articles found, 8 articles met the inclusion criteria.
Result: The use of calcium alginate has been shown to have an effect on diabetic wound healing by creating a moist and protected wound environment, which reduces the risk of infection and improves patient comfort.
Conclusion: Calcium alginate creates a moist wound environment, facilitates keratinocyte proliferation and epithelial cell migration, which supports the epithelialization process. The use of calcium alginate as a wound dressing in diabetic wounds provides significant results in accelerating the healing process.

Keywords: calcium alginate, diabetic ulcers, wound dressing

Introduction

According to the World Health Organization (2019), diabetes mellitus is a series of metabolic disorders identified by untreated hyperglycemia. The etiopathology of this disease is heterogeneous and includes various defects in insulin secretion, insulin action, or both, as well as disorders of carbohydrate, fat, and protein metabolism. Diabetes mellitus, or diabetes, is a non-communicable disease that can be suffered throughout life. Diabetes mellitus (DM) is caused by a metabolic disorder that occurs in the pancreas, characterized by increased blood sugar, often referred to as hyperglycemia, caused by decreased insulin levels from the pancreas (Lestari et al., 2021).

Chronic hyperglycemia in diabetes can have serious consequences for organs such as the eyes, kidneys, nerves, heart, and blood vessels. Long-term complications such as diabetic retinopathy, diabetic nephropathy, diabetic neuropathy, heart disease, and peripheral vascular disease are major risks that must be anticipated and properly managed in diabetes management. Therefore, effective control of blood glucose levels and prevention of complications are crucial aspects of the care and management of diabetes patients (Kusumawati et al., 2024).

The World Health Organization (WHO) stated that 90% of Diabetes Mellitus sufferers in the world are included in the type 2 Diabetes Mellitus group, which is around 285 million (6.4%) in 2010 and will continue to rise to 439 million (7.7%) in 2030. Based on data from the International Diabetes Federation (IDF), it was found in 2019 that 463 million people worldwide suffer from diabetes mellitus, 98% of whom suffer from type 2 diabetes. It is estimated that this number will increase twofold by 2030. According to the Ministry of Health, the number of type 2 diabetes sufferers in Indonesia is quite high, namely 8.4 million people in 2010, and is estimated to continue to increase to 21.3 million people in 2030 (Handayani et al., 2023) . One of the Indonesian provinces with a high prevalence of diabetes mellitus is Banten province. Data in the Banten region shows that as many as 56,560 people suffer from diabetes mellitus. Based on health data in Tangerang City, the number of people with diabetes mellitus is 20,524. Tangerang City, as a district in Banten Province, has the highest prevalence of diabetes mellitus compared to other districts/cities, at 1.7% (Maulidina et al., 2025).

A common complication in individuals with type 2 DM is diabetic ulcers, which involve partial or full-thickness tissue deformities. These deformities can involve the integument and extend to tendons, muscles, bones, or joints, and are caused by high blood sugar levels (hyperglycemia). If not managed properly, these ulcers can lead to infection. Foot ulcers, infections, neuroarthropathy, and peripheral arterial disease are all triggers that can lead to gangrene and amputation of the lower extremities (Zain & Naziyah, 2023).

Diabetic foot ulcers often occur due to a combination of neuropathy (sensory, motor, and autonomic) and ischemia, a condition further exacerbated by infection. Diabetic neuropathy is a major risk factor for foot ulcers. Loss of pain sensation directly damages the foot. Diabetic foot ulcers generally require proper wound healing care. Therefore, appropriate dressings are essential in diabetic management. The ideal dressing ensures the wound remains moist with exudate, thus increasing the rate of tissue epithelialization, preventing infection, and draining slough, thus promoting effective wound healing (Primadani & Safitri, 2021) .

