

# The effectiveness of wound cleansing using *Cocor Bebek* (*Kalanchoe pinnata*) leaves in healing diabetic foot ulcers

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## Abstract

This study aimed to evaluate the effectiveness of *Cocor Bebek* (*Kalanchoe pinnata*) leaves in wound cleaning for diabetic foot ulcers (DFU) and compare it with the use of NaCl solution. Diabetes mellitus (DM) and its complications, such as DFU, pose a global health problem with increasing prevalence. Given the

escalating occurrence of DFU, timely and effective treatment is crucial to prevent severe complications, including amputation. This research employed a quasi-experimental design with a pretest-posttest control group and was conducted at Rumah Luka Surabaya, Indonesia. The sample comprised 40 respondents with DFU, divided into an intervention group (using *Cocor Bebek* leaves) and a control group (using NaCl solution). Respondents' characteristics, including age, sex, occupation, duration of diabetes, and other factors, were assessed to understand their impact on the response to treatment. The results demonstrated a significant improvement in DFU wound healing in the intervention group after using *Cocor Bebek* leaves ( $p < 0.05$ ), along with reduced scores on Bates Jensen Wound Assessment Tool (BWAT) indicators such as wound edge, tunnel, and necrotic tissue type. Conversely, the control group using NaCl solution also exhibited significant improvement in wound healing ( $p < 0.05$ ), with decreased scores on indicators such as the amount of necrotic tissue and the quantity of exudate. This study underscores the potential of *Cocor Bebek* leaves in aiding wound healing in DFU, evident from clinical improvements and reduced BWAT scores. However, further research and clinical trials are needed to comprehensively support these findings and understand the mechanism of action, as well as the safety of using *Cocor Bebek* leaves in diabetic patients.

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## Introduction

Diabetes Mellitus (DM) has emerged as a significant global health challenge, marked by an increasing prevalence rate.<sup>1</sup> A consequential complication of diabetes is the occurrence of Diabetic Foot Ulcers (DFU), which has become a pressing global health concern, affecting regions such as Asia, ASEAN, and Indonesia.<sup>2</sup> As the number of individuals diagnosed with diabetes continues to rise, the prevalence of diabetic foot ulcers is escalating, posing substantial health implications globally and regionally.<sup>3</sup> Notably, 80% of cases with Diabetes Mellitus develop DFU complications, leading to leg amputation in severe instances.<sup>4,5</sup> Approximately 14-24% of diabetic foot patients eventually require amputation, with 75% of individuals with diabetes experiencing foot problems.<sup>5-8</sup>

Among the diabetic population, 44% undergo relatively expensive and prolonged diabetic wound treatment, as highlighted by Perkeni.<sup>6</sup> The mortality rate due to diabetic ulcers reaches 17-23% post-amputation, with a one-year mortality rate of 14.8%, escalating to 37% three years after amputation.<sup>7</sup> Diabetic foot ulcers exhibit a prolonged healing process compared to non-diabetic wounds due to their chronic nature.<sup>9</sup> Chronic wound conditions can result in persistent tissue damage and, ultimately, amputation if infections are not treated properly.<sup>10,11</sup>

Wound cleansing, a crucial aspect of both acute and chronic

wound care, involves the use of cleaning fluids selected based on their effectiveness and lack of cytotoxicity.<sup>12,13</sup> Despite a spectrum of treatment approaches for DFU, the negative consequences of inadequate or delayed intervention persist.<sup>14</sup> Infections pose a significant risk, exacerbating wound conditions and potentially leading to severe complications, including the necessity for amputation.<sup>15</sup> Consequently, the importance of effective and timely treatment cannot be overstated in preventing complications that jeopardize the limbs of individuals with diabetes.<sup>14,16</sup>

One alternative avenue for wound cleansing involves the use of *Cocor Bebek* Leaves (*Kalanchoe pinnata*) as a natural substitute. Although these leaves exhibit considerable potential as an herbal component for cleansing diabetic foot ulcers (DFU), their utilization remains limited. Despite being readily available and cost-effective for DFU sufferers, *Cocor Bebek* leaves (*Kalanchoe pinnata*) are not yet commonly employed in DFU wound cleaning procedures. Recognizing the need for more natural and effective treatment options for DFU, there is a growing interest in exploring the healing potential of *Cocor Bebek* Leaf (*Kalanchoe pinnata*)<sup>17</sup>. Nevertheless, the adoption of this leaf as a wound cleansing agent for DFU is progressing slowly, with many individuals still unaware of its benefits<sup>18</sup>.

