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RESEARCH ARTICLE (ORIGINAL)

Chronic wound healing with copaiba oleoresin application

Cicatrização de feridas crónicas tratadas com oleorresina de copaíba
Cicatrización de heridas crónicas tratadas con oleorresina de copaíba

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Abstract
Background: Chronic wounds represent a growing health problem in several countries. Ethnobotanical and preclinical studies suggest that copaiba oleoresin (*Copaifera* sp.) has healing properties.
Objective: To evaluate the clinical application of copaiba oleoresin in chronic wound healing.
Methodology: Retrospective case series study consisting of 6 participants with chronic wounds treated with 7% copaiba oleoresin with sunflower oil or 10% copaiba ointment. The primary endpoint was the percentage reduction in wound area at the end of follow-up.
Results: Mean age of participants was 54.5 (*SD* = 11.5) years. The causes of wounds were vascular (*n* = 3), surgical (*n* = 2), and traumatic (*n* = 1). All participants had a reduction of the wound area ranging from 15.5% to 100% during the follow-up (8 to 15 weeks). No complications were observed.
Conclusion: Treatment with copaiba oleoresin proved to be an effective and safe option in chronic wound treatment.

Keywords: case series; *copaifera*; wound healing

Resumo
Enquadramento: As feridas crónicas representam um problema crescente de saúde em diversos países. Estudos etnobotânicos e pré-clínicos sugerem que a oleorresina de copaíba (*Copaífera* sp.) possui propriedades cicatrizantes.
Objetivo: Avaliar a aplicação clínica da oleorresina de copaíba na cicatrização de feridas crónicas.
Metodologia: Estudo retrospectivo de série de casos composta por 6 participantes com feridas crónicas tratadas com: oleorresina de copaíba a 7% com óleo de girassol ou creme de copaíba a 10%. O desfecho primário foi a percentagem de redução da área lesada ao final do seguimento.
Resultados: Idade média dos participantes foi 54,5 (*DP* = 11,5) anos. As causas das feridas foram vasculares (*n* = 3), cirúrgicas (*n* = 2) e traumáticas (*n* = 1). Todos os participantes tiveram redução da área lesada variando entre 15,5% a 100%, durante o seguimento (8 a 15 semanas). Nenhuma complicação foi observada.
Conclusão*:* O tratamento com a oleorresina de copaíba mostrou-se uma opção efetiva e segura no tratamento de feridas crónicas.

Palavras-chave: série de casos; copaifera; cicatrização

Resumen
Marco contextual: Las heridas crónicas representan un problema sanitario creciente en varios países. Estudios etnobotánicos y preclínicos sugieren que la oleorresina de copaiba (*Copaífera sp.*) tiene propiedades cicatrizantes.
Objetivo: Evaluar la aplicación clínica de la oleorresina de copaiba en la cicatrización de heridas crónicas.
Metodología: Estudio retrospectivo de serie de casos compuesta por 6 participantes con heridas crónicas tratadas con oleorresina de copaiba al 7% con aceite de girasol o crema de copaiba al 10%. El criterio de valoración primario fue el porcentaje de reducción de la zona lesionada al final del seguimiento.
Resultados: La edad media de los participantes fue de 54,5 (*DP* = 11,5) años. Las causas de las heridas fueron vasculares (*n* = 3), quirúrgicas (*n* = 2) y traumáticas (n = 1). Todos los participantes presentaron una reducción de la zona lesionada que osciló entre el 15,5% y el 100% durante el seguimiento (de 8 a 15 semanas). No se observaron complicaciones.
Conclusión: El tratamiento con oleorresina de copaiba ha demostrado ser una opción eficaz y segura en el tratamiento de heridas crónicas.

Palabras clave: series de casos; *copaifera*; cicatrización de herida

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Introduction

Chronic wounds represent a growing health problem in several countries. An estimated 2% of the population in developed countries will have chronic wounds during their lifetime (Thaarup & Bjarnsholt, 2021). They mainly affect people with comorbidities, including diabetes mellitus, peripheral vascular disease, and systemic arterial hypertension (Oliveira et al., 2019a). Chronic wound care is a major concern and constitutes a daily challenge for the patient, caregivers, and professionals. In addition to discomfort and quality of life, delayed wound healing also affects patient health and costs (Oliveira et al., 2019a). Although there are several wound treatment options on the market, many of them are expensive. Thus, researchers and healthcare professionals have been searching for new therapeutic strategies to accelerate wound healing.

