



The Effects of Aloe Vera Plant and Gel on Oral Mucosal Wound Healing in Rabbits: A Histological Study



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BACKGROUND: *Aloe Vera* is a beneficial plant full of vitamins and minerals with wide applications in health, medicinal, and skin care. **Aims of the study:** is to see how *Aloe Vera* affects the histological structure of an adult male New Zealand rabbit's oral mucosal (buccal) lesion after it has been burned. **Materials and methods:** In the current investigation, 48 male New Zealand rabbits were employed. Each animal administered ketamine and xylazine intramuscular injection in the rabbit's thigh muscle. Within 5 minutes, adequate anesthesia had been achieved. In the operating room, animals were placed on the operating table. Electrosurgical Generator cautery was used for unipolar cauterization throughout the procedure. For burning of 0.5 cm of the rabbits' buccal oral mucosa, we employed a unipolar electrocautery pen with a (2.5) inch standard blade electrode at 95.5 °C. Following that, the rabbits were randomly split into four groups (12 rabbits for each group): Group 1 (normal oral mucosa without burning) (n= 12), Group 2 (burning oral mucosa without medicine) (n= 12), Group 3 (*Aloe Vera* plant) (n= 12), and Group 4 (*Aloe Vera* gel) (n= 12). Each group subdivided according to the medication period into (3, 7, 14 days) then 12 rabbits were sacrificed for each medication period. These rabbits' buccal tissues were removed for histological testing, and then statistics analysis was carried out. **Result:** The burn site was categorized by faint inflammatory cells infiltration, granulation tissue, angiogenesis, and re-epithelialization in *Aloe Vera* plant-treated buccal tissue, whereas the burn site was characterized by granulation tissue, angiogenesis, and re-epithelialization in *Aloe Vera* gel-treated buccal tissue, but without inflammatory cells infiltration. **Conclusion:** It is reasonable to believe that the *Aloe Vera* plant and gel might have a healing impact on a burned oral mucosal tissue. The *Aloe Vera* gel was much more successful in wound healing than the *Aloe Vera* plant.

Keywords: Aloe Vera, Oral mucosa, Wound healing, Burning oral mucosa.

Introduction

Aloe Vera gel (*Aloe Barbadensis*) is a transparent, odorless, and tasteless gel used to heal burns and skin ailments. The water storage side of the plant is represented by parenchyma, which is the

part in which water is retained in the shape of a viscous mucilage or fillet fluid [1].

The oral mucosa is a specialized moist tissue that runs from the lips' skin mucosal junction

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(vermillion border) anteriorly to the oropharynx posteriorly, lining the oral cavity [2], the buccal, gingival, and sublingual mucosa in the mouth cavity make up the oral mucosa. The mucosal epithelium of the mouth acts as a barrier between the underlying tissues and their surroundings.

The stratified squamous epithelium on the surface and the deeper lamina propria make up the oral mucosa histologically. These two tissues are referred to as the epidermis and dermis, respectively, in the skin. The oral mucosa is structurally diverse in different sections of the mouth, but three fundamental categories may be recognized based on its principal function: lining mucosa, masticatory mucosa, and specialized mucosa [3]. The wound is largely wounded or disordered tissue that has lost its microstructure integrity and is experiencing a difficult wound healing process. Many distinct forms of wounds are caused by a number of factors, include surgery (planned intervention), trauma (i.e., lacerations), and pressure wounds (i.e., pressure ulcers) [4]. Wound healing is essentially a survival process that entails attempting to maintain normal anatomic function and structure of the skin/mucosa following damage, whether accidental or intentional. The regeneration and tissue repair process are a sequence of molecular and cellular actions that occur when a tissue lesion occurs in order to heal the damaged tissue [5]. Wound Healing Phases: Wound healing is divided into four phases: hemostasis, inflammation, proliferation, and maturation/matrix remodeling [6]. *Aloe Vera* possesses antifungal, anticancer, anti-inflammatory, and immunomodulatory capabilities, as well as healing, moisturizing, anti-aging, and antibacterial characteristics, thus *Aloe Vera* was employed in this study to evaluate the impact of *Aloe Vera* on oral mucosal wound healing in rabbits due to its biological features.

Materials and Methods

Experimental Model

In this investigation, 48 white New Zealand healthy male adult rabbits with a mean weight of (1.75-2) Kg were employed. The animals were housed in normal conditions with the same feeding and housing conditions at (25°C) room temperature and 12 hours lighting system [7]. They were fed a standard diet of wheat and fresh vegetables, as well as water. During the experiment, the animal was kept in a cage at the College of Dentistry at the University of Mosul. A veterinary physician examined the animals

to determine their overall health and condition before the surgical operation. This investigation was carried out in conformity with the institutional animal research ethics committee's code (UoM. Dent/A.L.35/21) [8].

Animal Preparation

Each animal received a 40 mg/kg ketamine intramuscular injection in the rabbit's leg muscle, along with 4 mg/kg of rabbit weight xylazine [9]. The rabbit's weight was measured using electronic digital scales, the rabbit's responses were evaluated after 5-10 minutes to establish that anesthesia had been administered.

Animal Operation Procedure

Within 5 minutes, adequate anesthesia had been achieved. On the surgical table, animals were placed. Megapower Megadyne Electrosurgical Generator cautery was used during the operation. For unipolar cauterization, the device was set on ACE (Advanced cutting effect). This mode uses 150 watts of electricity and operates at a frequency of 400 Hz. For burning of 0.5 cm of the rabbits' oral mucosa, we employed a unipolar electrocautery pen with a (2.5) inch standard blade electrode at 95.5 °C [10].

Post-Operative Care

Following the procedure, the rabbits were segregated until they recovered from anesthesia. Monitor the eating and physical activity of affected animals during the first 24 hours after surgery.

Preparation of pure Aloe Vera

The gel of aloe vera was made according to the instructions [11]. The inner gel was retrieved using a sterile spatula after the outer covering of spotted *Aloe Vera* from the Liliaceae family was peeled. The gel was kept at room temperature in a clean container until needed.

