

# Enhancing Diabetic Foot Ulcer Healing: The Role of *Channa striata* Extract Nutrition in Accelerating Inflammatory, Proliferative, and Maturation Phases

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## Abstract

**Background:** Diabetic foot ulcers pose a severe complication for individuals with diabetes mellitus, necessitating effective therapeutic support such as albumin nutrition throughout the wound healing process. Derived from *Channa striata*, a commonly consumed source of albumin in Indonesia, this extract can potentially expedite wound healing.

**Objective:** This study aims to evaluate the efficacy of *Channa striata* extract nutrition in accelerating the inflammatory, proliferative, and maturation phases of diabetic foot ulcer healing.

**Methods:** This quantitative study employed a pre-experimental design using a single-group pretest-posttest approach. The study involved 30 diabetic patients who were administered a daily dose of 550 grams of *Channa striata* extract over four weeks. The Bates Jensen Assessment Tool (BWAT) assessed wound progress.

**Results:** Results revealed that the average participant age was 60.2 years, with an average diabetic history of seven years. The average wound duration was 8.7 weeks; 66.7% of the participants were female; 70% had Non-Insulin Dependent Diabetes Mellitus (NIDDM); and 56.7% were at stage IV. The study found a significant difference in BWAT scores before and after the administration of *Channa striata* extract in diabetic foot ulcer patients.

**Conclusion:** This study supports the effectiveness of *Channa striata* extract as an adjunct therapy in expediting the wound-healing phases in diabetic foot ulcers.

**Keywords:** Albumin; *Channa striata*; diabetic foot ulcers; wound healing phases

## INTRODUCTION

Individuals with Diabetes Mellitus (DM) often grapple with severe injuries due to unstable blood glucose levels (Vahwere et al., 2023). Diabetic Foot Ulcers (DFU), a severe complication emanating from peripheral neuropathy and peripheral arterial disease, can lead to amputations and even death (Crowley et al., 2023; Tai et al., 2021).

Diabetic foot wounds significantly contribute to heightened morbidity and mortality rates (Vahwere et al., 2023). The mortality rate associated with DFU development is estimated at 5% within the first 12 months (Everett & Mathioudakis, 2018). The International Diabetes Federation (IDF) indicates a

DFU prevalence of 10.0% to 30.0% in Africa, with amputation rates varying between 3.0%-35.0%. In Asia, DFU prevalence is under 15.0%, while in Europe, it significantly varies, with 17.0% in Belgium and 1.0% in Denmark. Brazil reports a 21.0% DFU prevalence, with amputation rates ranging from 10.0% to 13.0% (International Diabetes Federation, 2022).

Effective DFU management necessitates not only proper wound care techniques that maintain a moist wound environment but also adequate nutritional input (Everett & Mathioudakis, 2018; Safitri et al., 2022). The wound healing process, encompassing the inflammatory, proliferative, and

maturation phases, requires sufficient nutrient supplies (Tan & Dosan, 2019; Safitri et al., 2022). Albumin protein plays a crucial role in collagen synthesis and epithelial formation during these phases (Apriasari et al., 2022).

The high market price of human albumin necessitates a cost-effective substitute that retains its beneficial effects (Permana et al., 2023). Snakehead fish extract (*Channa striata*) is an affordable and accessible albumin source (Safitri et al., 2022).

*Channa striata*, a freshwater fish, is rich in wound-healing albumin (Nurilmala et al., 2021). Besides albumin, *Channa striata* also contains fat, glucose, minerals, zinc, Cu, Fe, and other minerals (Safitri et al., 2022). The healing process of diabetic ulcers requires protein intake support as a supplement (Nurilmala et al., 2021). A 100-gram serving of *Channa striata* contains up to 25.2% protein (Soniya & Fauziah, 2020). Therefore, *Channa striata* can enhance the immune system and play a crucial role in healing diabetic foot ulcers (Dewita et al., 2022).

The albumin and omega-6 in *Channa* Extract serve as antioxidants and anti-inflammatories in diabetic wounds (Apriasari et al., 2022). Additionally, they exhibit antihyperglycemic and antidiabetic properties (Soniya & Fauziah, 2020). *Channa striata* extract has been proven to decrease lymphocyte numbers in the diabetic wound healing process (Izzaty et al., 2014).

Normal albumin levels based on WHO recommendations in adults are 3.5-5.5 g/dL; as much as 80% of the risk of death is predicted to occur in patients with albumin levels of <2 g/dL (Alejandra Aguayo-Becerra et al. 2013). Hence, it takes a daily requirement of albumin in the range of 1500-2000 mg per day (Safitri et al., 2022).

So far, many practitioners have recommended that diabetic wound patients consume many albumin sources from egg whites and eat pure snakehead fish or *Channa striata* (Tungadi, 2020). However, the problem is that many people do not like the taste and aroma of fresh fish (Safitri et al., 2022). Even consuming good fish every day causes boredom and even nausea (Sita Udayanti & Rini Noviyani, 2023),

which actually has a bad impact on the nutritional status of patients.

