Vitamin A-loaded decellularized kidney capsule promoted wound healing in rat

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Introduction

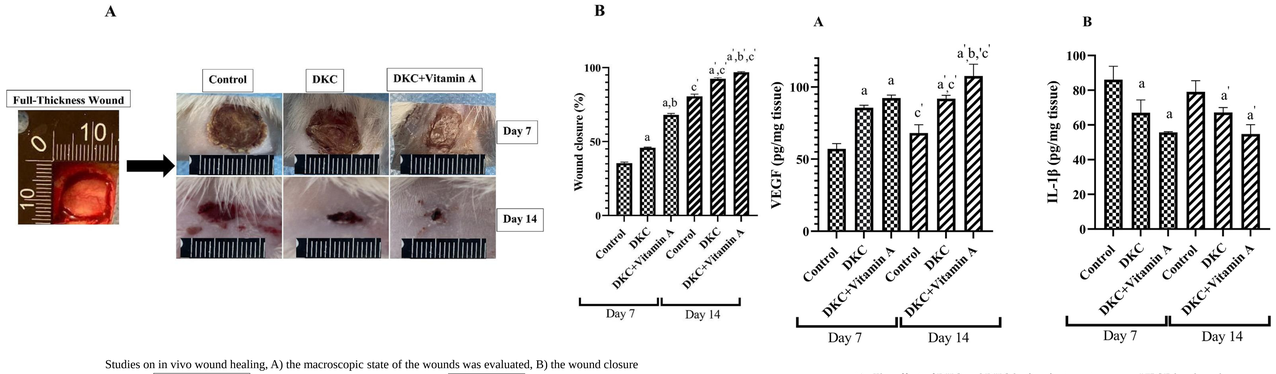
The skin is the largest organ in the human body that covers the body's whole surface. This tissue is an intricate organ that uses a variety of defense mechanisms, including chemical, physical, and microbiological barriers, to shield the host from harm from the outside world. The integumentary system is formed by the skin and its appendages that originate from the epidermis, such as hair follicles, sweat glands, sebaceous glands, nails, and mammary glands. Histologically, the skin is composed of two primary layers: the dermis and the epidermis. Growth factors, cytokines, chemokines, and other cells coordinately interact during the dynamic and intricate multiple-phase process that is normal wound healing. If these steps are not followed, wounds could become chronic and develop atypical scars. Patients' quality of life is impacted by chronic wounds since they necessitate frequent care and high medical expenses.

Methods

The present work aims to choose relevant data and implant a better scaffold in mice after the chemical-physical evaluation of the scaffold and determination of vitamin A dose was completed in a laboratory model. Based on pilot testing, scaffolds of 1.5 1.5 cm2 were cut, and various dosages of vitamin A were added to the scaffolds. The kidney capsule was broken up into tiny pieces, each measuring 1.5 by 1.5 cm2. The effectiveness of the DKCs loaded with vitamin A in wound healing was assessed using a full-thickness wound model. At the age of eight weeks, 30 healthy adult male rats weighing between 220 and 240 gr. The animals were then split into three groups: 1. control group (no treatment group), 2. DKC group (decellularized kidney. capsules, treatment group), and 3. DKC-15000 vA group (decellularized kidney capsules þ 15,000 U/ml vitamin A, treatment group). Following that, the rat's back developed a 1.5 1.5 cm2) full-thickness wound. Each group (n ¼ 5) received the treatments during two periods of 7 and 14 days. The DKC-15000 vA group was chosen and implanted in thewound model due to its superior performance in tests of toxicity, mechanical characteristics, contact angle, antibacterial test, and cell adherence. The scaffolds were positioned on the wound so that the scaffold's edgewas under the skin, negating the need for sutures and allowing researchers to assess the therapeutic effects of each scaffold in full-thickness wound healing.

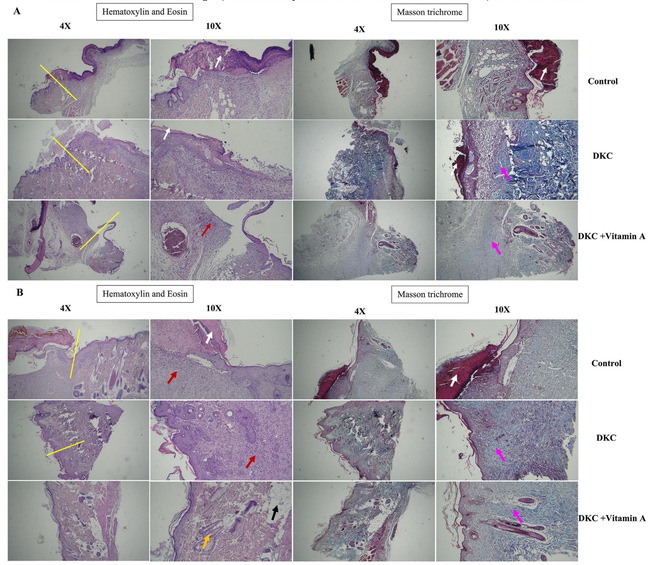
Results

The wound site in the control groups (days 7 and 14) showed the highest number of scabs. The process of epithelization is better observed by increasing the healing time and using the scaffold in the wound site. In the groups where the scaffold with and without. vitamin A was used as a wound dressing, the process of collagen tissue formation can be seen, although it is immature. Collagen bundles were formed in groups of the DKC þ vitamin A on the 14th day. The formation of hair follicles can also be seen in this group. Regeneration on the 14th day is described to be better than on the 7th day. The increase in VEGF level in all groups shows a time-dependent increase. On day 14, the level of VEGF in the DKC þ vitamin A group was significantly higher than in other groups. After that, the DKC group reported a high level of VEGF on day 14. The level of IL-1b, dependent on time, showed a decreasing trend in the treated samples compared to the control group. The DKC þ vitamin A group showed a significant reduction in inflammation, especially on the fourteenth day, compared to other groups, but this difference was not significant compared to other treatment groups. Wound closure in the control groups were 35.53 ± 0.55 % and 80.64 ± 1.46 % 7 and 14 days after wound formation, respectively. Wound healing in the DKC groups were 45.85 ± 0.45 % and 92.46 ± 0.83 % 7 and 14 days after wound formation, respectively. Wound closure in the DKC þ vitamin A groups was 68.00 ± 1.00 % on day 7 and 96.84 ± 0.45 % on day 14.



Studies on in vivo wound healing, A) the macroscopic state of the wounds was evaluated, B) the wound closure

A) The effect of DKC and DKC þ vitamin A treatments on VEGF levels and
B) B) IL-1b level in skin wounds after 7 and 14 days



Evaluations of wound healing in histopathology, A) day 7, B) day 14,

Conclusions

Decellularized kidney capsules with 0.5 % SDS were loaded with different doses of vitamin A and presented good properties as skin scaffolds. These features include appropriate mechanical behavior, biocompatibility, cell attachment, hydrophilicity, and antibacterial properties. A scaffold loaded with 15,000 U/ml vitamin A showed full-thickness wound healing within 14 days in rats with increased angiogenesis and VEGF levels. On the other hand, it caused the suppression of pro-inflammatory mediators such as IL-1b. These findings can introduce new evidence of a decellularized kidney capsule scaffold containing vitamin A for the treatment of skin wounds. Then, the above scaffold was evaluated on the full-thickness wound model in rat, which showed good wound contraction, and increased VEGF factor. It showed a decrease in IL-1b level. Therefore, the use of the above-mentioned decellularized scaffold in combination with medicinal agents effective in wound healing can be introduced for further pre-clinical studies.