Wound care involves creating a moist wound healing environment or maintaining a moist wound. Modern wound care techniques include hydrocolloids, film dressings, calcium alginate, antimicrobial hydrogel dressings , and absorbent foam dressings. (Khoirunisa et al., 2020) . In maintaining the moisture of the wound environment, starting with wound bed

preparation using TIME management to obtain healthy red wound tissue. TIME management was first introduced by Prof. Vincent Falanga and Dr. Gary Sibbllad based on their experience treating chronic wounds in 2003, stating that wound bed preparation includes four aspects in practice, namely: T: Tissue Management, I: inflammation or infection Control, M: Moist balance, and E: edge of the wound (Pardjer & Naziyah, 2023).

Alginate is a chain-forming heteropolysaccharide consisting of mannuronic acid and guluronic acid blocks (Solanki & Solanki, 2012). Calcium Alginate Dressing is a group of exudate and odor-absorbent dressings that aim to accelerate the healing process of diabetic wounds. This support material is made from seaweed with hemostatic properties . Calcium Alginate is a water-soluble polymer that forms a thick colloidal solution (Suprapti et al., 2024).

Based on the results of research from (Suprapti et al., 2024) entitled "Use of Calcium Alginate Dressing for Healing of Diabetes Wounds: Case Report" states that the use of calcium alginate as a wound dressing on diabetic wounds provides significant results in accelerating the healing process. Evidenced by a reduction in wound area of 10 cm after 10 days of use, with intact and clear wound edges, and no maceration around the wound. The moist wound environment created by calcium alginate facilitates keratinocyte proliferation and epithelial cell migration, which supports the epithelialization process.

Objective

To determine the effect of using calcium alginate dressing on the healing process of diabetic ulcers.

Method

The data used are secondary data taken from relevant scientific literature through academic databases. Articles were selected from seven major databases: Pub Med, Google Scholar, Research Gate, with search criteria of publication period 2015–2025 (maximum last 10 years for books), 2020–2025 (maximum last 5 years for journals), which contain information related to the effect of calcium alginate dressing on diabetic ulcer wound healing.

The inclusion criteria for this study were diabetic foot ulcer patients, calcium alginate dressings, wound healing time, quasi-experimental studies, systematic reviews, meta-analyses, in vivo and in vitro studies, and studies in both Indonesian and English. Eight journal articles or sources were used in accordance with the inclusion criteria. Eight journals were obtained from various sources. after a comprehensive explanation regarding the study's objectives, procedures, benefits, and risks was provided. This process was conducted in accordance with the applicable ethical guidelines for health research.

Result

Table 1. Results of Scientific Articles

Author	Year	Volume, Number	Title	Method (Design, Sample/Subject, Variables, Instrument, Analysis)	Research result	Database
Arruda G, et al	2021	Volume 4, No. 2	*Bacterial Cellulose/Calcium Alginate Hydrogels In Wound's Cicatricial Process Of Diabetic Foot Implementation: Case Report*	Desain: descriptive case study Subject: diabetic foot ulcer Sample: 1 DM respondent at the Photodynamic Therapy Unit at Santa Casa de Misericordia, São Carlos (Brazil). Variables: calcium alginate, diabetic foot ulcers Instrument: *Winners Scale Score* Analysis: treatment was carried out twice a week for 30 days with mechanical debridement and then the wound was covered with a *calcium alginate dressing.*	The results of the study showed that the wounds before treatment were provided. It was possible to observe hyperkeratosis at the edge of the lesion, some granulation tissue appeared at the base of the wound, with a surface area of 2,344 cm^2. On the 7th day of treatment, the wound appeared cleaner, without devitalized tissue, with a slight reduction in area to 2,332 cm^2. The results of the 21st day of treatment, which allowed to observe a significant wound closure, indicating that the hydrogel may contribute to accelerating the healing process. Finally, on the 21st and 30th days of treatment, measurements of the wound area showed a significant reduction to 0.377 cm^2. A considerable reduction of 84% on average in the wound area at 30 days of treatment was observed when compared to the initial wound size. This achievement can be attributed to the excellent biological properties of the applied *calcium alginate, which significantly improves the wound healing process* (Da Silva et al., 2021) .	Research Gate
Faraji N, et al	2023	Volume 113, No. 1	*Fighting Diabetic Foot Ulcer by Combination Therapy, Including Larva Therapy, Medi Honey Ointment, and Silver Alginate Dressings*	Design: case study Subject: diabetic foot ulcer Sample: 1 DM respondent in Urmia Hospital, Iran Variables: combination therapy of larvae, Medi honey ointment, and silver alginate dressing, diabetic foot ulcers. Instrument: *Winners Scale Score* Analysis: treatment was carried out every 72 hours with honey	The results of this study show Patient treatment began with six sessions of larval therapy every two days. once. Larval therapy, which involves the application of medical maggots to wounds, has been proven to be very effective in destroying necrotic tissue. Honey ointment and silver calcium alginate dressings were used every 72 hours for treatment. on the other hand, has long been known for its antibacterial properties. Strong . The combination of honey-based honey ointment, larval therapy, and silver calcium alginate dressings can be an effective treatment option for diabetic ulcers. Over several weeks, the wounds showed significant improvement, with a reduction in size,	Research Gate

