Regular articles

Antibacterial and surgical wound healing properties of ethanolic leaf extracts of Swietenia mahogoni and Carapa procera

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Abstract

Different concentrations of ethanolic extracts of Swietenia mahogoni and Carapa procera leaves were evaluated for antibacterial activity against Staphylococcus aureus ATCC25923, Escherichia coli ATCC 25922, and Pseudomonas aeruginosa ATCC 27853 using the agar well diffusion method. The extracts were also investigated for wound healing properties in white albino rats using the full thickness skin excision wound model. Twenty eight Sprague Dawley adult rats of both sexes were randomly divided into four groups. Animals in the test group were treated topically with 0.2ml of 20 mg/ml of the extract for 11 days post-surgery. The positive and negative control groups were treated with cicatrin ® powder (neomycin and bacitracin) and sterile distilled water respectively. The minimum concentrations of the extracts that inhibited the growth of S. aureus and E. coli were 5 mg/ml & 10 mg/ml; and 2.5 mg/ml & 5 mg/ml for S. mahogoni and C. procera respectively. The extracts at the concentration of 20mg/ml did not inhibit growth of P. aeruginosa. On day 4 post-surgery, there were significant differences (P<0.05) in the mean percentage wound healing between groups treated with the extracts and sterile water. It was concluded that the ethanolic leaf extracts of S. mahogoni and C. procera have antibacterial and wound healing properties.

Key words: Swietenia mahogoni; Carapa procera; antibacterial; healing.

1. Introduction

The use of medicinal plants to treat illnesses is as old as man [1, 2]. Nigerian folklore contains, several medicinal plants used in the treatment of various ailments or diseases. These include those used for the treatment of wound, ulcers, and infections caused by microorganisms. Many plants have been studied worldwide and shown to possess antibacterial and wound healing activities [2, 3]. These properties are enhanced by the presence of active principles mostly steroids, saponins, tannins and glycosides [4].
Swietenia mahogoni a tropical tree belongs to the family meliaceae and the superfamily swietenioideae. It is widespread in the tropics and has ethnomedical uses [5]. It is documented that S. mahogoni is used as an astringent, abortifacient and antiseptics [4]. It is also reported to be used in the treatment of diarrhea, malaria, fever and tuberculosis [4]. The seed oil of S. mahogoni has been reported to have antimicrobial activity [6].

Carapa procera is a member of the family meliaceae and is commonly called African Carbwood [7] although it is also called Monkey cola. C. procera has been studied and has been shown that the seed contains fat that is used on the skin and hair [8]. Among other traditional uses, it has also been reported to be used to treat wounds and other injuries [5, 9].

Following widespread use of antibiotics, antibacterial resistance among bacteria has appeared making it necessary to have access to an alternative antibacterial agent to obtain an antibacterial effect [9]. The presence of bacteria in a wound does not necessarily indicate that infection had occurred or lead to impairment of wound healing. However, the increased bacterial load can lead to reduced healing or no healing at all [2, 10, 11]. Currently, efforts are being made to evaluate the antibacterial and wound healing properties of S. mahogoni and C. procera.

2. Materials and methods

2.1. Plant materials

Fresh leaves of Swietenia mahogoni and Carapa procera were collected between April and June from Abak Itenge, Abak Local government of Akwa Ibom State, Nigeria. The plants were identified by Mr Ugwu, P. O. of the Department of Botany, University of Nigeria, Nsukka, where voucher specimens were deposited.

2.2. Extraction

The leaves of S. mahogoni and Carapa procera were dried under room temperature, then pulverised in the Department of Crop Science, University of Nigeria. Following this, 1000 g and 500 g of the pulverized plants were placed in bottles containing 3540 ml and 2470 ml of analytical ethanol, respectively. These were then vigorously shaken and left for 48hrs to allow efficient extraction. The shaking was repeated each day and the extracts were then passed through Whatman filter papers. The filtrates were evaporated at 40 °C and yields of 84.11 g of S. mahogoni and 58.80 g of C. procera were obtained. The extracts were then stored in a refrigerator at 4 °C.

2.3. Animals

Twenty eight Sprague Dawley rats of both sexes weighing between 100-225g were used for this study. They were obtained from the zoological garden of the Zoology Department, University of Nigeria, Nsukka and then kept in the animal house of the Department of Veterinary Parasitology and Entomology, University of Nigeria, Nsukka, where they were allowed to acclimatize for two weeks. They were fed standard rat ration [(Grower’s mash) Vital feed®, Bukuru, Jos] and fresh water ad libitum.