Currently, the research team is trying to make snakehead fish extract in the form of capsules so that it does not cause an uncomfortable taste and aroma. The extraction process was carried out by stable heating and irradiation so that snakehead fish extract was produced as much as 550 mg per capsule. This study aims to demonstrate the benefits of administering a daily dose of 550 mg of *Channa striata* extract, conveniently packaged for easy consumption. Specifically, the research examines the extract's impact on accelerating angiogenesis and epithelial tissue formation in diabetic foot ulcers.

## **METHOD**

This pre-experimental quantitative research employed a single-group pretest-posttest design without a control group. The study participants were individuals with stage II-IV diabetic foot ulcers who were patients at the Alficare Center Bengkulu Medical Surgical Nursing Specialty clinic. Initially, the sample comprised 35 respondents. However, five individuals were excluded due to inconsistent consumption of *Channa striata* and irregular wound treatment, leaving a final sample size of 30 respondents selected using a consecutive sampling method.

All participants received identical treatment in terms of technique and application of modern wound dressing materials. Each patient was given 550 grams of snakehead fish extract (*Channa striata*) daily three times for four weeks. The extract was taken directly from fresh *Channa striata* fish, processed, and packaged by a standardized factory. Extraction was carried out at an optimal and constant temperature of 40°C, and sterilization was performed using the gamma irradiation technique to obtain superior extracts. The extract was packaged in the form of capsules so that it did not cause an unpleasant aroma and ensured accurate gramation of albumin. The advancement of wound healing was assessed using the Bates Jensen Wound Assessment Tool (BWAT). Measurements were taken twice: prior to the administration of *Channa striata* (pretest) and four weeks post-administration (posttest). All participants provided informed consent for the procedure. Before being

implemented, this research protocol had undergone an approval process by the health research ethics committee in STIKes Sapta Bakti Bengkulu with the number 052/DRMIK/KEPKSTIKesSaptabakti/2023. The data was processed and analyzed using a computer application with a Shapiro-Wilk normality test and bivariate analysis using the Wilcoxon test.

The study encompassed 30 individuals with diabetic foot ulcers. Both univariate and bivariate analyses were conducted. The univariate analysis aimed to assess the respondents' characteristics. A description of the characteristics of people with diabetic ulcers can be seen in the following Table 1:

## RESULTS

### Univariate Analysis

**Table 1. Average Distribution of Respondents' Characteristics Based on Age, Duration of Diabetes, Injury Duration, Gender, Type of Diabetes, and Wound Stage in People with Diabetic Foot Ulcers (n:30)**

No.	Characteristic	Result
1	<b>Age (years)</b>	
	Mean	60.2
	Median	61
	Min-Max	42-75
	Standard Deviation	9.434
2	<b>Duration of Diabetes (years)</b>	
	Mean	7
	Median	6
	Min-Max	1-20
	Standard Deviation	4.259
3	<b>Injury Duration (weeks)</b>	
	Mean	8.7
	Median	8
	Min-Max	1-20
	Standard Deviation	4.632
4	<b>Gender</b>	
	Male	10 (33.3%)
	Female	20 (66.6%)
	N	30 (100%)
5	<b>Type of Diabetes</b>	
	IDDM	9 (30%)
	NIDDM	21 (70%)
	n	30 (100%)
6	<b>Wound Stage</b>	
	Stage III	13 (43.3%)
	Stage IV	17 (56.7%)
	n	30 (100%)

The average age of the respondents was 60.2 years, with a standard deviation of 9.434 years. On average, the respondents had been diagnosed with DM for seven years. The initial treatment visit revealed an average DFU duration of 8.7 weeks. The majority of the study participants were female (66.7%), with Non-Insulin Dependent Diabetes Mellitus (NIDDM) being the most common type of diabetes 70%. Additionally, 56.7% of the participants were at wound stage IV at the initial visit (see Table 1).

### Bivariate Analysis

The bivariate analysis aimed to validate the effectiveness of *Channa striata* extract statistically in accelerating epithelialization in diabetic foot ulcers. Data normality testing was carried out using the Shapiro-Wilk test with the help of SPSS with  $p = 0.05$ . The output value in the sig column from the SPSS test results was smaller than  $p > 0.05$ , so the data was not normally distributed, so bivariate analysis used the Wilcoxon test.

**Table 2. Difference in Mean Wound Healing Score Before and After Administration of *Channa striata* Extract on Diabetic Foot Ulcers (n:30)**

Variables	Mean	Standard Deviation	Min-Max	p-value
BWAT Scores Before	46.17	8.579	32-65	0.000
BWAT Scores After	28.4	3.793	23-37	

By using the Bates Jensen wound assessment tool (BWAT) before the intervention, the mean wound healing score was 46.17, with a standard deviation of 8.579. After the intervention, the mean BWAT score reduced to 28.4 (standard deviation 3.793). Bivariate analysis results aimed to identify differences in BWAT scores before and after daily administration of 550 mg of *Channa striata* extract over four weeks. The analysis yielded a p-value of 0.000, indicating a significant difference in BWAT scores pre- and post-administration of *Channa striata* 550 mg. Thus, the effectiveness of *Channa striata* in promoting the healing of diabetic foot wounds was statistically confirmed (see Table 2).