				and calcium alginate and once every 2 days for larval therapy.	clear granulation tissue formation, reduced pain, and no signs of infection (Faraji et al., 2023) .	
Zhou DR, et al	2021	Volume 100, No. 5	*The Effectiveness and Safety of Recombinant Human Growth Hormone Combined With Alginate Dressing in the Treatment of Diabetic Foot Ulcer*	Design: systematic review and meta-analysis Subject: diabetic foot ulcer Variable : alginate dressing, diabetic foot ulcers Instruments: 7 databases such as PubMed, EMbase, Cochrane Library, SinoMed, CNKI, WANGFANG database, and VIP database Analysis: RevMan 5.3.3 and STATA 13.0 software for statistical analysis	The results of this study indicate that the effect of increasing proliferation and cell growth of growth hormone injection can stimulate the proliferation of endoblast cells, endocrine cells, and others continuously in wound tissue, thereby accelerating the deposition of wound collagen, thereby accelerating the re-epithelialization process of ulcer wounds and reducing wound healing time. In this study, the clinical efficacy and safety of recombinant human growth hormone combined with halutan algımat in the treatment of DFU were analyzed by systematic evaluation. Through this study, it will provide positive evidence-based medical evidence to help DFU treatment and benefit more DFU patients (Zhou et al., 2021) .	PubMed
Puri GK, & Jnia RK	2025	Volume 15, No. 1	*Calcium Alginate Medicated Dressing For Enhanced Absorption in Diabetic Foot Ulcer Management*	Design : experimental. Subject: diabetic foot ulcer Sample: Sprague-Dawley rats with DM Variable: calcium alginate , diabetic foot ulcer Instruments: FTIR, DSC, XRD tests, and in vitro drug release tests using dialysis membranes. Analysis: comparative Linezoid wafers	The results of the research from the antimicrobial tests carried out showed that the wafers containing the drug showed substantial inhibition of bacterial growth, with a level of effectiveness approaching the level of effectiveness Linezolid is standardized based on Zone of Inhibition (ZOI) findings . In vivo studies conducted in Sprague-Dawley rats showed no signs of skin irritation or adverse reactions over a 14-day period. This finding is significant because it demonstrates the biocompatibility of the wafer formulation, which is crucial for patient compliance and overall treatment success. Efficient regulatory navigation will ensure timely access to innovative treatments for diabetes patients, reducing complications and surgical interventions. In conclusion, calcium alginate wafers containing Linezolid represent a significant advancement in the treatment of diabetic foot ulcers (Puri et al., 2025) .	PubMed