2.4. Screening for antibacterial activity

Extracts were screened for antibacterial activity against Staphylococcus aureus ATCC25923 (American Type Culture Collection, Virginia), Escherichia coli ATCC25922, and Pseudomonas aeruginosa ATCC27853. Different concentrations of the extracts were screened for antibacterial activity using the agar well diffusion method as described by Adeniyi et al [12]. The concentrations of the extracts used were 20 mg/ml, 10 mg/ml, 5 mg/ml, 2.5 mg/ml and 1.25 mg/ml. Following incubation at 37 °C for 24 hrs, the inhibition zone diameters (IZD)
induced by the different concentrations of extracts were measured using a meter rule. Each screening was carried out in triplicate and the mean IZD was recorded to the nearest millimetre.

2.5. Screening for wound healing

The animals were divided into four groups, with seven animals per group. Group 1 and II were the test groups, while III and IV were positive and negative control groups, respectively. Each rat was anaesthetized with chloroform and the hair on the skin of the back was clipped. Following disinfection of the clipped area with 2% detol® solution, a full thickness circular skin incision of about 20 mm in diameter was made and carefully dissected out. The wound surface area was immediately measured by placing a transparent tracing paper over the wound and tracing its outline. The tracing paper was placed on a 1 mm² graph sheet and traced. The squares were counted and the area recorded in mm².

*Staphylococcus aureus* ATCC 25923 standardized to contain approximately $1.3 \times 10^8$ cfu/ml (0.5 Macfarland standard) was used to contaminate the wound site of all the experimental animals shortly after the wound was created.

Group I: test animals were treated with 0.2 ml of 20 mg/ml aqueous extract of *S. mahogoni* topically once daily for 11 days.

Group II: test animals were treated with 0.2 ml of 20 mg/ml aqueous extract of *C. procera* topically once daily for 11 days.

Group III: the positive control was treated with cicatrin® powder (neomycin and bacitracin) once daily for 11 days.

Group IV: the negative control was treated with sterile distilled water once daily for 11 days.

The wound area of each animal was measured under light chloroform anaesthesia on the 1st, 4th, 7th, 10th, 14th and 17th day post surgery. The percentage wound healing on these days was determined. Physical changes in the wound surface were evaluated for each group of animals.

2.6. Analysis of data

The data were statistically analysed using one-way analysis of variance (ANOVA) and significant means were separated by Least Significant Difference (LSD). The level of statistical significance was taken as $P = 0.05$.

3. Results

Extracts showed concentration-dependent activity against the test organisms. The highest activities were recorded at higher concentrations of the extracts. *Swietenia mahogoni* and *Carapa procera* extracts at a concentration of 1.25 mg/ml exhibited no antibacterial activity against all the test bacteria. The extract of *C. procera* at the concentration of 2.5 mg/ml also exhibited no antibacterial activity against the test bacteria. The extracts of both plants exhibited no activity against *Pseudomonas aeruginosa* even at a concentration of 20 mg/ml.

3.1. Effect of plant extracts on wound healing

There was an obvious reduction in the wound area throughout the experimental period in all the groups for both extracts. For *Swietenia mahogoni*, *Carapa procera* and the antibiotic-treated group, a sharp reduction in wound area was observed between the 1st and 7th day post-surgery, while a gradual reduction in the wound area was recorded between day 7 and 17 post-surgery. The group treated with distilled water showed a less dramatic change in wound area during the first seven days and later matched that of the extract-treated groups.
These results are shown in Table 2.

Although the reduction in the surface areas of the surgical wounds induced by extracts of *Swietenia mahogoni*, *carapa procera*, as well as the antibiotics, was initially rapid, the mean percentage wound healing was not significantly different ($P>0.05$) from the healing percentages in the water-treated group on post-surgery day 17. On day 4 post-surgery, the percentage healing in the water-treated group was significantly ($P<0.05$) lower than that in the *S. mahogoni*-, *C. procera*- and antibiotic-treated groups.

There was no weal formation on day 1 post surgery in the cicatrin®-treated group. The wound surfaces of some of the animals in the water-treated group were wet and, by day 7, a swab culture of the wound showed the presence of *S. aureus*. On day 10 post-surgery, the wound surfaces of the water-treated group were normal just like those of the other groups.