Experimental protocol

A total of 48 rabbits were separated randomly into four main groups, each with 12 rabbits. Each main group subdivided according to the time of sacrifice as a following: (3,7,14) days after surgery, the animals were sacrificed.

- 1- Control negative group (normal tissue): This group consists of 12 rabbits with normal tissue that were neither burned nor given any medication.
- 2- Control positive group: This group consists of 12 rabbits who had their oral mucosal tissue (buccal) burnt without any treatment.

- 3- *Aloe Vera* gel group: this group consists of 12 rabbits that had their oral mucosal tissue (0.5 cm) burnt and then administered the fake *Aloe Vera* gel daily for 3, 7, and 14 days to evaluate how it affected wound healing.
- 4- *Aloe Vera* plant group: 12 rabbits had their oral mucosal tissue (0.5 cm) burnt and then administered pure *Aloe Vera* gel daily for 3 days, 7 days, and 14 days to observe how it affected wound healing.

Preparation of the Specimens for Histopathological Examination

Three, seven, and fourteen days after the animals were burned, 12 animals from each group were slaughtered. Biopsies were obtained from the operated region after that. We obtained tissues from the burnt region of the oral mucosa from each killed rabbit. The specimens were fixed for 48 hours in 10% formaldehyde, and then processed with ethanol alcohol and xylene before being embedded and marked in paraffin wax blocks and frozen for 24 hours. Then, using the microtome, cut coronally in serials to a thickness of 4 microns. The tissues were collected on an identifiable glass slide after a ribbon of cut tissue with wax at the incision level was transferred to a 60 °C water bath. Following that, the slides were de-waxed, colored with hematoxylin and eosin, fixed with DPX, and examined under a light microscope [12]. And the scores to be evaluated histopathological were the degree of inflammation, The amount of granulation tissue formation, and the degree of re-epithelialization respectively, according to the (Sultana *et al.*, 2009, Gupta and Kumar, 2015) [13,14]

Statistical analysis

The data was managed and analyzed using the statistical program SPSS Version 25. The data were collected in order to determine the means and standard deviation of each group. These data were utilized to assess the differences between groups using a nonparametric test (Kruskal-Wallis H) at each sacrificial date period, with a significance value of $p \leq 0.05$.

Results

Results of Clinical Assessment

All group rabbits were subjected to daily clinical examinations for the wound field and surveillance for overall health and physical activity by a veterinary physician. All of the rabbits' wounds were free of infection and exudate.

Histological Findings at Three Days Period Post-burning

Control positive oral mucosa sections obtained on the third day after burning revealed damage of the epithelium layer of the oral mucosa, as well as marked infiltration by inflammatory cells, a small amount of granulation tissue, and angiogenesis; neo-blood vessels were founded only at the edge of the defect without re-epithelialization. Oral mucosa sections treated with *Aloe Vera* plant material revealed a modest quantity of granulation tissue and sparse quantity of angiogenesis without re-epithelialization, which was smaller than that seen in control positive oral mucosa sections. Oral mucosa sections treated with *Aloe Vera* gel revealed considerable inflammatory cell infiltration, granulation tissue, and angiogenesis with re-epithelialization but little angiogenesis (Fig. 1).

Histological Findings at One Week Period Post-burning

Oral mucosa slices from the control positive group, taken one week after burning, exhibited considerable inflammatory cell infiltration, granulation tissue, angiogenesis, and re-epithelialization. Oral mucosa sections treated with *Aloe Vera* plant material indicated considerable inflammatory cell infiltration, which was marginally less than that seen in control positive oral mucosa sections. It showed high amount of granulation tissue and moderate amount of angiogenesis and re-epithelialization. Oral mucosa sections that treated with *Aloe Vera* gel showed moderate infiltration by inflammatory cells which was slightly less than that for *Aloe Vera* plant. It showed high amount of granulation tissue and angiogenesis with moderate amount of re-epithelialization (Fig. 2a-c).

Histological findings at two weeks period post-burning

Oral mucosa sections from the control group two weeks after burning exhibited inflammatory cell infiltration, granulation tissues, and angiogenesis, as well as a moderate level of re-epithelialization. Oral mucosa sections handled with *Aloe Vera* plant material revealed a low level of inflammatory cell infiltration, a moderate quantity of granulation tissue, and angiogenesis, as well as a high level of re-epithelialization. There were no inflammatory cells infiltrating oral mucosa sections treated with *Aloe Vera* gel. It showed a significant quantity of granulation tissue and angiogenesis, as well as a high level of re-epithelialization (Fig 3a-c).

