PUBLIKASI KARYA ILMIAH

EKSPLORASI KASIAT EKSTRAK BATANG MUSA CAVENDISH SEBAGAI PEMBALUT LUKA BARU: STUDI PERBANDINGAN DENGAN SOFRATULLE®

Oleh :

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PROGRAM STUDI S1 KEPERAWATAN

FAKULTAS ILMU KESEHATAN

UNIVERSITAS MUHAMMADIYAH PONOROGO

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Untuk memperoleh gelar sarjana keperawatan (S.kep) dalam program studi S1 Keperawatan Fakultas Ilmu Kesehatan Universitas Muhammadiyah Ponorogo

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DAFTAR ISI

Cureus Journal of Medical Science

Feb 18, 2024

Hi Nuraini ,

On behalf of the Cureus Journal of Medical Science, I hereby confirm the acceptance and publication of your article entitled Exploring the Efficacy of Musa Cavendish Stem Extract (Mucase) as a Novel Wound Dressing: A Comparative Study With Sofratulle®. This article has been peer-reviewed and will be indexed in PubMed Central after publication.

Title: Exploring the Efficacy of Musa Cavendish Stem Extract (Mucase) as a Novel Wound Dressing: A Comparative Study With Sofratulle®

Authors: Nuraini K. Amanah, Sugeng Mashudi, Siti Munawaroh, Auliya W. Azzarin, Fadhilah N. Karimah, Fahmie Gunawan

Publication date: February 18, 2024

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Best regards,

Graham Parker-Finger

Graham Parker-Finger
Director of Editorial Operations

Cureus

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Exploring the Efficacy of Musa Cavendish Stem Extract (Mucase) as a Novel Wound Dressing: A Comparative Study With Sofratulle®

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Abstract

Background

This investigation explores the wound-healing potential of Musa Cavendish banana components. Specifically, the Musa Cavendish stem extract (MUCASE), comparatively assessing its efficacy against the commercial conventional wound dressing Sofratulle® as a sterile gauze containing the antibiotic framycetin sulfate BP 1%, designed for accelerating wound healing. While Musa Cavendish banana components have been acknowledged for their topical applications, scarce research has scrutinized the specific impact of MUCASE as a wound dressing, especially concerning its comparison with Sofratulle®.

Purpose

The primary objective is to evaluate and compare the effectiveness of Sofratulle® and varied concentrations of MUCASE in managing incision wounds.

Materials and methods

Fifteen male *Rattus norvegicus* rats were randomly allocated into five groups, each subjected to distinct treatments: 40%, 20%, 10% MUCASE, Sofratulle®, and negative control. Over a seven-day treatment span, measurements of the exudation along with the incision wounds' surface area and the rate of wound contraction were conducted.

Result

The findings revealed significant differences in wound conditions within each group pre- and post-dressing application, except for the negative control and MUCASE 10% groups. Particularly, MUCASE 10% exhibited suboptimal outcomes compared to MUCASE 40%, 20%, and Sofratulle®, showcasing a non-significant ratio of wound healing ($p > 0.05$). A comparable potential was exhibited by MUCASE 40%, 20%, and Sofratulle® in accelerating the healing of incisional wounds.

Conclusion

Both Sofratulle® and MUCASE are deemed suitable as wound dressings to facilitate efficient and swift wound healing. Nevertheless, the study's outcomes suggest that MUCASE surpasses Sofratulle® in accelerating the healing process of wounds.

Categories: Preventive Medicine, Integrative/Complementary Medicine, Dermatology
Keywords: rattus novergicus wistar, musa cavendish stem extract, sofratulle®, wound dressing, wound healing

Introduction

The complex wound-healing process has a series of clinical stages that necessitate appropriate wound management. The hemostasis-inflammation stage is a barrier against infection with fibrin clot forms and fluid loss, while the proliferation and remodeling/maturational stage facilitate tissue strength and volume recovery. Factors such as wound form, hypoxia, bacterial colonization, ischemia, reperfusion injury, alterations in cellular response, and defects in collagen synthesis impact the duration of this process [1,2]. Effective wound healing application strategies are deemed necessary to enhance positive clinical outcomes [3].