The potential of plants used in traditional medicine can be based on historical data records about these plants, which provide comprehensive information to support their use (Rocha et al., 2021). Among them, copaiba (*Copaifera* spp.) has been used for hundreds of years, supporting its current use in traditional medicine. Recently, its efficacy in wound treatment has been confirmed by ethnobotanical (Ricardo et al., 2018), in vitro, and animal studies (Kauer et al., 2020). However, human research is still scarce in the current scientific literature, which makes it essential to understand the role of copaiba oleoresin in chronic wound healing. This study aimed to assess the clinical application of copaiba oleoresin in chronic wound healing.

Background

Wound healing is a physiological process that relies on molecular and cellular mechanisms, and some of these wounds become chronic (Martinengo et al., 2019). Some authors consider chronic wounds as wounds that do not show 20-40% of area reduction after 2-4 weeks of treatment. However, there is no pre-established consensus on chronicity (Kyaw et al., 2018; Martinengo et al., 2019). A simplistic definition considers that chronicity occurs when the wound persists after 12 weeks, or there is a poor response to treatment (Kyaw et al., 2018). A common characteristic of these wounds is that they do not progress through the orderly stages of healing and thus stop in a prolonged inflammatory phase despite the treatment offered (Kyaw et al., 2018; Martinengo et al., 2019).

Several therapeutic options are available for wound treatment, including the use of medicinal plants, such as copaiba (*Copaifera* spp.). Current preclinical studies suggest that copaiba oleoresin possesses emollient, healing, anti-inflammatory, antimicrobial, antiseptic, and antifungal properties (Quemel et al., 2021). Animal studies using copaiba at 10% have demonstrated its ability to promote epithelial regeneration by stimulating angiogenesis, re-epithelialization, wound retraction, and remodeling mechanisms (Gushiken et al., 2017; Kauer et al., 2020). Copaiba ointment at 10% was included in the Formulary of Phytotherapeutics of the Brazilian Pharmacopoeia as an anti-inflammatory and healing agent since 2011 (Agência Nacional de Vigilância Sanitária [ANVISA], 2011) backed only by ethnobotanical studies. In 2021, *Copaifera* spp. was removed from this form (ANVISA, 2021) due to the scarce literature about its use in current clinical practice. However, this herbal medicine still appears as an option in the wound care protocol available in the Brazilian Unified Health System (SUS). The result of this case series study will be the beginning of a search for clinical evidence.

Research Question

What is the effect of the topical application of copaiba oleoresin on chronic wound healing?

Methodology

A case series study was conducted using a retrospective, descriptive, and observational approach in a municipality in the state of Minas Gerais/Brazil, which has 450,024 thousand inhabitants, according to the last census of 2010 (IBGE, 2022). This setting was selected due to the municipality's long history of using herbal medicines and caring for a large number of people with chronic wounds. The Phytotherapy Program "Farmácia Viva" started in 2006 in this municipality, aiming to provide herbal medicines from 27 plant species. Among these medicines are preparations with copaiba for topical use on wounds: 10% copaiba ointment (OR10%) and 7% copaiba oleoresin with sunflower oil (OR7% + OG).

The inclusion criteria for this study's sample were medical records of individuals with a chronic wound persisting for at least 12 weeks without signs of healing; aged 18 years or older; and whose wounds were treated with copaiba oleoresin between January 2016 and December 2019. The records were to contain the sociodemographic data and clinical status of the participant, as well as the following study variables: the number of wounds; measurements of the wound area at the beginning and end of follow-up; description of wound appearance (granulating/necrotic tissue, condition of wound edges, type of exudate); and presence of infection (microorganism culture and antibiogram). Patients with prior history of alcoholism or psychiatric illness, using immunosuppressive medication during wound treatment, and wounds involving the entire circumference of the lower limbs were excluded.