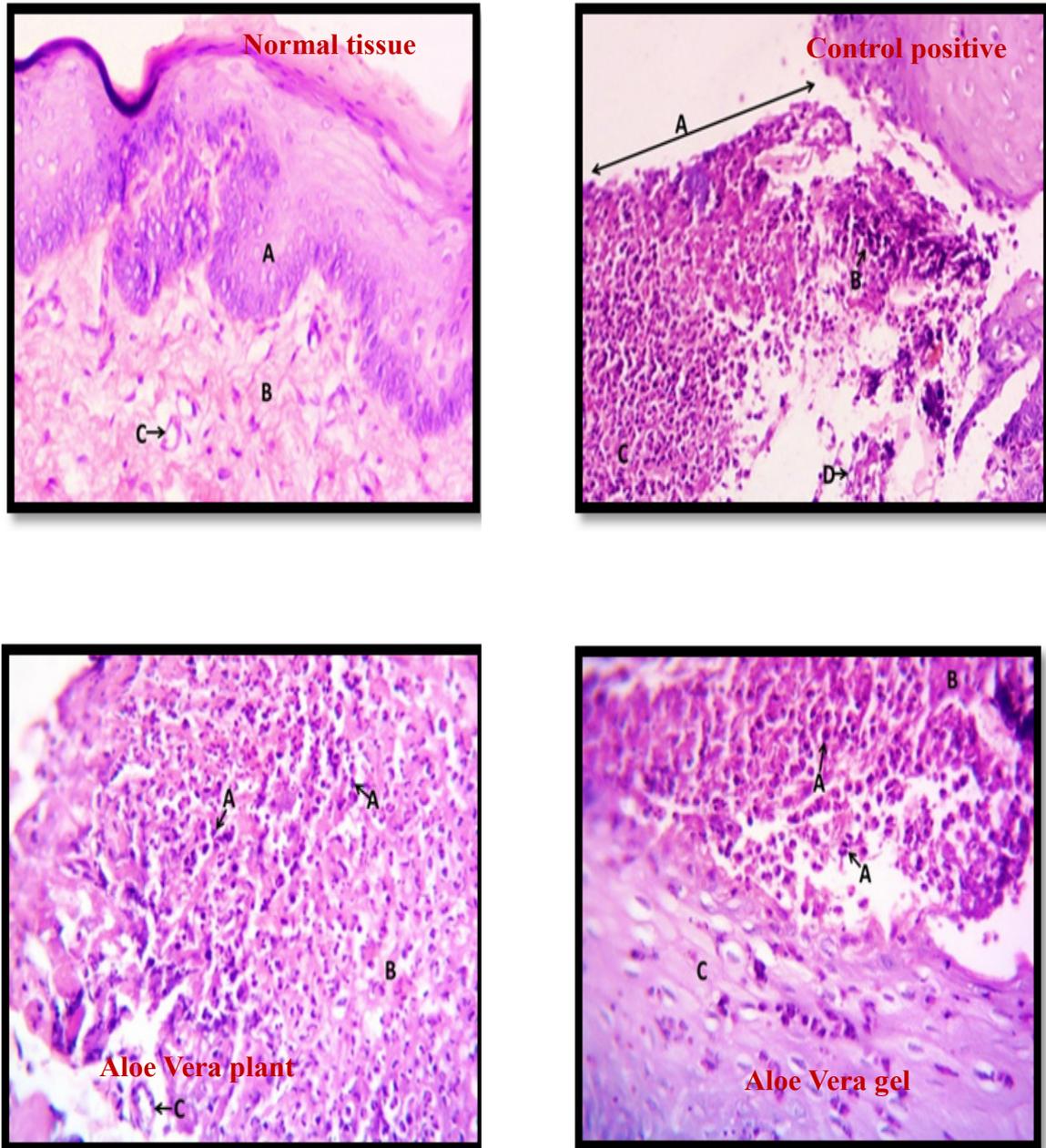


Fig. 1. photomicrograph of rabbit oral mucosa of control group (without burn) shows normal epithelium of mucosa (A), submucosa (B), and blood vessels (C) without inflammation (score 0), granulation tissue (score 0), angiogenesis (score 0) and re-epithelialization (score 0). H&E stain, 400X. photomicrograph of rabbit oral mucosa of control positive of burn group (after 3 days) shows the burn site characterized by destruction of epithelium layer of mucosa (A), inflammatory cells infiltration (score 3) (B), granulation tissue (score 1) (C), angiogenesis (score 1) (D) without re-epithelialization (score 0). H&E stain, 400X. photomicrograph of rabbit oral mucosa of plant treatment burn group (after 3 days) shows the burn site characterized by inflammatory polymorph nuclear cells infiltration (score 2) (A), granulation tissue (score 2) (B), angiogenesis (score 1) (C) without re-epithelialization (score 0). H&E stain, 400X. photomicrograph of rabbit oral mucosa of gel treatment burn group (after 3 days) shows the burn site characterized by inflammatory polymorph nuclear cells infiltration (score 2) (A), granulation tissue (score 2) (B) and re-epithelialization (score 1) (C). H&E stain, 400X.