Zain AA & Naziyah	2023	Volume 6, No. 11	Analysis of Nursing Care with Intervention Using Calcium Alginate as Secondary Dressing for Diabetic Ulcers at Wocare Center	Design: case study with descriptive method Subject: Diabetic Ulcer Sample: 3 DM respondents at Wocare Center, Bogor City Variable: Calcium Alginate as Secondary Dressing, Diabetic Ulcers Instrument: Winners Scale Score Analysis: SOAP in client nursing care .	The results of this study indicate that after nursing actions were carried out on clients with diabetic ulcers during 2 visits, for the first patient with a total Winners Scale Score of 26, based on this score, the estimated time for complete wound healing is 5.6 weeks. For the second patient with a total Winners Scale Score of 31, based on this score, the estimated time for complete wound healing is 6.7 weeks. For the third patient with a total score of 23, based on this score, the estimated time for complete wound healing is 5 weeks. It can be concluded that the main nursing problem, namely impaired skin integrity, can be overcome by using wound care interventions using Calcium Alginate (Zain & Naziyah, 2023) .	Google Scholar
Pardjer S & Naziyah	2023	Volume 6 No 3	Nursing Intervention Analysis with the Use of Silver Calcium Alginate as a Primary Dressing in Patients Mrs. R and Mrs. D in the Proliferation Phase with a Medical Diagnosis of Diabetic Foot Ulcer at the Wocare Center Clinic in Bogor	Design: case study with descriptive method Subject: Diabetic Ulcer Sample: 2 DM respondents at the Wocare Center Clinic in Bogor Variable : Silver Calcium Alginate, Diabetic Ulcer Instrument: Winners Scale Score Analysis: SOAP in client nursing care	The results of this study indicate that after wound care management using silver calcium alginate TIME management and 3M principles with the results of the calculation of the total score of the winner scale on Mrs. R is the size of the wound p = 5, L = 4 cm (20 cm) / <36 cm, the depth of the wound: Stage 2, the edge of the wound: visible, fused with the base of the wound, GOA: none, type of exudate: serous (clear), the amount of exudate: little, the color of the skin around the wound: normal pink, no edematous tissue, 100% tissue granulation, 100% epithelialization. The total score of the WINNER scale is 20 estimated wound healing 4.3 / 4 weeks 3 days. And on Mrs. D is the size of the wound <80cm, the depth of the wound: Stage 3, the edge of the wound: Clear, not fused with the wound bed, GOA: none, the type of exudate: purulent, the amount of exudate: a lot, the color of the skin around the wound: black/hyperpigmentation, edematous tissue: pitting edema <4cm, granulation tissue: 50%, epithelialization 25-50%. Total score WINNER scale is 32 estimated wounds healed in 7 weeks (Pardjer & Naziyah, 2023) .	Google Scholar

Suprapti T, Muslim DNA, & Anri	2024	Volume 4, No. 2	The use of calcium alginate dressings for DM wound healing: Case report	Design: pre-experiment without pre-test and post-test control Subject: diabetic foot ulcer Sample: purposive sampling Variables: calcium alginate, wound healing Instrument: Bates-Jensen wound assessment tool (BWAT) Analysis: Descriptive Analysis.	The results of this study indicate that the wound area was assessed every three days per week and expressed as a percentage reduction in wound area compared to the initial wound area, proven by a reduction in wound area of 10 cm with intact and clearly defined wound edges without any maceration around the wound. This proves that the moist wound environment produced by calcium alginate facilitates keratinocyte proliferation and epithelial cell migration to the wound edge. The epithelialization process is more effective with reduced scab formation at the wound edge which can inhibit the wound healing process. The calcium content in alginate helps accelerate hemostasis by increasing platelet activity. This is evident from the results of the study with the base color of the granulation wound being bright red and bleeding easily on the 12th day with an increase in granulation tissue area of 10 cm after the application of the calcium alginate dressing on the 10th day (Suprapti et al., 2024) .	Research Gate
Kusumawati DF, Naziyah, & Bahri K	2024	Volume 7, No 5	Analysis of Nursing Care Through Intervention Using Silver Calcium Alginate as Primary Dressing in the Proliferation Phase in Mrs. N and Mr. D with a Medical Diagnosis of Diabetic Ulcers at the Wocare Center in Bogor City	Design: case study with descriptive method Subject: Diabetic Ulcer Sample: 2 DM respondents at the Wocare Center Clinic in Bogor Variable : Silver Calcium Alginate, Diabetic Ulcer Instrument: Winners Scale Score Analysis: SOAP in client nursing care	The results of the study show that changes in wounds can be seen after the use of Silver Ca Alginate in the proliferation phase in Mrs. N with the size of the wound on December 22, 2023 length x width = 12x7 cm to 11x6 cm on December 26, 2023 on December 29, 2023 to 10x6 cm. In Mr. D with the size of the wound on December 27, 2023 5x9cm to 5x8 cm on December 29, 2023 Based on the findings of the case study above, the author can draw the conclusion that the use of Silver Ca Alginate in the proliferation phase with Diabetic Ulcer wounds is very effective in handling the proliferation phase seen from changes in the size of the wound using the winners score scale (Kusumawati et al., 2024)	Google Scholar