#### DISCUSSION

The physiology of wound healing consists of three phases: inflammation, proliferation, and maturation. Each phase necessitates adequate nutrition, with protein serving as a primary source, alongside carbohydrates and fats. Therefore, it is crucial to identify affordable and readily available protein sources. Natural ingredients are relatively safe, provided their chemical content is identified (Yuliana et al., 2022). In Indonesia, *Channa striata* emerges as a widely available source of animal albumin.

Administering *Channa striata* extract as a source of albumin protein, based on the results of this study, has been confirmed to be effective as an adjunct therapy in healing diabetic foot ulcers. *Channa striata* is known to have a higher protein content than eggs (Nurilmala et al., 2021). The high albumin content in *Channa striata* plays a significant role in new tissue formation at wound sites (Yuliana et al., 2022). This study's findings align with previous research on diabetic foot wounds, which demonstrated a significant decrease in the BWAT value.

During the inflammatory phase of wound healing, albumin has been proven to effectively expedite inflammation control in diabetic foot wounds. This

corroborates with the findings of this study, which suggest that *Channa striata* extract plays a role in managing inflammation and treating wound infections (Apriasari et al., 2022). Upon administering *Channa striata* to the study sample, signs of inflammation such as redness, swelling, pain, and warmth around the wound were significantly reduced.

The subsequent phase of wound healing is proliferation, encompassing granulation activity, collagen synthesis, and epithelialization. Epithelialization is a process where wound epithelial cells migrate upward to repair the damaged skin area (Tan & Dosan, 2019). The formation of epithelial tissue represents a critical part of the proliferation phase in wound healing physiology. Further research conducted in Kalimantan has confirmed that *Channa striata* is an anti-inflammatory and accelerates wound healing (Siswanto et al., 2016). Inflammatory signals help trigger the epithelialization process by stimulating keratinocyte cells to migrate, differentiate, and stratify, optimally covering the skin surface.

*Channa striata* provides an anti-inflammatory effect by adding macrophages to the diabetes mellitus wound healing process (Apriasari et al., 2022). Promptly addressing inflammation supports acceleration in subsequent wound healing phases. Research has shown that *Channa striata* extract reduces lymphocyte concentration between 50%-100%, equivalent to the function of ibuprofen (Izzaty et al., 2014). The anti-inflammatory effect of *Channa* on the angiogenesis process can control the expression of NF-B and increase the expression of VEGF, which is beneficial for the wound-healing process (Apriasari et al., 2022).

Wound environmental conditions influence epithelialization. Optimal collagen synthesis from albumin, epithelialization, and migration of epidermal and other active cells occur more effectively and rapidly in a moist, well-nourished

wound surface compared to a dry, malnourished wound environment (Tan & Dosan, 2019). Epithelialization can be inhibited in dry, scabbed, or crusty wound environments. A moist environment and the supply of albumin, a collagen-forming material in fibrous tissue, can expedite epithelialization.

Other research indicates that *Channa striata* protein contains 15 types of amino acids, including nine types of essential amino acids: histidine, threonine, arginine, methionine, valine, phenylalanine, leucine, isoleucine, and lysine (Soniya & Fauziah, 2020). Individuals with diabetic feet require protein intake support as a supplement or management aid to improve diabetes mellitus wound healing. *Channa striata* contains eight essential amino acids: Allin, valine, histidine, arginine, leucine, lysine, methionine, and isoleucine (Nurilmala et al., 2021). Moreover, the amino acids leucine, glutamic acid, and the minerals Fe and Zn found in *Channa striata* can enhance the immune system and play a crucial role in healing diabetic foot ulcers (Dewita et al., 2022). Improving the immunity of individuals with diabetic foot ulcers supports the rapid formation of epithelialization. Amino acids serve as essential micronutrients during the epithelialization process. The dominant amino acids in *Channa striata* are leucine (0.539%) and glutamic acid (1.446%) (Dewita et al., 2022).

This research has several limitations. The progression of wounds was not reported periodically. This research was only focused on chronic wounds, namely diabetic wounds. This study did not use a control group, so a study with a larger sample size was needed. Possible biases could occur in the use of natural albumin nutrients from food.

## CONCLUSION

The efficacy of *Channa striata* extract in expediting the healing process of diabetic foot wounds has been substantiated. Albumin and its anti-inflammatory properties within the extract facilitate the prompt resolution of the inflammatory phase of wounds. The albumin content, combined with a rich assortment of amino acids and minerals in *Channa striata*, effectively enhances the proliferation process and promotes the formation of epithelial tissue in diabetic foot wounds.

This study has proven that snakehead fish extract capsules (*Channa striata*) 550 mg are effective in helping the healing process of diabetic wounds, which is expected to be an opportunity for other research on acute and chronic wound types such as pressure injuries, surgical wound infections, and cancer wounds. The research in the form of *Channa striata* extract syrup packaging has the opportunity for further research on samples with difficulty swallowing capsules. It is also recommended to develop further research using control groups and a more significant number of samples.

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