In the study setting, daily treatment was provided by the caregiver or the patient at home. The wound was cleansed with 0.9% saline solution, followed by copaiba application, and covered with sterile compresses and crepe bandages. Outpatient care was provided at least once a week by the nursing and cardiovascular surgery team. The wound area was the primary endpoint of the study, obtained by linear measurement. The measurements (cm) of the major longitudinal (L) and transverse (T) axes of the wound were recorded. The following calculating formula was used: $A(cm^2) = L(cm) \times T(cm) \times 0.785$, where A =

area; L= longitudinal axis, and T = transverse axis (Khoo & Jansen, 2016; Mehl et al., 2020).

The percentage of wound area reduction over the period was calculated starting from the initial area minus the area at the end of follow-up: A% = 100 (A_0 - A_1) / A_0, where A% = reduction rate; A_0 = initial area; A_1 = final area.

Descriptive analysis was carried out because this was a case study, which precludes the application of statistical tests. However, to ensure the validity and reliability of the study, the accuracy of the data collection process was maintained. This study was approved by the Research Ethics Committee of the Federal University of Minas Gerais, as well as of the municipality of the study, with opinions number 4,446,489 and 4,653,026, respectively.

Results

The six participants were aged from 44 to 65 years, with a mean of 54.5 (SD = 9.5) years. The mean among male participants was 50.7 (SD = 11.5), and among female participants was 58.3 (SD = 7) years. The participants had one or two wounds, with seven being the total number of wounds analyzed. Three wounds in three men and four wounds in three women. Other demographic characteristics are presented in Table 1. The diseases presented by the participants were peripheral vascular disease, hypertension, diabetes mellitus, heart disease, chronic kidney disease, rheumatoid arthritis, and dyslipidemia (Table 1).

Table 1

Sociodemographic and clinical profile of the study participants

Participant Gender	Age (years)	Skin color	Employment status	Marital status	BMI (Kg/m²)	No. wounds	Comorbidities	Used medication
1 M	44	Black	U.	single	27.78	1	PVD	None
2 F	65	White	R.	married	25.39	1	SAH, DM, PVD, RA	losartan potassium, metformin hydrochloride, prednisone, piroxicam
3 M	44	Brown	P. L..	married	26.23	1	SAH, DM, PVD, heart disease,	losartan potassium, insulin, ASA, hydrochlorothiazide, simvastatin, and captopril
4 F	59	Black	P.L.	single	40.16	2	SAH, DM, PVD	losartan potassium, ASA, simvastatin ;
5 M	64	Brown	R.	married	22.91	1	SAH, DM, PVD, heart disease, dyslipidemia	simvastatin, ASA, furosemide, insulin, metformin, spironolactone, enalapril, carvedilol
6 F	51	Unknown.	R.	single	31.64	1	SAH, DM, PVD, CKD	insulin, isosorbide, tacrolimus, mycophenolate, atenolol, and prednisone

Note. F = Female; M = Male; BMI = Body mass index; U = Unemployed; R = Retired; P.L.= Paid leave; ASA = Acetylsalicylic acid; SAH = Systemic arterial hypertension; DM = Diabetes mellitus; PVD = Peripheral vascular disease; RA = Rheumatoid arthritis; CKD = Chronic kidney disease.

The etiology of the wounds varied between trauma, surgery, and venous insufficiency. Regardless of the etiology, all wounds were located in the lower limbs (Table 2).

Table 2

Characteristics of chronic wounds

Wound	Etiology	Duration of wound	Compression	Location
1	Vascular	8 months	Short stretch	Right medial lower leg
2	Traumatic	1 year	Does not apply	Right posterior knee
3	Surgical	+ 3 months	Does not apply	Left foot
4[a]	Vascular	20 years	Short stretch	Left medial malleolus
4b	Vascular	20 years	Short stretch	Left lateral malleolus
5	Surgical	3 months	Does not apply	First metatarsal of the right foot
6	Traumatic	4 months	Does not apply	Right calcaneus

Participant 1 had a history of peripheral vascular disease and recalcitrant chronic venous ulcer in the medial region of the lower third of the right leg. She underwent surgical debridement four weeks before the beginning of the follow-up. At this time, she received antibiotic therapy with cefepime hydrochloride due to culture results for *Stenotrophomonas maltophilia* and *Enterococcus faecalis*. She used analgesics only when necessary. The peripheral skin presented desquamation, and 10% Rosa Mosqueta lotion (*Rosa aff. rubiginosa*) was used.