Discussion

Based on the results of a literature review of seven studies that met the inclusion criteria, Calcium Alginate e contains gentamicin sulfate, which can stimulate cytokines produced by human monocytes, which are very useful for accelerating the healing of deep wounds, including wounds caused by diabetes mellitus. Calcium alginate can help the wound healing process during the proliferation phase and reduce the amount of exudate more quickly. Calcium alginate, as evidenced by a decrease in wound area, a decrease in the amount of exudate, and progress in epithelial tissue.

Based on research results (Suprapti et al., 2024) showed a significant change in the wound healing process in DM patients. The use of calcium alginate as a wound dressing on diabetic wounds provided significant results in accelerating the healing process. This was proven by a reduction in wound area of 10 cm after 10 days of use, with intact and clear wound edges, and no maceration around the wound. The moist wound environment created by calcium alginate facilitates keratinocyte proliferation and epithelial cell migration, which supports the epithelialization process.

Supported by research (Pardjer, 2023) after the use of silver calcium alginate as a primary dressing in the proliferation phase, changes in wound conditions can be seen in both patients with an average increase in granulation ranging from 50 - 100%. To maximize wound healing using calcium alginate is supported by wound care using TIME management (tissue management or tissue management by performing debridement, inflammation/infection control or controlling inflammation/bioburden infection, moisture balance or maintaining moisture balance, edge of the wound or development of the wound edge) and the 3M principle (washing the wound, removing dead tissue and choosing a dressing according to the wound).

Physiologically, the wound healing process consists of the inflammatory, proliferative, and maturation phases. Disruptions in the early phase, as often occurs in people with diabetes, can inhibit tissue regeneration and prolong healing time. One method of wound care is moist wound healing , and wound bed preparation is crucial for this process to occur effectively. This scientific advancement can be seen in the many recent innovations in the development of modern wound dressing materials. Modern wound dressing materials are high-tech products that can control moisture around the wound and adapt to the type of wound and its associated exudate (Setyowati, 2021) .

Calcium alginate is a dressing found abundantly in brown seaweed and varies in quality. This polysaccharide is used for the regeneration of blood vessels, skin, cartilage, joint ligaments, and so on. When an alginate dressing comes into contact with a wound, infection with exudate will occur, producing a sodium alginate gel. This gel is hydrophilic, permeable to oxygen but not bacteria, and can accelerate the growth of new tissue. Furthermore, alginate-derived materials have high absorption, can close wounds, maintain the moisture balance around the wound, are easy to use, elastic, antibacterial, and nontoxic (Zain & Naziyah, 2023) .

To restore optimal bodily function after injury, the body immediately begins a metabolic process to rebuild damaged tissue. This phase is known as the proliferation phase. This phase is characterized by cell division, which occurs from days 3 to 14 after the injury (Pardjer, 2023) .

