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Review Article

The Effect of the Stem Bark of Khaya senegalensis on Wound Healing in Rabbits: A Preliminary Study

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Abstract

Background: This experimental study was carried out to investigate the effect of powdered bark of Khaya senegalensis on wound healing in rabbits.
Method: A total of eight rabbits were grouped into two groups: 1 and 2. Square wounds were made at the lumbar area of each rabbit by removing the skin to expose the fascia covering the lumbar muscles each wound was measured and to the wound of the experimental group (Group 1), approximately 0.75g (1.5ml) of the stem bark was spread over the wounded region in paste form. Nothing was applied to the wound of the control animals. All the eight wounds were measured using a vernier caliper and tracing paper for 21days. Later on, the wound areas were estimated by using fine graph paper by counting the number of square millimeters within the traced areas.
Results: The information obtained was analyzed graphically and the wound healing curve showed that wound closure in the experimental group was more rapid compared to the control group (Group 2).
Conclusion: It was concluded that the stem bark used in this experiment may play a role in wound healing by accelerating wound closure. However, further analysis of the stem bark is required before any extrapolations of its effect on human wound healing is made.

Keywords: *Khaya senegalensis, Wound Healing, Cutaneous Wounds, Medicinal Plants, Rabbits*

Introduction

Medicinal plants represent one of essential sources of therapeutic care in many parts of Africa, including Nigeria.
The use of plants and herbs for medicinal purposes is also spread over all the world. The reason for the high dependence on these medicinal plants could be due to the availability of these vegetation, especially in rural areas where drugs and health care are not readily accessible or available to majority of the people in that locale, their low expenses compared to synthetic drugs also, the appearance of various adverse effects of synthetic chemical medication [1]. The therapeutic value of Khaya senegalensis has been recognized in different systems of traditional medicine for the treatment of various conditions [2]. The decoction of the stem bark of the extract is commonly used for the treatment of jaundice, dermatoses, malaria, fever, mucous diarrhea, venereal diseases as well as hook worm infection [2, 3] In Sudan in folk medicine watery maceration of the bark of *Khaya senegalensis* is used in treatment of malaria, hepatitis, dysentery and sinusitis. Also leaves of plants were used to treat dermatological disorders, abdominal diseases, malaria and trachoma [1]. Khaya

senegalensis extracts have been reported to having anti-inflammatory, antibacterial, antihelminthic, anti-tumor, anti-oxidant and antiplasmodial activities [1] Khaya senegalensis is used in Cote d'Ivoire as an ingredient in arrow poison. Bark scales are sometimes used as a fish poison. The bark is bitter and has a considerable reputation in its use for treatment of fever. The bark is also used to treat syphilis as well as a vermifuge, taenicide and a depurative. The bark extract is used as a remedy for jaundice, dermatoses, scorpion bite, infection of the gums, hookworm, bleeding wounds (disinfectant), allergies and as a laxative. Khaya senegalensis seeds and leaves are used for treating fever, headache; its roots are used as cure for sterility, for the treatment of mental illness, syphilis, leprosy and also as an aphrodisiac. The crushed bark and seeds are utilized to stimulate blood flow to the pelvic region, hence causing menstruation. Bark also used in traditional veterinary practice, for cattle suffering from liver fluke, for treating ulcers in camels, donkeys and horses, and in horses for internal diseases associated with mucous diarrhea [7]. Despite the extensive research undertaken on the stem bark extract of Khaya senegalensis, there has been little documented studies on its effect on wound healing. This preliminary investigation was undertaken to investigate the effect of Khaya senegalensis on cutaneous wound healing.

Wound is a collective term describing conditions in which there is a disruption/interruption or damage to the structural integrity of the epithelial and/or the underlying tissues [4]. It includes abrasions, abscesses, bites, burns, blisters, boils, bruises (contusions), clean cuts (incisions), fractures, injuries, skin lesions, sores and ulcers [5]. Wound healing involves a complex process involving hemostasis, inflammation, angiogenesis and eventual regeneration of the skin [6]. The process of wound healing seeks to restore the anatomical continuity of disrupted tissue. Wound healing comprises of many stages including coagulation of blood formed in the wound area, inflammation, formulation of granulation tissue, matrix formation, remodeling of connective tissue, deposition of collagen fibers as well as wound strength acquisition phase [12].