Meanwhile, the exploration of innovative approaches in wound healing applications, particularly those involving plant extracts as dressings, is ongoing. Research suggests that natural compounds derived from plant extracts possess antioxidant properties, neutralizing reactive oxygen radicals and inhibiting lipid peroxidation [4-6]. These compounds hold the potential to accelerate the process of wound healing. For instance, the proven effectiveness of biomass extract from Musa Cavendish banana (MACE) stem in accelerating wound healing and its use as a food supplement and stabilizing agent in the food industry has been demonstrated [7]. Despite this, the considerable surplus biomass produced from banana stems, leaves, and peels, particularly in East Java Province, Indonesia, presents a challenge [8,9]. Thus, utilizing Musa Cavendish biomass potentially enhances innovative strategies in the health sector.

The literature on herbal medicine acknowledges the numerous benefits of extracts from Musa Cavendish, including its ability to treat diabetes and its anti-inflammatory, antioxidant, antifungal, and antibacterial qualities [10]. Studies by Matook et al. confirm the significant influence of Cavendish banana peel extract as an antibacterial and antioxidant agent [11]. Additionally, research by Zhang et al. also suggests using raw banana stem nanocellulose in wound dressings [12]. Despite these promising attributes, more information is needed about the type of extract from Musa Cavendish banana stem (MUCASE) that can accelerate wound healing, as it has yet to be thoroughly examined as a wound dressing. Therefore, further study is required to fully comprehend MUCASE's potential as a wound dressing and its impact on the rate at which wounds heal.

Furthermore, this study assesses the efficacy of different concentrations of Musa Cavendish stem extract wound dressings. It compares them to commercial conventional wound dressings like Sofratulle®. Sofratulle is a sterile gauze containing the antibiotic framycetin sulfate BP 1%, demonstrating encouraging outcomes in wound healing [13]. Sofratulle® has been recognized for its ability to create and maintain a moist wound environment, a crucial factor in promoting optimal conditions for wound healing. Despite this, Sofratulle® presents challenges when dressing wounds, such as quick, uneven, and strong adherence to the attached gauze, accompanied by limited suppurative bleeding and infection, a worsening of the inflammatory response, and trauma that is highly hyperpigmented and slightly hypertrophic [14]. The long-term use of aminoglycoside antibiotics in Sofratulle® raises concerns about negative impacts, including developing other infections, such as fungal infections [15].

Consequently, the primary research question guiding this investigation is whether the application of MUCASE accelerates the wound healing process compared to conventional dressings. Additionally, this study explores the mechanisms MUCASE may contribute to enhanced wound healing outcomes. Therefore, this study aims to extract MUCASE and evaluate its efficacy as a natural wound dressing. The gel extracted from the stem will be tested in vivo to compare its performance with the commercial product Sofratulle®. This research is significant as it marks the first application of an extract from the stem of Musa Cavendish to wound dressings to accelerate the healing process.

Materials And Methods

Materials

The study was conducted at two institutes, Trade Business of Citra Alam Pharmacy Laboratory, Ponorogo, East Java, Indonesia, and Akafarma Sunan Giri Laboratory, Ponorogo, East Java, Indonesia. The study gathered fresh Musa Cavendish plant stems from Kunti and Pulung villages in Ponorogo, East Java, Indonesia. Utilizing the experimental observations in this study, an in vivo random control group design involving *Rattus norvegicus* rats was employed. Comparisons were made with the conventional wound dressing Sofratulle®. Ethical approval for the research was secured from the Institute of Health Science Ethical Clearance Committee in Strada Indonesia, Kediri, Indonesia, with reference number 3946/KEPK/X/2023.

Following this, Musa Cavendish stems were cleaned and cut into thin pieces. Two processing methods were employed: oven-drying for six hours at 60 °C for the initial trial and indirect sun-drying for two to three days, which proved to be the best method after evaluation of the initial trial (Figure *1* for the extraction process). The processed stems were ground and sifted to produce a powder with a mesh size of 40 [16].