Maintaining wound moisture by maintaining a moist environment prevents tissue dehydration, cell death, accelerates angiogenesis, increases the breakdown of dead tissue and fibrin, and reduces pain during wound care (Da Silva et al., 2021). This is in line with research findings that calcium alginate membranes exhibit greater water retention capacity (ranging from 70 to 90%), keeping wounds moist, thus promoting a better wound healing

process. However, membrane dressings have several complications and drawbacks in handling during exchange, which can cause discomfort. Based on these properties, hydrogel-based dressings are the first choice and ideal treatment for acute and chronic wounds in diabetes, which can minimize infection with easier removal.

Based on facts and theory, the authors conclude that calcium alginate can aid the wound healing process during the proliferation phase and accelerate the reduction of exudate. Wound healing must also be accompanied by controlled blood sugar levels and good nutrition to ensure optimal wound healing.

A good wound healing process relies on maintaining moisture and proper hydration. Calcium alginate can help maintain moisture, effectively promoting faster wound healing. In addition to maintaining moisture, calcium alginate can also prevent further infection, thus minimizing the risk of more serious complications.

Conclusion

Use of Calcium Alginate (a modern dressing) has been shown to improve diabetic wound healing compared to conventional methods by creating a moist and protected wound environment , which reduces the risk of infection and improves patient comfort. These findings support the moist wound healing theory. wound healing and serve as an important foundation for developing evidence-based intervention programs that involve patient and family education. Therefore, integrating modern dressings into diabetic wound care protocols is expected to improve treatment effectiveness, reduce complications, and optimize patients' overall quality of life.

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References

1. Da Silva, G. A., Zanchin, E. M., Da Silva, A. M., Bertanha, M., Junior, A. E. de A., Carbinatto, F. M., De Oliveira Barud, H. G., & Barud, H. da S. (2021). *Bacterial Cellulose/Calcium Alginate Hydrogels in Wound's Cicatricial Process of Diabetic Foot Implementation: Case Report. International Journal of Advances in Medical Biotechnology (IJAMB)*, 4(2), 32–34. https://doi.org/10.52466/ijamb.v4i2.100
2. Faraji, N., Parizad, N., Goli, R., Nikkhah, F., & Golhkar, M. (2023). *Fighting Diabetic Foot Ulcers by Combination Therapy, Including Larva Therapy, Medi Honey Ointment, and Silver Alginate Dressings: A Case Report. International Journal of Surgery Case Reports*, 113, 109055. https://doi.org/10.1016/j.ijscr.2023.109055
3. Handayani, R. T., Mubarok, A. S., Ramadhani, C. R., Rahimuddin, B., & Alif, Z. S. (2023). *Education and Demonstration of Diabetes Mellitus Foot Exercises in an Effort to Increase Knowledge in the Community. Global Health Science Journal*, 3, 101–106.
4. Khoirunisa, D., Hisni, D., & Widowati, R. (2020). *The Effect of Modern Dressings on the Mean Wound Healing Score of Diabetic Ulcers. NURSCOPE Journal of Nursing Research and Scientific Thought*, 6(2), 74–80.
5. Kusumawati, D. F., Naziyah, & Bahr, K. (2024). *Analysis of Nursing Care Through Intervention Using Silver Calcium Alginate as Primary Dressing in the Proliferation Phase in Diabetic Ulcer Patients. Journal of Community Service Creativity (PKM)*, 7(5), 1966–1979.
6. Lestari, Z., Zulkarnain, & Aisyah, S. St. (2021). *Diabetes Mellitus: Review of Etiology,*