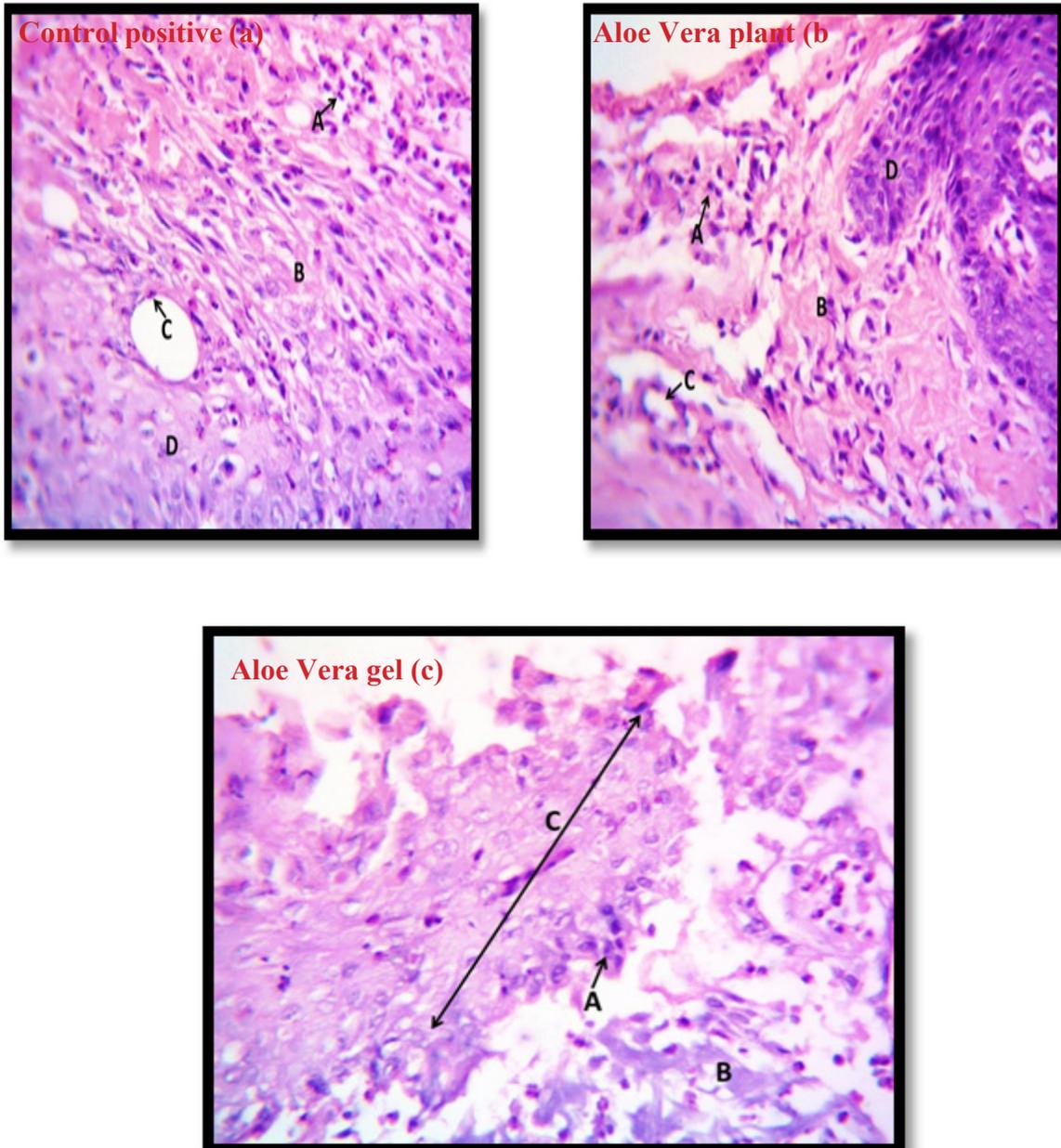


Fig. 2(a). Photomicrograph of rabbit oral mucosa of control positive of burn group (after 7 days) shows the burn site characterized by inflammatory polymorph nuclear cells infiltration (score 2) (A), granulation tissue (score 2) (B), angiogenesis (score 2) (C) and re-epithelialization (score 2) (D). H&E stain, 400X.

Fig. 2 (b). Photomicrograph of rabbit oral mucosa of plant treatment burn group (after 7 days) shows the burn site characterized by inflammatory polymorph nuclear cells infiltration (score 2) (A), granulation tissue (score 3) (B), angiogenesis (score 2) (C) and re-epithelialization (score 2) (D). H&E stain, 400X.

Fig. 2 (c). Photomicrograph of rabbit oral mucosa of gel treatment burn group (after 7 days) shows the burn site characterized by inflammatory polymorph nuclear cells infiltration (score 2) (A), granulation tissue (score 3) (B) and re-epithelialization (score 2) (C). H & E stain, 400X.

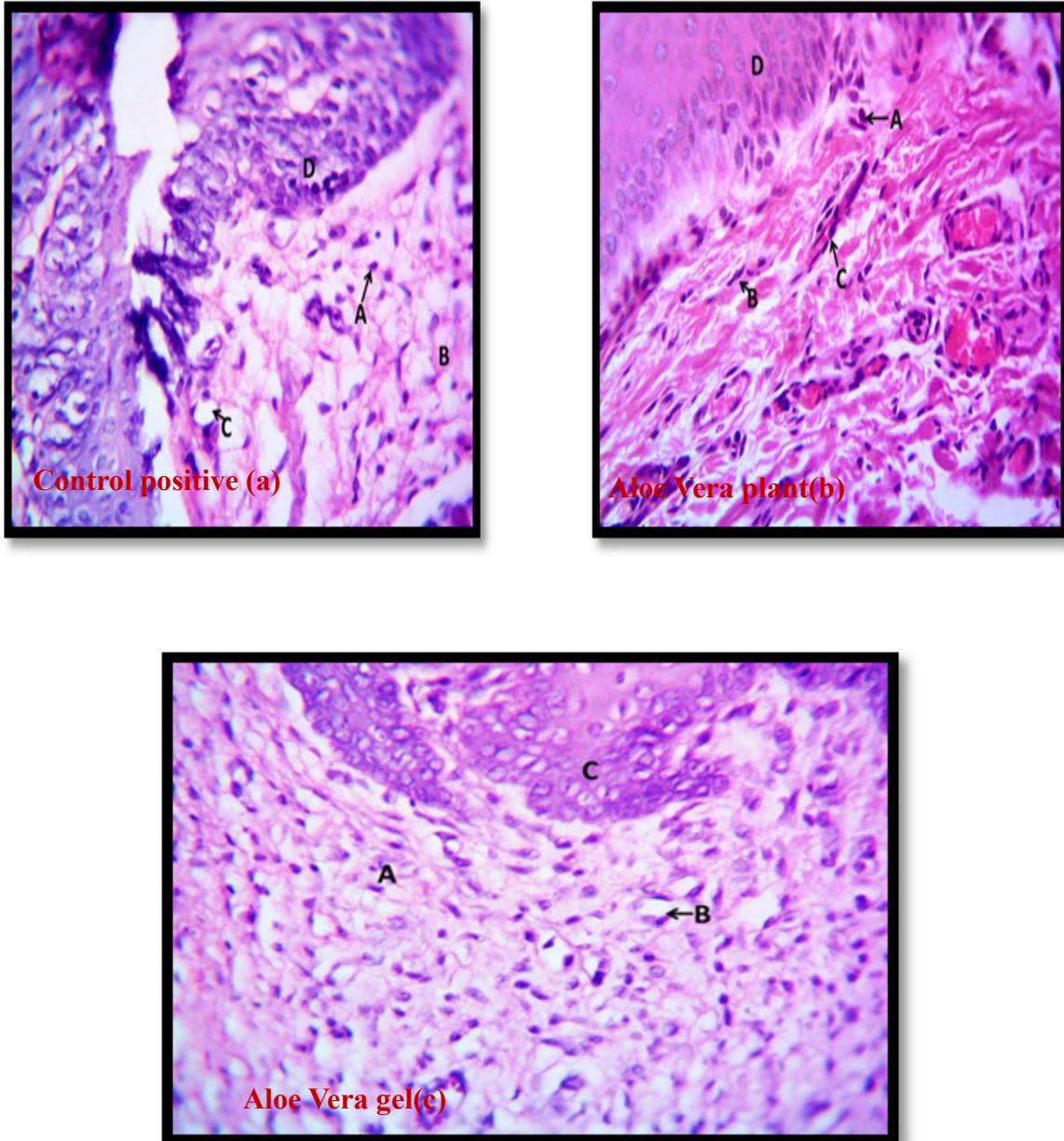


Fig. 3(a) Photomicrograph of rabbit oral mucosa of control positive of burn group (after 14 days) shows the burn site characterized by inflammatory cells infiltration (score 1) (A), granulation tissue (score 1) (B), angiogenesis (score 1) (C) and re-epithelialization (score 2) (D). H&E stain,