Wound cleansing using *Cocor Bebek* leaves presents a potential solution for DFU healing<sup>19</sup>. These leaves contain active substances, including steroid glycosides, saponin compounds, tannins, flavonoids, and terpenoids, offering cooling, antiseptic, astringent, anti-inflammatory, fever-reducing, asthma-relieving, stomach ulcer-treating, ulcer-healing, and wound-healing properties<sup>20</sup>. Previous research, including Kony Putriani's study in 2023<sup>21</sup>, demonstrates that *Cocor Bebek* (*Kalanchoe pinnata*) contains healing compounds such as flavonoids, saponins, and tannins. Kony Putriani's research also evaluates the antibacterial effectiveness of methanol extract against *Propionibacterium acnes* and *Staphylococcus aureus*.<sup>21</sup> In white rats, a 20% concentration of *Cocor Bebek* leaf ethanol extract ointment proves most effective in healing incision wounds.<sup>22</sup> Additional studies indicate anti-inflammatory activity in rat feet induced by carrageenan with a 2% ethanol extract of *Cocor Bebek* leaves.<sup>21</sup> Purwanitingsih (2020)<sup>23</sup> examines the antibacterial efficacy of *Cocor Bebek* leaf extract against *Salmonella typhi* using the Kirby Bauer method, revealing high antibacterial power. Another study indicates that higher concentrations of *Cocor Bebek* leaf extract expedite the healing process of cut wounds in white rats, with a 15% concentration proving most effective.<sup>24</sup>

While existing research highlights the efficacy of *Cocor Bebek* in wound healing and antibacterial activity, it is essential to note that the focus has primarily been on these aspects rather than the plant's application for diabetic diseases. This study aimed to evaluate the effectiveness of *Cocor Bebek* (*Kalanchoe pinnata*) leaves in wound cleaning for diabetic foot ulcers (DFU) and compare it with the use of NaCl solution.

## Materials and Methods

This study utilized a quasi-experimental design with a pretest-posttest control group approach. The research was conducted in June 2022 at a Health Facility in Surabaya, Indonesia. The sample for this study consisted of 40 respondents divided into two groups: the intervention group and the control group. Group selection was carried out using the Simple Random Sampling method. The inclusion criteria involved patients with diabetic foot injuries of degree

2-3, blood sugar levels < 200 mg/dL, regular intake of diabetes drugs or insulin injections, and having a normal weight (BMI = 18.5-22.9).

The dependent variable in this study was wound cleaning using *Cocor Bebek* leaves (*Kalanchoe pinnata*), while the independent variable was wound healing in diabetic patients. Self-administered questionnaires were employed to collect sociodemographic data, including age, sex, occupation, duration of diabetes, history of diabetes, history of diabetic foot wound care, history of diabetic diet, exercise habits, heredity, drug consumption, comorbidities, and blood sugar levels during data collection.

The instrument used for wound cleaning with *Cocor Bebek* leaves (*Kalanchoe Pinnata*) was a Standard Operating Procedure for wound treatment involving a decoction of 5 pieces of *Cocor Bebek* leaves (100 gr) and 1 L of water, boiled for 15 minutes until the cooking water reduced to 500 ml for the intervention group, while the control group was treated with usual wound washing using NaCl solution 0.9%.

An instrument to measure diabetic foot wound healing employed the Bates Jensen Wound Assessment Tool (BWAT) with 13 indicators, including size, depth, wound edge, tunnel, necrotic tissue type, necrotic tissue count, exudate type, exudate count, skin color around the wound, peripheral edema, hardening of peripheral tissue, granulation tissue, and epithelialization. DFU score measurements were performed over 14 days or 6 interventions.

Data were analyzed using the Wilcoxon test within each group (intervention and control), and the Mann-Whitney test was utilized to assess the relationship between the two groups with a significance level of 5%. This research received approval from the Ethics Committee of Stikes Hang Tuah Surabaya with reference number PE/44/VI/2022/KEPK/SHT dated June 15, 2022.

## Results

Based on Table 1, the intervention group was dominated by respondents aged 30-40 years, female gender, work as housewives, suffer from DM for less than 12 months, and have a family history of DM. The majority of respondents did not exercise regularly, took DM or insulin drugs regularly, maintained a diet, and had random blood sugar levels <200 mg / dL. Meanwhile, the control group was dominated by respondents aged 50-60 years, female gender with other types of work, suffering from DM for 1-2 years and 2-3 years, having a hereditary history of DM, not exercising regularly, taking DM drugs or insulin regularly, maintaining a diet, and having random blood sugar levels <200 mg / dL.