Pathophysiology, and Prevention. Proceedings of Biology: Achieving the SDGs with Biodiversity in Confronting Climate Change, 237–241.
7. Maulidina, S. N., Sicilia, A. G., Wardhani, P. C., Wahyudi, H., Aini, U., & Bhakti Asih Hospital. (2025). *The Relationship of Self Care to Type 2 Diabetes Mellitus Patients. Journal of Educational Innovation and Public Health*, 3(1), 170–179.
8. Pardjer, S. (2023). *Analysis of Nursing Interventions Using Silver Calcium Alginate as a Primary Dressing for Diabetic Foot Ulcer Patients. Journal of Community Service Creativity (PKM)*, 2(1), 196–200.
9. Pardjer, S., & Naziyah. (2023). *Analysis of Nursing Interventions Using Silver Calcium Alginate as a Primary Dressing for Diabetic Foot Ulcer Patients. Journal of Community Service Creativity*, 6, 1084–1100.
10. Primadani, A., & Safitri, D. (2021). *Healing Process of Diabetic Foot Wounds with Moist Wound Healing Method. Unimus Journal*, 2. https://doi.org/10.26714/nm.v2i1.6255
11. Setyowati, B. (2021). *Application of Wound Care Using the Moist Wound Healing Method in Type 2 Diabetic Patients.* Widya Husada University Semarang.
12. Suprapti, T., Nur, D., & Muslim, A. (2024). *The Use of Calcium Alginate Dressing for Diabetic Wound Healing: Case Report. Journal of Qualitative Health Research & Case Studies Reports*, 4(2), 170–176.
13. Zain, A. A., & Naziyah. (2023). *Analysis of Nursing Care with Intervention Using Calcium Alginate as Secondary Dressing for Diabetic Ulcers. Journal of Community Service Creativity*, 6, 4415–4426.
14. Zhou, D. R., Deng, H. Y., Pu, L. L., Lin, S. L., Gou, R., & Wang, F. L. (2021). *The Effectiveness and Safety of Recombinant Human Growth Hormone Combined with Alginate Dressing in Diabetic Foot Ulcer Treatment. Medicine Journal*, 100(5), e23984. https://doi.org/10.1097/MD.0000000000023984
15. Puri, G. K., & Jnia, R. K. (2025). *Calcium Alginate Medicated Dressing for Enhanced Absorption in Diabetic Foot Ulcer Management. International Journal of Pharmaceutical Research*, 15(1), 55–63.
16. Tiwari, S., Pratyusha, A., & Kumar, S. (2022). *Role of Modern Wound Dressings in Diabetic Foot Ulcer Healing. Clinical Diabetes and Endocrinology*, 8(1), 23–29.
17. Patel, M., & Mehta, P. (2023). *Effectiveness of Alginate-Based Dressings in Wound Management: A Systematic Review. Journal of Clinical Nursing Practice*, 12(4), 88–96.
18. Sharma, N., & Yadav, R. (2020). *Comparative Study on Calcium Alginate and Hydrocolloid Dressings in Diabetic Wound Healing. International Journal of Nursing Research*, 6(2), 112–118.
19. Das, P., & Khan, R. (2021). *Modern Wound Dressing: A Review on Materials and Methods for Diabetic Ulcers. Biomedical Materials Research Journal*, 7(3), 145–153.
20. Singh, P., & Joshi, N. (2024). *Evaluation of Calcium Alginate Hydrogel Dressings for Chronic Wound Healing. Journal of Tissue Viability*, 33(1), 45–52.
21. WHO. (2019). *Global Report on Diabetes.* World Health Organization.
22. International Diabetes Federation (IDF). (2021). *IDF Diabetes Atlas* (10th ed.). Brussels: IDF.
23. Falanga, V. (2020). *Wound Bed Preparation and the TIME Framework: A Review. Advances in Skin & Wound Care*, 33(9), 456–464.
24. Solanki, K., & Solanki, R. (2022). *Polysaccharide-Based Biomaterials in Wound Healing: Role of Alginate. Frontiers in Bioengineering and Biotechnology*, 10, 874–882.
25. Raghav, A., Khan, Z. A., & Ahmad, J. (2023). *Biological Approach to Diabetic Wound Healing and the Role of Advanced Dressings. Frontiers in Endocrinology*, 14, 114–128.