(b) Photomicrograph of rabbit oral mucosa of plant treatment burn group (after 14 days) shows the burn site characterized by slight inflammatory cells infiltration (score 1) (A), granulation tissue (score 2) (B), angiogenesis (score 2) (C) and re-epithelialization (score 3) (D). H&E stain, 400X.

(c) Photomicrograph of rabbit oral mucosa of gel treatment of burn group (after 14 days) shows the burn site characterized by granulation tissue (score 2) (A), angiogenesis (score 2) (B) and re-epithelialization (score 3) (C) without inflammatory cells infiltration (score 0). H&E stain, 400X.

Kruskal-Wallis According to statistical analysis, the control positive group had the greatest mean of inflammatory cell infiltration, whereas the *Aloe Vera* gel group had the lowest mean. On the third day, the P-value was found to be 0.05, representing a significant difference in inflammatory capability across the four groups. On the 7th and 14th days, the control positive group had the greatest mean of inflammatory cell infiltration, while the *Aloe Vera* gel group had the lowest mean score; P-value was discovered to be 0.05, indicating that the four groups had a significant difference in inflammatory cell capacity on those days (Table 1).

Kruskal-Wallis According to statistical analysis, the group treated with *Aloe Vera* gel had the highest mean of granulation tissue production, whereas the control positive group had the lowest mean. The P-value was (0.05), indicating that there was a significant difference in granulation tissue capacity between the four groups on the third day. On the 7th and 14th days, we noted that the group treated with *Aloe Vera* gel had the highest mean of granulation tissue production, whereas the control positive group had the lowest mean. At the 7th and 14th days, the P-value was determined to be (0.05), indicating a significant difference in granulation tissue capacity across the four groups (Table 2).

Kruskal-Wallis Statistical analysis indicated that the group treated with *Aloe Vera* gel had the greatest mean of angiogenesis, whereas the control positive group had the lowest mean. The P-value was found to be (0.05), indicating a significant difference in Angiogenesis capacity between the four groups on the third day; on the seventh and fourteenth days, we noticed that the group treated with *Aloe Vera* gel had the highest mean of angiogenesis, while the control positive group had the lowest mean. At the 7th and 14th days, the P-value was determined to be (0.05), indicating a significant difference in angiogenesis capability amongst the four groups (Table 3).

Kruskal-Wallis Statistical analysis indicated that the group treated with *Aloe Vera* gel had the highest mean of re-epithelialization, whereas the control positive group had the lowest mean. The P-value was found to be (0.05), indicating a significant difference in re-epithelialization capacity between the four groups on the third day; on the seventh and fourteenth days, we noticed that the group treated with *Aloe Vera* gel had the highest mean of re-epithelialization, while the control positive group had the lowest mean. At the 7th and 14th days, the P-value was determined to be (0.05), indicating a significant difference in re-epithelialization capability across the four groups (Table 4).

TABLE 1. Histopathological Findings of inflammation score of oral mucosal wound.

Parameters	Duration	Control (Normal tissue) Mean ± SD	Control positive Mean ± SD	<i>Aloe Vera</i> plant Mean ± SD	<i>Aloe Vera</i> gel Mean ± SD	P- Value
Inflammation	3 rd day	0.00±0.00	2.75±0.50	2.00±0.81	1.75±0.95	0.013*
	7 th day	0.00±0.00	2.12±0.62	1.62±0.43	1.25±0.50	0.009*
	14 th day	0.00±0.00	1.63±0.61	0.62±0.75	0.25±0.50	0.024*

* Significant Difference at $p \leq 0.05$.

TABLE 2. Histopathological Findings of granulation tissue score of oral mucosal wound.

Parameters	Duration	Control (Normal tissue) Mean ± SD	Control positive Mean ± SD	<i>Aloe Vera</i> plant Mean ± SD	<i>Aloe Vera</i> gel Mean ± SD	P- Value
Granulation tissue	3 rd day	0.00±0.00	1.25±0.50	1.62±0.75	2.00±0.81	0.016*
	7 th day	0.00±0.00	1.56±0.65	2.40±0.48	3.00±0.40	0.06*
	14 th day	0.00±0.00	1.36±0.64	1.63±0.56	1.81±0.44	0.024*

* Significant Difference at $p \leq 0.05$.

TABLE 3. Histopathological Findings of angiogenesis score of oral mucosal wound.

Parameters	Duration	Control (Normal tissue) Mean ± SD	Control positive Mean ± SD	<i>Aloe Vera</i> plant Mean ± SD	<i>Aloe Vera</i> gel Mean ± SD	P- Value
Angiogenesis	3 rd day	0.00±0.00	0.97±0.36	1.42±0.60	2.02±0.62	0.009*
	7 th day	0.00±0.00	1.50±0.42	2.21±0.26	3.18±0.30	0.003*
	14 th day	0.00±0.00	1.23±0.99	1.86±0.63	2.28±0.89	0.026*

* Significant Difference at $p \leq 0.05$.

TABLE 4. Histopathological Findings of re-epithelialization score of oral mucosal wound.

Parameters	Duration	Control (Normal tissue) Mean ± SD	Control positive Mean ± SD	<i>Aloe Vera</i> plant Mean ± SD	<i>Aloe Vera</i> gel Mean ± SD	P- Value
Re-epithelialization	3 rd day	0.00±0.00	0.10±0.12	0.52±0.82	1.47±0.70	0.021*
	7 th day	0.00±0.00	1.22±0.53	1.69±0.93	2.01±0.73	0.016*
	14 th day	0.00±0.00	1.88±0.38	2.77±0.43	3.07±0.34	0.006*

* Significant Difference at $p \leq 0.05$.