At the beginning of the follow-up, the wound had an area of 31.40 cm2, deeper than the skin level, with well-defined intact edges and bright red granulating tissue. A small part of the tendon was exposed (near the lower edge), there was no dead tissue and minimal sanguineous exudate (Figure 1*). Topical treatment consisted of OR7% + OG and compressive therapy with short-stretch monolayer bandages. Follow-up was at 13 weeks, when the wound was flat, with an area reduction of 30.14 cm2, corresponding to 95.99% (Table 3), pigmented epithelial tissue, and a flat healed area (Figure 1**).

Figure 1

Wound of participant 1: at day 1 (1) and end of 13-week follow-up (1**)*

Source: Surgery Outpatient Archives

Participant 2 presented a persistent wound on the posterior region of the right knee. One year ago, he suffered trauma from a car accident. He underwent surgery to correct a trochanteric fracture, with loss of connective and muscle tissue. The surgical wound presented wound dehiscence leading to a delayed healing process. The patient underwent physiotherapeutic treatment and complained of generalized pain and constant use of analgesics. First, the wound was treated with hydrocolloid, sunflower oil, and collagenase ointment without improvement. At the beginning of the follow-up, the wound had an area of 11.30 cm2, with flat and intact edges. The wound bed presented reddish, moist granulating tissue with minimal exudate. The peripheral skin presented desquamation and retraction with fibrotic tissue that restricted knee movement (Figure 2*). The topical medication used was OR7% + OG. At the 8th week of follow-up, the total wound area had a reduction of 5.70 cm^2 (Figure 2**). The follow-up was at 15 weeks when there was a 100% reduction of the wound area and the presence of pink epithelialization tissue with improved desquamation.

Figure 2

Wound of participant 2: at day 1 (2) and week 8 of follow-up (2**)*

Source: Surgery Outpatient Archives

Participant 3 presented a surgical wound from tarsometatarsal amputation on the left foot, performed more than 3 months ago due to infection caused by a perforating accident. On the first day, the wound was 30.14 cm^2, with a moist, bright red bed, excessive granulating tissue above skin level, and no dead tissue. There was a large amount of pink serous exudate, and the edges were regular and attached. The peripheral skin was intact and mildly desquamative (Figure 3*). OR7% + OG was used as a topical medication, and treatment was carried out at the health care facility or, occasionally, by the patient himself at home. At the end of the follow-up, after 15 weeks, there was a wound area reduction of 25.43 cm^2, which corresponded to 84.37% of the initial area (Table 3). There was a small area with pinkish, moist granulating tissue and pigmented re-epithelialization tissue. At the lower edge, the plantar fascia presented hyperkeratosis, and the peripheral skin was dry (Figure 3**).

Figure 3

Wound of participant 3: at day 1 (3) and end of 15-week follow-up (3**)*

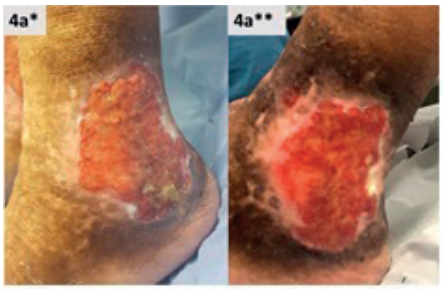
Source: Surgery Outpatient Archives.

Participant 4 had two wounds on the left ankle, one on the lateral malleolus region (Figure 4) and the other on the medial region (Figure 5), with more than 20 years of existence. Ten years ago, the patient underwent bilateral medial vein ligation and stripping and skin graft in the ulcers without success. The patient complained about pain in the wound region that hardly improved with analgesics. The patient had been using Unna boot for two years with a reduction of the wound area. In the fourth and eighth weeks of follow-up, antibiotic therapy with amoxicillin/clavulanate was recorded for the treatment of wound infection. The lower limbs were swollen. Wound care was performed at the health care facility, using OR10% ointment on both wounds and compressive therapy with a monolayer elastic bandage. The peripheral skin was moisturized and intact using 10% horsetail lotion (*Equisetum* sp.).