Table 2 shows a significant decrease in scores for various DFU indicators after intervention with *Cocor Bebek* leaves and NaCl solution. Wilcoxon tests indicate a p value of  $0.000 \leq \alpha = 0.05$ , signifying significant improvement in DFU healing for both interventions. Additionally, the Mann-Whitney test reveals significant differences in the effectiveness of DFU healing between the *Cocor Bebek* leaves and NaCl groups, with a p value of  $0.003 \leq \alpha = 0.05$ .

## Discussion

After cleaning wounds with *Cocor Bebek* leaves, BWAT indicators such as wound fringe, tunnel, necrotic tissue type, exudate type, exudate count, skin color around the wound, peripheral edema, hardening of peripheral tissue, granulation tissue, and epithelialization showed decreased scores, indicating improved

wound conditions. Megawati’s 2023 research highlighted that *Cocor Bebek* leaves, containing flavonoids, saponins, and tannins, aid wound healing.<sup>25</sup> Flavonoids act as antioxidants and anti-inflammatories, saponins stop bleeding and have antibacterial properties, while tannins counteract inflammatory mediators and possess antibacterial effects.<sup>26</sup> Alkaloids, steroids, and terpenoids in *Cocor Bebek* leaves contribute to antibacterial, antiulcer, anti-fungal, antiviral, hepatoprotective, and antiseptic properties.<sup>27–29</sup> The post-intervention group exhibited accelerated wound healing, benefiting from the multifaceted effects of *Cocor Bebek* leaves. BWAT assessment indicated smaller post-intervention scores, reflecting faster healing in the intervention group.<sup>27,30</sup> Factors influencing this improvement included respondent characteristics like ages between 30-40 years, diabetes mellitus drug consumption, adherence to a diet, and blood sugar levels <200 mg/dL, as outlined in Table 1.

After cleaning wounds with NaCl, BWAT indicators such as necrotic tissue count, exudate count, peripheral edema, and hardening of peripheral tissue showed decreased scores, signifying improved wound conditions. NaCl 0.9% is an isotonic, safe, non-irritant solution that preserves granulation tissue, maintains wound

moisture, and aids the healing process.<sup>31</sup> It matches the body’s salt content, preventing hypersensitivity reactions and promoting epithelial tissue development.<sup>32</sup> NaCl 0.9% serves as a cleansing and rehydration fluid, removing excessive wound fluid and metabolic waste to create a moist environment for autolytic debridement.<sup>33</sup> The control group, undergoing NaCl 0.9% wound cleansing, exhibited faster wound healing as indicated by BWAT scores. Post-control scores were smaller than pre-control scores, reflecting accelerated healing. Factors contributing to this improvement in the control group, outlined in Table 1, include regular consumption of Diabetes Mellitus drugs and adherence to a diet by respondents.<sup>34–36</sup>

After cleaning wounds with *Cocor Bebek* leaves and NaCl, BWAT observations revealed differences in the rate of score decrease for indicators such as depth, wound fringe, type and number of necrotic tissue, type and amount of exudate, skin color around the wound, granulation tissue, and epithelialization. Statistical tests indicated a significant difference in the effectiveness of DFU healing between the intervention group (*Cocor Bebek* leaf wound cleaning) and the control group (NaCl wound cleaning). The advantage of the intervention group lies in the natural

**Table 1.** The characteristics of respondents in Surabaya Wound House, with division between intervention group (Pok) and control group (N=40).

Characteristics of respondents	Intervention group (%)	Control group (%)
Age		
30-40 years	50	0
40-50 years	20	20
50-60 years	30	50
>60 years	0	30
Gender		
Man	55	20
Woman	45	80
Work		
Housewives	45	20
Farmer	0	0
Self employed	15	0
Private employees	25	0
Civil servants	0	5
Retired civil servant	0	30
Other	15	45
Years with diabetes mellitus		
<12 months	45	5
1-2 years	30	35
2-3 years	10	35
>3 years	15	25
History of diabetes		
Exist	90	95
None	10	5
Sports habits		
Ever	0	0
Never	100	100
DM/insulin medication consumption		
Yes	100	100
Not	0	0
Maintaining diet		
Yes	100	100
Not	0	0
Blood sugar		
<200 mg/dL	95	100
>200 mg/dL	5	0

**Table 2.** Statistical analysis result of BWAT indicator changes before and after intervention in experimental and control groups.