Materials and methods

Eight healthy rabbits weighing 1.2-1.4kg were obtained from a local breeder. They were housed in the animal house, University of Maiduguri and fed with vegetables and water ad libitum. They were then sorted into two groups, namely groups 1 and 2, Group 1 being the experimental group and Group 2 being the control group. The rabbits were allowed to acclimatize for the period of two weeks before the investigation began.

Pre-operative Procedures

Magnesium Sulfate (50mg/kg) was used as anesthesia. It was prepared by dissolving 20g in enough distilled water to make 100ml in a process described by Lumb and Jones [1]. This was administered as an intramuscular injection. Ketamine hydrochloride (7.5mg/kg) was administered as an alternative to anesthesia in some of the rabbits. Procaine penicillin was used as an antibiotic against infection. These were all administered through the intramuscular route.

The bark of Khaya senegalensis was harvested and sun-dried. The dried stem bark was then pounded and passed through a sieve to obtain a fine powder. The bark powder was then made into a paste by dissolving 5g in 10ml of distilled water. A new paste was prepared every other day to ensure maximum freshness.

Operative Procedures

The operative procedure used for this experiment was previously described by Kennedy and Cliff [8] and used by Mawera *et. al*, [9], Attah *et. al*, [10] The experimental procedure was supervised by a qualified expert. The lumbar region was chosen as the most suitable region for this procedure because it was the least disturbed area in any posture the rabbit adopted, also, the lumbar region was uniformly flat, thus facilitating easy measurement after the surgery. Fur from the lumbar area of each rabbit was shaved using a pair of blunt scissors and a skin incision extending to the superficial fascia was made. The skin of the marked area was removed by a pair of forceps and sharp scissors. Gauze bandages were applied to the wound to stop blood flow and the wound area was measured and recorded. The animals were then kept in separate cages to avoid additional injury to the wound area by claws of other rabbits. The feeding of the rabbits continued with vegetables and water.

Post-operative Procedures

Approximately 1.5ml (0.75g) of paste was applied to the wound of the experimental animals. This treatment continued until the third day, post-surgery day (PSD 3) when a thick granulation tissue was formed atop the wound area of group 1 animals, thereby inhibiting the entry of the paste into the wound. The paste was then further thinned as a new mixture was prepared by adding 5g of bark powder to 20ml distilled water. This was then applied to the wound area of experimental animals. Nothing was added to the wound areas of the animals in the control group. The wound size of each animal was measured and recorded daily for 21 days using a vernier caliper, the wound areas were also traced out using tracing paper after the granulation tissue peeled off the wound are in both groups. The wound areas were estimated with the aid of fine graph paper by counting the number of squares in the traced areas which represented the wound boundaries. Photographs of the wounded region were taken at various stages during the course of the experiment. The estimated wound areas obtained were then represented graphically.