The wound of the left lateral malleolus (Figure 4a*) was 37.68 cm^2 at the beginning of the follow-up (Table 3). The edges were flat and irregular, with some macerated regions. The wound bed presented mostly clean, moist, poorly granulating, light-colored tissue, attached slough in a small area near the lower edge, and a large quantity of haemoserous exudate. At the end of follow-up, the wound had predominantly pink granulating tissue with no necrosis. Presence of minimal re-epithelialization tissue near the edges and persistence of macerated regions (Figure 4a**). In the 13-week period, there was a reduction of 5.84 cm^2 of the wound area, which corresponded to 15.5% of the total area (Table 3). The complaints of pain persisted, despite the use of analgesics.

Figure 4

Lateral malleolus wound of participant 4: at day 1 (4a) and end of 13-week follow-up (4a**)*

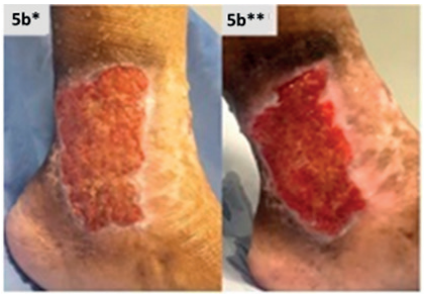


Source: Surgery Outpatient Archives

The wound of the left medial malleolus (Figure 5) had an area of 40.03 cm2 at the beginning of the follow-up (Table 3) and flat and irregular edges. The granulating tissue was moist, pale in color, and without necrosis (Figure 5b*). Presence of moderate haemoserous exudate. At the end of the follow-up, the wound had pink granulating tissue and no dead tissue. Presence of epithelialization tissue in almost all the edges of the wound (Figure 5b**). In the 13-week period, there was a reduction of 10.51 cm^2 of the wound area, which corresponded to 26.25% (Table 3).

Figure 5

Medial malleolus wound of participant 4: at day 1 (5b) end of 13-week follow-up (5b**)*



Source: Surgery Outpatient Archives

Participant 5 presented a surgical wound after transmetatarsal amputation of the hallux with delayed healing (Figure 6). The patient had a history of acute myocardial infarction and amputation of the left leg three years ago. He underwent closed amputation of the D hallux three months prior to follow-up. After seven days, open resection and debridement of the first 1st metatarsal of the right foot were performed due to wet gangrene. He had antibiotic therapy with clindamycin/ceftriaxone (12 days) and amoxicillin/clavulanate (7 days) in the pre- and postoperative periods of the first procedure. In the second procedure, he started ciprofloxacin/clindamycin because signs of infection persisted. The results of the wound biopsy cultures showed infection by Enterococcus faecalis (multidrug-resistant) and *Staphylococcus aureus* (multi-sensitive). OR7% + OG was used as a topical medication. At the beginning of the follow-up (Figure 6*), the wound area of the right medial foot was 23.12 cm^2. The wound bed showed pinkish granulating tissue, moist throughout. Presence of serous and purulent exudate, flat, macerated, and rolled edges in the lower region (plantar skin). There is no photographic record at this stage. At week 4, the area was 9.42 cm^2 (Figure 6**). At the 8th week of follow-up, the wound had a 100% area reduction (Table 3). The region of re-epithelialization showed hyperkeratosis with adequate pigmentation (Figure 6***).