BWAT indicator	Intervention group			Control group			p
	Pre-test	Post-test	Δ	Pre-test	Post-test	Δ	
Size	2	2	0	2	2	0	0.003 <sup>c</sup>
Depth	2	2	0	4	4	0	0.003 <sup>c</sup>
Wound fringe	3	1	2	4	4	0	0.003 <sup>c</sup>
Tunnel	3	1	2	1	1	0	0.003 <sup>c</sup>
Types of necrotic tissue	3	2	1	3	3	0	0.003 <sup>c</sup>
Number of necrotic tissues	2	2	0	5	4	1	0.003 <sup>c</sup>
Types of exudate	3	1	2	4	4	0	0.003 <sup>c</sup>
Number of exudates	2	1	1	4	3	1	0.003 <sup>c</sup>
Skin color around the wound	3	1	2	4	4	0	0.003 <sup>c</sup>
Peripheral edema	4	2	2	1	1	0	0.003 <sup>c</sup>
Edge hardening	3	2	1	3	2	1	0.003 <sup>c</sup>
Granulation network	3	2	1	5	5	0	0.003 <sup>c</sup>
Epithelialization	5	2	3	5	5	0	0.003 <sup>c</sup>
p	0.000 <sup>a</sup>			0.000 <sup>b</sup>			

<sup>a</sup>Wilcoxon test of pre-post tests in the intervention group; <sup>b</sup>Wilcoxon test of pre-post tests in the control group; <sup>c</sup>Mann-Whitney test between the intervention and control groups.

compounds present in *Cocor Bebek* leaves, including flavonoids, saponins, tannins, alkaloids, steroids, and terpenoids, which accelerate wound healing by reducing glucose absorption, exhibiting antibacterial, anti-inflammatory, and antiseptic properties.<sup>37,38</sup> Saponins in *Cocor Bebek* leaves stop bleeding, treat wounds, and have antibacterial and anti-inflammatory effects, while tannins act as anti-inflammatory and antibacterial agents.<sup>39,40</sup> Alkaloids, steroids, and terpenoids in *Cocor Bebek* leaves contribute antibacterial, antidiabetic, and antifungal properties, further enhancing wound healing.<sup>39-41</sup>

The control group (wound cleaning with 0.9% NaCl) primarily contained 0.9% sodium and chloride compounds, serving as an isotonic fluid and physiological saline to maintain wound moisture and enhance epithelial tissue migration.<sup>42,43</sup> Variances in compound content between the intervention (*Cocor Bebek* leaf wound cleaning) and control groups influenced DFU improvement, with the intervention group exhibiting faster healing. Observations indicated more effective wound cleaning in the intervention group, reflected in decreased BWAT scores across 10 out of 13 indicators, including wound fringe, tunnel, necrotic tissue type, exudate type, exudate count, skin color around the wound, peripheral edema, hardening of peripheral tissue, granulation tissue, and epithelialization. In contrast, the control group showed decreased scores on three indicators—number of necrotic tissues, number of exudates, and hardening of peripheral tissues. This underscores the superior effectiveness of wound cleansing with *Cocor Bebek* leaves compared to 0.9% NaCl in treating diabetic foot ulcers. External factors, such as the age of diabetes mellitus sufferers in the control group exceeding one year, may impact improvements in DFU healing across BWAT indicators, necessitating discussion and consideration based on previous studies on long-term diabetes.

## Conclusions

Wound cleansing using *Cocor Bebek* leaves (*Kalanchoe pinnata*) significantly enhances the healing of diabetic foot ulcers (DFU). The utilization of *Cocor Bebek* leaves has demonstrated

effectiveness in reducing scores on various BWAT indicators, including wound fringe, tunnel, necrotic tissue type, exudate type, exudate count, skin color around the wound, peripheral edema, hardening of peripheral tissue, granulation tissue, and epithelialization. This study provides evidence that *Cocor Bebek* leaves contain active compounds, such as flavonoids, saponins, tannins, alkaloids, steroids, and terpenoids, which can offer anti-inflammatory, antibacterial, antiseptic, antidiabetic effects, and accelerate wound healing. Therefore, the use of *Cocor Bebek* leaves can be considered a potential natural alternative for cleaning wounds in diabetics with diabetic foot ulcers.

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