Results

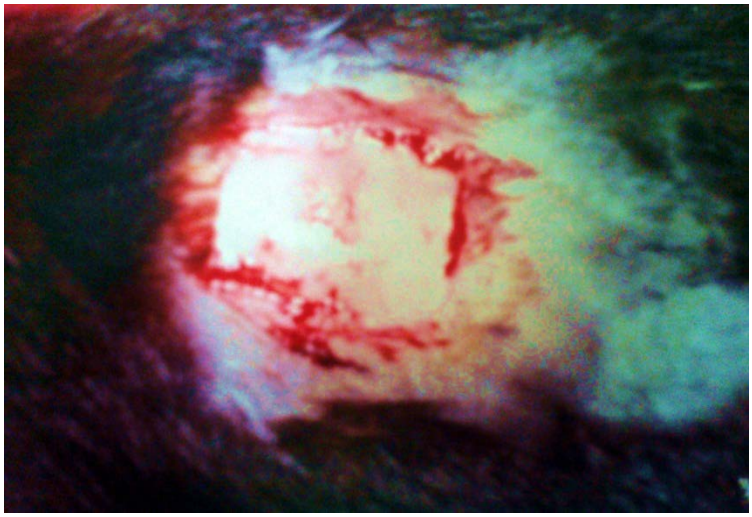


Figure 1: wound on the lumbar region a few minutes after the operation

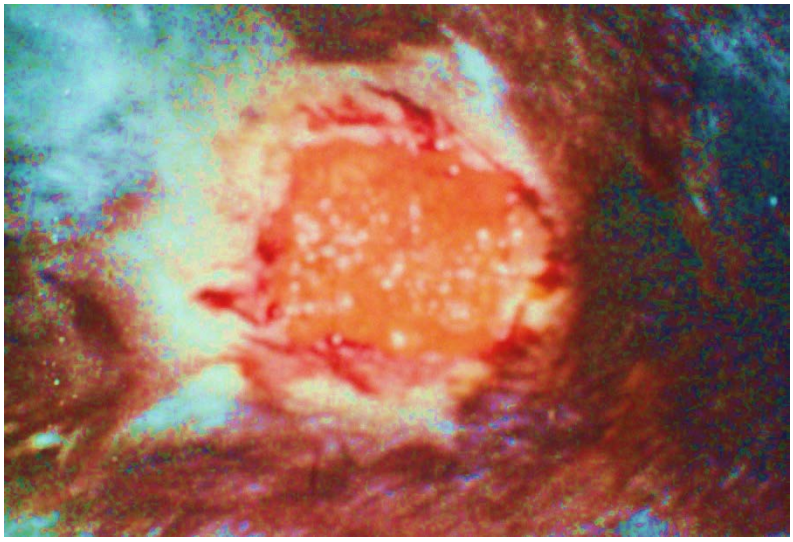


Figure 2: experimental animal with applied paste

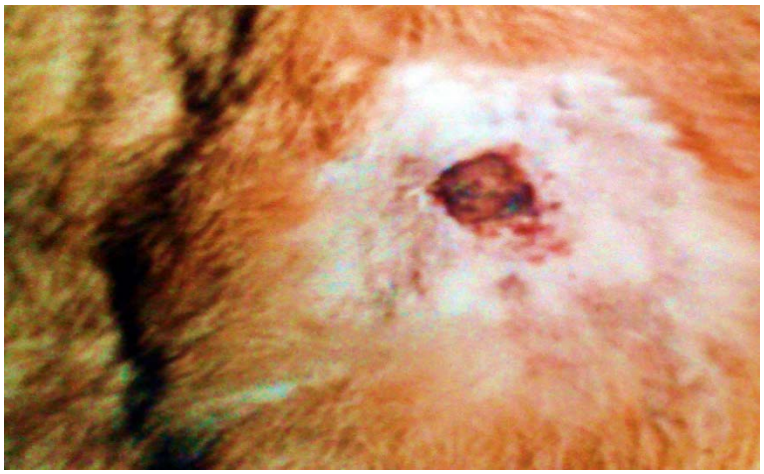


Figure 3: wound of the experimental animal on day 20

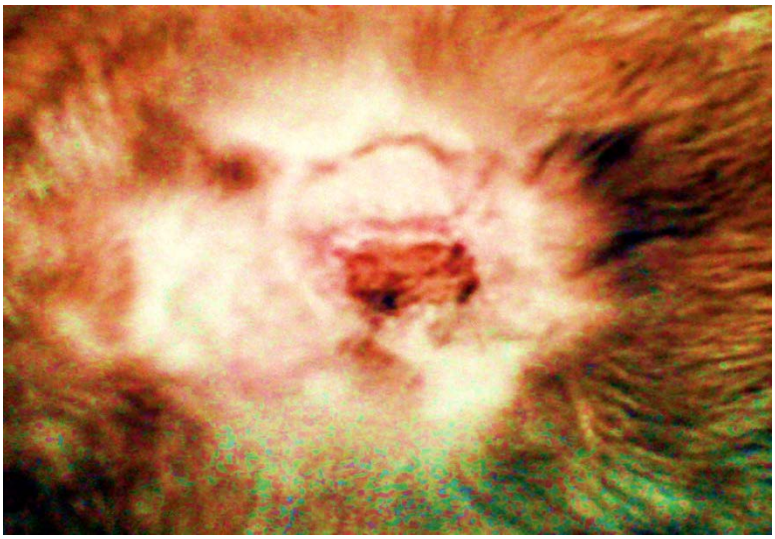
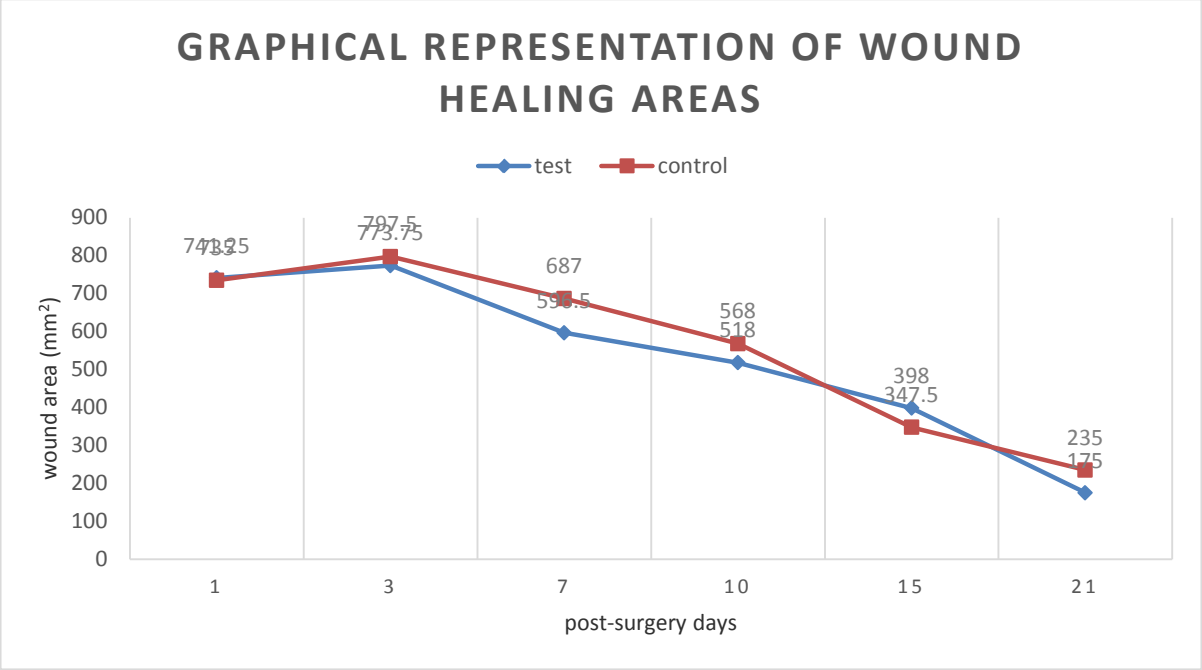


Figure 4: wound of the control animal on day 20

Table 1: wound sizes in the days following the surgery.

Post-surgery days	Test animals (mm^2)	Control animals (mm^2)
1	741.25	735
3	773.75	797.5
7	596.5	687.5
10	518	568
15	398	347

21	175	235



Discussion

Wound healing is determined by wound closure which is estimated by the rate at which the wound decreases with time. The wound area in both animals showed an increase in surface area and this can be observed as a spike on the graph on post-surgery days 1-3, this could be attributed to the contractile action of the underlying muscles which pulls on the attached skin, thus widening the wound surface and boundaries. This is in accordance with the research studies undertaken by Mawera [9] and Attah [10] and also in accordance with Slatter [11] who stated that when a full thickness of skin is lost, the wound edges initially retracts thus enlarging the wound. From the second to the fifth day, the wound areas in both groups showed progressive decrease in size, although on the test animals, the wound healing curve showed a steeper decline compared with the curve for control animals. This is also observed on post- surgery days 10-15. The rapid closure of wounds treated with Khaya senegalensis could be due to its anti-inflammatory effect [1], thus, facilitating rapid wound closure.

The wounds in the test animals also developed granulation tissue which formed a tough covering over the wound and may have enhanced rapid wound closure by contracting the flaps of skin bordering the wound, thus pulling them together. Furthermore, the granulation tissue sealed the wound completely, hence protecting the wound from invading pathogens and enhancing healing. The absence of a thickened granulation tissue in the control animals may had subjected the wound to stress in form of muscular contractions, which may had interfered with wound closure, which may account for the difference in the wound healing curves in both groups on post-surgery days 5-10.

In post-surgery days 15-21, there was a great reduction in both wound areas, although the wound area in the control group showed closure at this period, the wound size in the test group measured 175mm^2 (compared to 235mm^2 in the control group). This experimental study shows that Khaya senegalensis plays a role in rapid wound closure especially in the few days following surgery, however, this study does not demonstrate the significant healing effect of the stem bark of Khaya senegalensis and its effect on the epidermis and dermis. Further study and full biochemical and pharmacological research are required to analyze and expound the active substances in the stem bark paste that enhances wound closure.

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