Figure 6

Wound of participant 5: seven days before beginning follow-up (6), at week 4 (6**,) and at the end of 8-week follow-up (6**)*

Source: Surgery Outpatient Archives

Participant 6 had a wound on the right calcaneus as a result of trauma, with delayed healing. She performed hemodialysis until 2016, when she received a kidney transplant. She underwent revascularization of the right superficial femoral artery in December 2018. After eight days, debridement of the calcaneal wound was performed, with the indication of a skin graft. She received antibiotic therapy with amoxicillin/clavulanate (14 days) before the surgical procedure due to infected gangrene. She received meropenem in the perioperative and postoperative period (10 days) due to biopsy results showing negative coagulase *Staphylococcus* spp. and multi-resistant *Acinetobacter baumannii*. On the first day of follow-up, the wound was 20.02 cm^2 (Figure 7), had a moist, clean bed, minimal pinkish granulating tissue, a small area of attached slough on the lower region, and moderate serous exudate. The edges were macerated and rolled in the lower (plantar) region. The peripheral skin was moisturized and intact. She complained of severe pain in the right lower limb, requiring the use of analgesics. The treatments were applied at the health unit and occasionally at home using OR7% + OG.

Figure 7

Wound of participant 6: at day 1 of the 10-week follow-up

Source: Surgery Outpatient Archives

At the end of the follow-up, the wound had pinkish, moist granulating tissue and intact edges. There was an area reduction of 19.24 cm^2, which corresponded to 96.10% of the initial area (Table 3). The re-epithelialization tissue was moist and evenly colored. There was no photographic record. The limb was warm, with good perfusion and mobility. Thus, the skin graft surgery was suspended.

Table 3

Results of chronic wound treatment with copaiba oleoresin

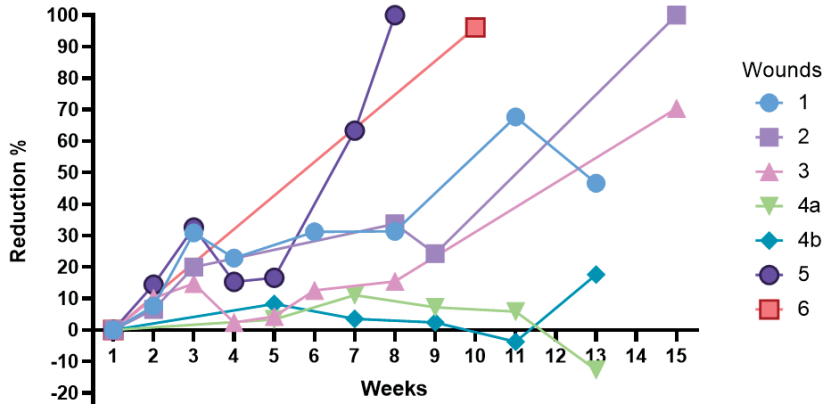
Cases	Follow-up				Wound			
					Area (cm^2)			Reduction
	Pharmaceutical treatment	Time (weeks)	Infection	Antibiotics	Initial A_0	Final A_1	A_0.A_1	(%)
1	OR7% + OG	13	No	Noo	31.40	1.26	30.14	95.99
2	OR7% + OG	15	No	No	11.30	0	11.30	100.00
3	OR7% + OG	15	No	No	30.14	4.71	25.43	84.37
4a	OR10% ointment	13	Yes	Yes	37.68	31.84	5.84	15.50
4b	OR10% ointment	13	Yes	Yes	40.03	29.52	10.51	26.25
5	OR7% + OG	8	Yes	Yes	23.12	0	23.12	100.00
6	OR10% ointment	10	No	No	20.02	0.78	19.24	96.10

Note. Preparations: OR7% + OG = 7% copaiba oleoresin with sunflower oil; OR10% = 10% copaiba ointment; A_0 = initial area; A_1 = final area.

The healing rate was different between the participants' wounds, corresponding to the area reduction (evolution) in the weeks of follow-up (Figure 8).

Figure 8

Percentage of wound area reduction (healing) per week of follow-up



Discussion

All participants received copaiba in OR7%+OG or OR10% ointment as treatment and achieved wound area reduction and improved wound appearance at the end of follow-up, such as the formation of healthy, infection-free granulating tissue. The causes of the wounds were vascular (n = 3), surgical (n = 2), and traumatic (n = 1). The mean follow-up time was 12.14 (SD = 2.34). Wound area at the beginning of the follow-up ranged from 11.30 to 40.03 cm^2, and the percentage of area reduction ranged from 15.5% to 100%.