Discussion

The purpose of this study was to evaluate oral mucosal healing in rabbit models after using *Aloe Vera* plants and gels. Because rabbits are characterized by high availability, ease of handling and treatment, and habitation, a study model with rabbits has been implicated [15]. The three-day, one-week, and two-week healing intervals were selected based on the requirements of the assessment of oral mucosal healing, which is known for its rapid recovery potential [16], the current findings imply that *Aloe Vera* gel has a greater healing impact on oral mucosal wounds than *Aloe Vera* plants. Throughout all research time intervals, all oral mucosal specimens treated with *Aloe Vera* gel and plant had lower inflammatory cell infiltrate means than control specimens. These findings are consistent with those of Sánchez-Machado *et al.* [17], who claimed that *Aloe Vera* has the potential to inhibit inflammatory processes by reducing leukocyte adhesion and increasing their phagocytic and proliferative activity, a process mediated by *Aloe Vera* inhibition of COX-2 pathways.

Inflammation is a stage of the healing process in which cells produce substances that attract cells responsible for the subsequent stages of repair. According to Afshin *et al.* [18], the immune-modulatory activity of *Aloe Vera* gel was significantly higher than that of *Aloe Vera* plant and control positive specimens throughout all study time intervals, with a reduction in the number of migrating neutrophils and down regulation of the metalloproteinase-9, which reduced inflammation. *Aloe Vera* gel and plant inhibit inflammatory response by suppressing COX-2 pathway and arachidonic acid metabolites, which reduce prostaglandin E2 biosynthesis and nitric oxide (NO) production, resulting in inhibition of pro-inflammatory cytokines such as IL-6, IL-8, and tumor necrosis factor (TNF-) with abolishment of their genes involved in the early phase of acute inflammatory response. As a result, there is an early reduction in inflammation, which describes the current research findings during the first interval post-wounding, which showed significantly less inflammatory response in the oral mucosal *Aloe Vera* gel and plant group than in the control positive group [19]. According to the findings of the current study, *Aloe Vera* gel has a more favorable impact than *Aloe Vera* plant and has a positive control on the proliferative phase of the healing process in particular, by

boosting the quantity of granulation tissue generated. During the study's time intervals, *Aloe Vera* gel-treated oral mucosal specimens had larger granulation tissue amounts than the *Aloe Vera* plant and control groups [20]. The findings of granulation tissue development are consistent with those of Oryan *et al.* [21], who discovered that *Aloe Vera* gel treatment increased the pace and efficiency of fibroplasia more than *Aloe Vera* plant application, perhaps due to increased collagen and ECM glycosaminoglycans synthesis. The effect of the acetylated glucomannan; a mannose-rich polysaccharide presents in *Aloe Vera* gel; interacting with fibroblast receptors and stimulating cell activity and proliferation, which significantly increased the amount of deposited ECM glycosaminoglycans and collagen synthesis, and resultant accelerated collagen fibers polymerization and maturation lead to a higher number of fibroblasts and fibrocytes in *Aloe Vera* treated wounds. The current study found that granulation tissue formation was accelerated and promoted, which is supported by the findings of Atiba *et al.* [22], who found that *Aloe Vera* has growth-promoting effects and stimulates the proliferation of several cell types while also upregulating the expression of multiple growth factors such as VEGF and TGF- β more than the *Aloe Vera* plant.

The development of neo-vasculature for the repair of wounded tissue's circulatory system is a crucial series of events that begins with a process known as 'sprouting,' in which adhesion molecules such as PECAM-1 and others are responsible for endothelial cell orientation [23]. The neovascularization process has a distinct timing and shape pattern, with the vessels initially forming an inner ring of circularly organized vessels at the wound margin, followed by outside radially oriented vessels that supply the inner ones. The inner vascular ring regresses when the incision heals and closes, resulting in the vessel ring's full removal. The radially oriented vessels then gradually link, establishing a new vascular network [24]. The more central and peripheral blood vessels generated, the more active the angiogenic process is, and this unique pattern of neovascularization rationalizes and explains the current research angiogenesis scoring criteria [25].

The results of this study's angiogenic evaluation of oral mucosa indicate that *Aloe Vera* gel has a more beneficial effect on neovascularization than *Aloe Vera* plant, which is consistent with a previous study [26], They found that *Aloe Vera* gel treatment accelerates wound angiogenesis by

upregulating VEGF expression, as evidenced by a larger number of VEGF immunoreactive endothelial cells in the granulation tissue of *Aloe Vera* gel treated wounds compared to *Aloe Vera* plant and control wounds. The use of *Aloe Vera* gel improves and speeds up the wound healing response, including the epithelialization process, as evidenced by the current study's findings [27]. They noted better whole thickness wound healing and epithelialization process in particular due to increased fibroblast and keratinocyte proliferation and migration. Fibroblasts are the main cells in the proliferative phase, and they play a key role in the creation of the ECM, which serves as a framework for keratinocyte migration and proliferation. Greater mean values for *Aloe Vera* gel treated specimens during all study time intervals, indicating the favorable action of *Aloe Vera* gel on wound epithelialization process, which can be rationalized by accelerated epithelial migration rate and higher number of fibroblasts; indicating the favorable action of *Aloe Vera* gel on wound epithelialization process, which can be rationalized by accelerated epithelial migration rate and higher number of fibroblasts, Bioactive elements of *Aloe Vera* gel, primarily polysaccharides such as acemannan, glucomannan, mannose-6-phosphate, glycoprotein, and lectins, activate it. *Aloe Vera* gel polysaccharides increase fibroblast proliferation as well as hyaluronic acid and hydroxyproline synthesis, which improves ECM and healing speed [28]. The epithelialization results in this study are consistent with those reported by Burusapat *et al.* [29], who found a significantly greater epithelialization rate in *Aloe Vera* gel treated defects of split thickness skin graft donor sites. The use of medicinal plants in wound healing has medicinal and medical uses (30). The main reason for wound healing in herbal products is the presence of antioxidants and active herbal substances that have a therapeutic effect (31, 32).