### 4. Discussion

The phytochemical constituents of plant extracts are known to be responsible for their therapeutic properties. Alkaloids, glycosides, flavanoids, tannins, terpenes, and saponins contained in the studied plants are responsible for their antibacterial properties whereas proteins, carbohydrates and reducing sugars provide essential nutrients that promote wound healing [13, 14].

From Table 1, it can be seen that the ethanolic extracts of *Swietenia mahogoni* and *Carapa procera* exhibited activity against two of the three tested organisms. The highest activity was recorded at higher concentrations. None of the extract concentrations inhibited *Pseudomonas auriginosa*.

<table>
<thead>
<tr>
<th>Extract</th>
<th>Typed organisms</th>
<th>20 mg/ml</th>
<th>10 mg/ml</th>
<th>5 mg/ml</th>
<th>2.5 mg/ml</th>
<th>1.25 mg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Swietenia mahogoni</em></td>
<td><em>Escherichia coli</em> ATCC 25922</td>
<td>17</td>
<td>16</td>
<td>13</td>
<td>10</td>
<td>-</td>
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<tr>
<td></td>
<td><em>Staphylococcus aureus</em> ATCC 25923</td>
<td>28</td>
<td>20</td>
<td>15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><em>Pseudomonas auriginosa</em> ATCC 27853</td>
<td>-</td>
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</tr>
<tr>
<td><em>Carapa procera</em></td>
<td><em>Escherichia coli</em> ATCC 25922</td>
<td>17</td>
<td>14</td>
<td>12</td>
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<tr>
<td></td>
<td><em>Staphylococcus aureus</em> ATCC 25923</td>
<td>18</td>
<td>14</td>
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<td><em>Pseudomonas auriginosa</em> ATCC 27853</td>
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</table>

The antibacterial activities of the leaf extracts of *S. mahogoni* and *C. procera* may be the reason why they are widely used in folk medicine [4, 5].

The results in Table 2 show a daily reduction in the mean wound surface area from the 1st to 17th day post-surgery, especially in the extract- and cicatrin®-treated groups. These changes were clearly seen from day 7 post-surgery and then subsequently there seemed to be equal response to different treatments. Normally, no visible wound contraction is seen until 5 to 9 days after injury [15]. The timing of the topical antimicrobials is critical and the maximum effect is often achieved soon after injury [16]. This largely explains why, although it is not common to have visible wound contractions within 1 to 5 days post surgery, *S. mahogoni*, *C. procera*, and cicatrin® treatments may have triggered early contractions of the wound, hence accounting for the difference. By day 17 post-surgery, the four treatment groups
exhibited almost the same percentage wound healing and differences were clear between the 1st to 7th day (by post-surgery day 4 & 7 the percentage healing produced by the leaf extracts of *S. mahogoni*, *C. procera*, and cicatrin®-treated groups was 13.2% and 34.7%; 14.2% and 36.7%, 13.99% and 41.64% respectively, clearly demonstrating their efficacy in enhancing wound healing when compared with the water-treated group with a value of 6.76% and 30% on the respective days). The attainment of an equal rate of healing by all the groups from post-surgery days 10 to 17 is probably due to the excellent health of the experimental animals and their probably high immune responses. Again, the albino rats were young adults, and they continued to grow rapidly with a probably high metabolic rate and this may have contributed to some of the above observations [9, 17].

To further support the wound healing efficacy of *S. mahogoni* and *C. procera*, on day 9, the wound surfaces of some animals in the sterile water-treated group were seen to exhibit slight creamy exudation. This was cultured, isolated and identified as *Staphylococcus aureus*. These organisms are among the most important bacteria that cause disease in humans and animals. They are also normally found in the skin [16]. However, this *Staphylococcus* organism may also be the organism that contaminates the wound surface of the animals. This was not the case in the extract- and cicatrin®-treated groups. This probably explains why *S. mahogoni*, *C. procera*, as well as cicatrin®-treatments exhibited a higher level of healing than the negative control.

In the first day, no weal formation was observed in the cicatrin®-treated group and, by day 4 post surgery, the wound surfaces of most of the animals in the sterile water-treated group were only slightly dry while those in the extract- and cicatrin®-treatment groups were completely dry. Although scab and scar tissues formation were observed in all the groups, the time of formation and its nature also varied. The rats did not exhibit any reaction to the plant extracts showing that their application caused no irritation or pain.

The result of the present study show that ethanolic leaf extracts of *Swietenia mahogoni* and *Carapa procera* exhibit marked growth inhibitory activity against *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923. *S mahogoni* and *C. procera* also exhibit wound healing properties

### References


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