Several studies have shown a correlation between the percentage reduction of wound area and treatment efficacy (Mehl et al., 2020; Khoo & Jansen, 2016). In this study, the wound with the lowest reduction rate at the end of follow-up (15.5%) had an infection at the start of treatment and was more than 20 years old. Surprisingly, the same patient had another wound, with a different result (26.25%), which suggests the interference of other factors on the healing process, possibly a difference in vascularization in the region of the wounds. The other wounds had a high reduction rate, close to or greater than 95%, as seen in wounds 1 (95.99%), 2 (100%), 3 (94.2%), 5 (100%), and 6 (96.16%).

The wounds with the highest reduction rates, above 95%, during the follow-up showed an average reduction of more than 34% per week. A peak in the wound area reduction rate (percentage) was identified near the 3rd week of treatment. This finding confirms the efficacy of copaiba in

wound treatment demonstrated in ethnobotanical studies (Ricardo et al., 2018) and preclinical trials (Quemel et al., 2001). A wound area reduction of 10% to 15% per week of treatment predicts healing (Mehl et al., 2020). A wound area reduction of 20 to 40% within two to four weeks of treatment is used as a predictor of healing (Khoo & Jansen 2016), suggesting treatment efficacy.

The therapeutic indication for 10% copaiba ointment is described in the 1st edition of the Brazilian Pharmacopoeia, however, records in the literature on use in humans, as well as on the treatment doses used, are rare. One study shows the application of *Copaifera officinalis* in 3% ointment to treat ultraviolet radiation burns, with satisfactory results for pain improvement and anti-inflammatory activity (Becker et al., 2020). Another clinical trial (double-blind) evaluated the effects of a gel with 1% *Copaifera langsdorfii* essential oil, compared to a placebo, for acne treatment. The study was conducted in a group of 10 subjects and concluded that the areas treated with copaiba had significantly greater effects in reducing pustules than the areas treated with the placebo (da Silva et al., 2012). In animals, a topical application of 10% oleoresin was used on horse wounds once a day. The copaiba-treated group showed better healing results, specifically after seven days of treatment (Kauer et al., 2020). In another animal study, with groups of rats, different concentrations of *Copaifera duckey Dwyer* oleoresin were tested against Nebacetin and Collagenase ointments. The 10% copaiba group showed significantly reduced wound areas, demonstrating a healing effect for oleoresin at this concentration (Dias et al., 2021).

Local factors such as infection and the presence of necrotic tissue can delay the wound healing process (Oliveira et al., 2019b). In the case series, at the beginning of the follow-up, three wounds (from 2 participants) were infected. Another two wounds showed small areas with minimal necrotic tissue. The formation of healthy, infection-free granulating tissue was noted in all participants. However, this may be related to previous treatments or debridements.

Regarding the factors that hinder wound healing, common characteristics were observed, such as PVD, SAH, and DM. The presence of chronic diseases and characteristics such as age are widely cited in the literature as factors that interfere with the healing process and prolong treatment time (Oliveira et al., 2019b).

Factors such as the care setting (at home or in the healthcare unit) and the person responsible for providing the treatment (the participant themselves, caregiver, or healthcare professional) did not influence the rate of wound area reduction.

There were no recorded complications (adverse events) such as bleeding, pain, necrosis, worsening of the wound appearance, or allergic reactions that could be attributed to the use of the preparations with copaiba oil.

Limitations of this study include data obtained from secondary sources, not always properly filled out, and diversity of wound etiology. To mitigate possible effects of the limitations presented on the results, data from participants evaluated weekly by a single professional were used. Since this is a case study, the effectiveness of copaiba in wound healing should be considered with caution until further studies can corroborate the results found.

Conclusion

The results of this study mirror data from in vitro studies and records of the traditional use of copaiba oleoresin, evidencing the effectiveness of this phytotherapeutic agent in chronic wound treatment.

Since copaiba use is based on traditional medicine, this finding has implications for clinical practice, constituting an option for the formulation of new products for chronic wound treatment.

The results add to the scientific literature evidence of the adjuvant benefits of copaiba oleoresin in chronic wound treatment. However, the data instigate the development of comparative and controlled clinical studies that allow statistical analysis of the healing capacity of wounds of various etiologies with copaiba oleoresin treatment.

Author Contributions

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