Conclusion

The data of this study revealed that *Aloe Vera* plant and *Aloe Vera* gel has accelerate oral wound healing and the potential to be used as a wound-healing agent for the oral mucosal wound.

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Conflicts of interest

The authors declared no competing interests.

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References

1. Ramachandra, C. T., and Rao, P. S. Processing of Aloe vera leaf gel: a review. *American Journal of Agricultural and Biological Sciences*, **3**(2), 502-510 (2008).
2. Qamar, M. A., Shahid, S., Javed, M., Sher, M., Iqbal, S., Bahadur, A., and Li, D. Fabricated novel g-C₃N₄/Mn doped ZnO nanocomposite as highly active photocatalyst for the disinfection of pathogens and degradation of the organic pollutants from wastewater under sunlight radiations. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, **611**, 125863 (2021).
3. Brizuela, M., and Winters, R. Histology, Oral Mucosa. In *Stat Pearls [Internet]*. Stat Pearls Publishing (2021).
4. Rajab, A. A., Al-Wattar, W. T., and A Taqa, G. The Roles of Apigenin Cream on Wound Healing in Rabbits Model. *Journal of Applied Veterinary Sciences*, **7**(1), 1-5 (2022).
5. Taqa, G. A., and Albanna, S. S. Histological and Clinical Finding of Systemic Melatonin on Wound Healing after Tooth Extraction in Rabbits. *Journal of Applied Veterinary Sciences*, **7**(1), 18-23 (2022).
6. Mustafa, E. A., Al-Mashhadane, F. A., and Taqa, G. A. The Activity of Alcoholic Extract of *Urtica Urens* Against *Staphylococcus aureus* and Oral Wound Healing. *Journal of International Dental and Medical Research*, **13**(3), 957-963 (2020).
7. Hasan, L. A. Evaluation the properties of orthodontic adhesive incorporated with nano-hydroxyapatite particles. *The Saudi Dental Journal*, **33**(8), 1190-1196 (2021).
8. Taqa, G. A., Mustafa, E. A., and Al-Haliem, S. M. Evaluation of anti-bacterial and efficacy of plant extract (*Urticaurens*) on skin wound healing in rabbit. *International Journal of Enhanced Research in Science Technology & Engineering*, **3**(1), 64-70 (2014).
9. Ahirwar, R., and Tripathi, A. K. E-waste management: A review of recycling process, environmental and occupational health hazards, and potential solutions. *Environmental Nanotechnology, Monitoring & Management*, **15**, 100409 (2021).

10. Beriat, G. K., Akmansu, S. H., Ezerarslan, H., Dogan, C., Han, U., Saglam, M. and Kocaturk, S. The comparison of thermal tissue injuries caused by ultrasonic scalpel and electrocautery use in rabbit tongue tissue. *Bosnian Journal of Basic Medical Sciences*, **12**(3), 151 (2012).
11. Rani, R. U., Kumar, S. A., Kaliappan, S., Yeom, I. T., and Banu, J. R. Low temperature thermochemical pretreatment of dairy waste activated sludge for anaerobic digestion process. *Bioresource Technology*, **103**(1), 415-424 (2012).
12. Rahmoune, B., Morsli, A., Khelifi-Slaoui, M., Khelifi, L., Strueh, A., Erban, A. and van Dongen, J. T. Isolation and characterization of three new PGPR and their effects on the growth of Arabidopsis and Datura plants. *Journal of Plant Interactions*, **12**(1), 1-6 (2017).
13. Sultana, J., Molla, M. R., Kamal, M., Shahidullah, M., Begum, F., and Bashar, M. A. Histological differences in wound healing in maxillofacial region in patients with or without risk factors. *Bangladesh Journal of Pathology*; **24**(1), 3-8 (2009).
14. Gupta, A., and Kumar, P. Assessment of the histological state of the healing wound. *Plastic and Aesthetic Research*; **2**, 239-242 (2015).
15. Guo, Y., Xu, Q., Canzio, D., Shou, J., Li, J., Gorkin, D.U. and Wu, Q. CRISPR inversion of CTCF sites alters genome topology and enhancer/promoter function. *Cell*, **162**(4), 900-910 (2015).
16. Groeger, S., and Meyle, J. Oral mucosal epithelial cells. *Frontiers in Immunology*, **10**, 208, pages 1-22 (2019). doi: 10.3389/fimmu.2019.00208
17. Sánchez-Machado, D.I., López-Cervantes, J., Sendón, R., and Sanches-Silva, A. Aloe vera: Ancient knowledge with new frontiers. *Trends in Food Science & Technology*, **61**, 94-102 (2017).
18. Afshin, A., Sur, P.J., Fay, K.A., Cornaby, L., Ferrara, G., Salama, J.S. and Murray, C. J. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, **393**(10184), 1958-1972 (2019).
19. Reyes-Avalos, M.C., Minjares-Fuentes, R., Femenia, A., Contreras-Esquivel, J.C., Quintero-Ramos, A., Esparza-Rivera, J.R., and Meza-Velázquez, J.A. Application of an alginate-chitosan edible film on figs (*Ficus carica*): Effect on bioactive compounds and antioxidant capacity. *Food and Bioprocess Technology*, **12**(3), 499-511 (2019).
20. Iglesias-Bartolome, R., Uchiyama, A., Molinolo, A. A., Abusleme, L., Brooks, S. R., Callejas-Valera, J. L. and Morasso, M. I. Transcriptional signature primes human oral mucosa for rapid wound healing. *Science Translational Medicine*, **10**(451), eaap8798 (2018).
21. Oryan, A., Alemzadeh, E., and Moshiri, A. Biological properties and therapeutic activities of honey in wound healing: A narrative review and meta-analysis. *Journal of Tissue Viability*, **25**(2), 98-118 (2016).
22. Atiba, A., Nishimura, M., Kakinuma, S., Hiraoka, T., Goryo, M., Shimada, Y. and Uzuka, Y. Aloe vera oral administration accelerates acute radiation-delayed wound healing by stimulating transforming growth factor- β and fibroblast growth factor production. *The American Journal of Surgery*, **201**(6), 809-818 (2011).
23. Enoch, S., and Leaper, D. J. Basic science of wound healing. *Surgery (Oxford)*, **26**(2), 31-37 (2008).
24. Reinke, J. M., and Sorg, H. Wound repair and regeneration. *European Surgical Research*, **49**(1), 35-43 (2012).
25. Eming, S. A., Martin, P., and Tomic-Canic, M. Wound repair and regeneration: mechanisms, signaling, and translation. *Science Translational Medicine*, **6**(265), 265sr6-265sr6 (2014).
26. Atiba, A., Nishimura, M., Kakinuma, S., Hiraoka, T., Goryo, M., Shimada, Y. and Uzuka, Y. Aloe vera oral administration accelerates acute radiation-delayed wound healing by stimulating transforming growth factor- β and fibroblast growth factor production. *The American Journal of Surgery*, **201**(6), 809-818 (2011).
27. Asbari, M., Hidayat, D. D., and Purwanto, A. Managing Employee Performance: From Leadership to Readiness for Change. *International Journal of Social and Management Studies*, **2**(1), 74-85 (2021).

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28. Rajab, A. M., Taqa, G. A., and T Al-Wattar, W. The Effect of Topically Applied Hyaluronic Acid on Skin Wound Healing in Rabbits. *Journal of Applied Veterinary Sciences*, **7**(1), 38-45 (2022).
 29. Burusapat, C., Supawan, M., Pruksapong, C., Pitiseree, A., and Suwantemee, C. Topical Aloe vera gel for accelerated wound healing of split-thickness skin graft donor sites: A double-blind, randomized, controlled trial and systematic review. *Plastic and Reconstructive Surgery*, **142**(1), 217-226 (2018).
 30. Abbasi, N., Ghaneialvar, H., Saneei, S., Zangeneh, M.M. and Zangeneh, A. Assessment of the wound healing property of aqueous extract of *Stevia rebaudiana*: An ethno medicinal plant. *Plant Biotechnol. Persa.*, **3** (1), 9-17(2021).
 31. Urainab, S., Mehreen, A. and Zahid, S. Essential Oils Have the Potential to Be Effective Therapeutic Agents In The Future. *Plant Biotechnol. Persa.*, **4** (1), 18-24 (2022).
 32. Mashabela, N.M. and Otang-Mbeng, W. Evaluating the effect of fertilizers on physiological growth, chemical, bioactive components and secondary metabolites in *Vigna unguiculata* (L.). *Plant Biotechnol. Persa.*, **4** (1), 37-49(2022).

آثار نبات وهلام الصبار على التئام الجروح المخاطية الفموية في الأرانب (دراسة نسيجية) : آثار نبات وهلام الصبار على التئام الجروح المخاطية الفموية في الأرانب

Running title

آثار نبات وهلام الصبار على التئام الجروح المخاطية الفموية في الأرانب (دراسة نسيجية)

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الخلفية : الصبار نبات مفيد مليء بالفيتامينات والمعادن مع تطبيقات واسعة في الصحة والطب والعناية بالبشرة. تهدف الدراسة: الى معرفة كيفية تأثير هلام الصبار على التركيب النسيجي لأفة الغشاء المخاطي للحم (الشدق) للذكور الارانب البالغين بعد حرقها. استخدمت الدراسة الحالية ٤٨ من ذكور الأرانب النيوزيلندية. تم إعطاء الكيتامين و زيلازين كحقنة عضلية في عضلة فخذ الأرنب. و قد تم الحصول على التخدير الكامل في غضون ٥ دقائق. تم وضع الحيوانات على طاولة العمليات ثم تم إجراء العملية عن طريق استخدام قلم الكي الكهربائي أحادي القطب مع قطب شفرة قياسي مقاس ٢,٥ بوصة عند ٩٥,٥ درجة مئوية لحرق ٠,٥ سم من خد الغشاء المخاطي للحم للأرانب. بعد ذلك تم تقسيم هذه الأرانب عشوائيا إلى أربع مجموعات (12 أرنبًا لكل مجموعة): المجموعة الأولى هي المجموعة الضابطة (الغشاء المخاطي الطبيعي للحم بدون حرق) (ن = 12) ، المجموعة الثانية هي المجموعة الإيجابية الضابطة (حرق الغشاء المخاطي للحم بدون دواء) (ن = 12) ، المجموعة الثالثة هي مجموعة نبات الصبار (ن = 12) والمجموعة الرابعة هي مجموعة هلام الصبار (ن = 12) و قد تم تقسيم كل مجموعة وفقا لفترة العلاج إلى (٣ ، ٧ ، ١٤ يوما) ثم تم التضحية ب 12 أرنبًا لكل فترة علاج . تم استئصال الأنسجة الشدقية لهذه الأرانب للاختبار النسيجي ثم تم إجراء دراسة إجراء التحليل الإحصائي لها . لقد أظهرت النتائج ان موقع الحرق في أنسجة الشدق المعالجة من نبات الألويفيرا يتميز بتسلل الخلايا الالتهابية الطفيفة والأنسجة الحبيبية وتولد الأوعية الدموية وإعادة الظهارة، في حين أظهر هلام الصبار المعالج لأنسجة الشدق أن موقع الحرق يتميز بالأنسجة الحبيبية وتولد الأوعية وإعادة الظهارة، دون تسلل الخلايا الالتهابية. لقد استنتجنا من هذه الدراسة أن نبات وهلام الصبار لهما تأثيرا شافيا على جرح الغشاء المخاطي للحم بعد الحرق وأن هلام الصبار كان أكثر فعالية في التئام الجروح من نبات الصبار

الكلمات المفتاحية: الصبار ، الغشاء المخاطي للحم ، التئام الجروح ، حرق الغشاء المخاطي للحم.