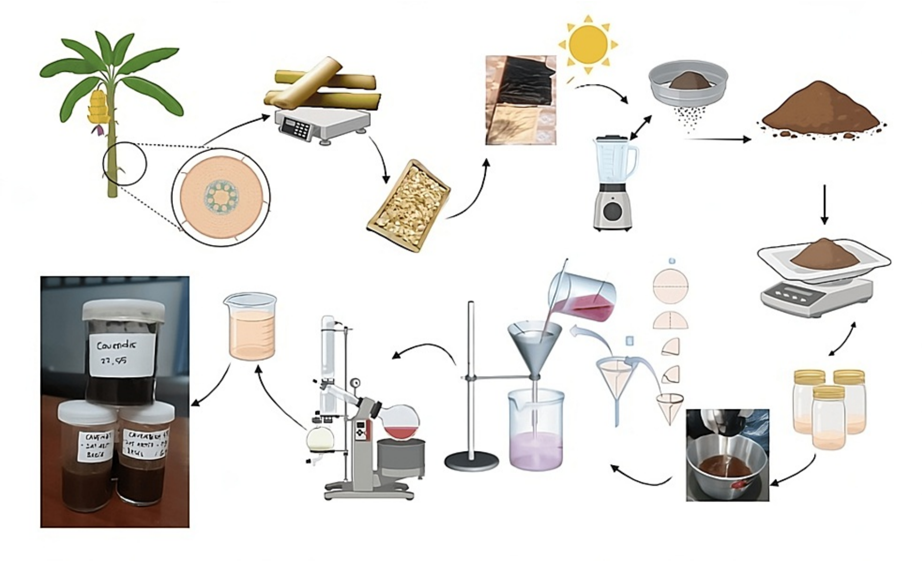

FIGURE 1: Preparation of crude material

a: banana stems separated; b: weigh the raw stems; c: cut into squares and washed; d: drying process covered by black fabric; e: grinding and sifting process; f: banana stems powder; g: weighting and mixing with 70% alcohol and soaking for 24 hours; h: filtration process; i: evaporation process; j: extraction process added by hydroxypropyl methylcellulose (HPMC); k: extracted gel

Image credits: Nuraini Khoirotun Amanah, created in Biorender.com

Extraction procedure

The maceration method of extraction involved placing 100 grams of Musa Cavendish stem powder into a container. Maceration was used to minimize thermal degradation and preserve the structural integrity of heat-sensitive MUCASE compounds. Maceration's cold extraction process, conducted at room temperature with a menstruum of 1000 ml 70% ethanol, was poured onto the material to ensure comprehensive coverage of the entire plant material. The container was tightly closed and left undisturbed for at least three days. The mixture was stirred periodically during this period, and the bottle was shaken occasionally to ensure even extraction. After the extraction, the miscella was separated from the remaining plant material through filtration or decantation. The resulting macerate was then filtered using filter paper, and the separation between the extract and the solvent was done through evaporation, which could be carried out using an oven or a water bath, resulting in a concentrated extract with a thick and dark brown consistency [16-18]. The filtration ensures satisfactory extraction yields while mitigating the risk of thermal degradation and addressing concerns related to the potential alteration of bioactive components.

The next step involved adding methylparaben and propylparaben as preservatives that had previously been dissolved in polyethylene glycol as a surfactant, cleanser, emulsifier, and humectant. Following the best possible homogeneity of the extract, the mixture was added to the hydroxypropyl methylcellulose (HPMC) solution and agitated until a homogenous consistency was produced. The combination was then sealed tightly and placed inside a tube.

Creating gel formulation and wound dressing MUCASE

In creating gel formulations, three variants containing Musa Cavendish stem extract were developed for wound dressings, with concentrations of 10%, 20%, and 40%. Each formulation contained 40 grams of the extracted gel, designed for twice-daily use over seven days. Gel compositions were structured based on Table *1* specifications. Gel-making involves weighing ingredients, mixing water with hydroxypropyl methylcellulose (HPMC), adding preservatives, and sealing the resulting mixture in a tube [19].

No	Ingredient	F1 (10%) (g)	F2 (20%) (g)	F3 (40%) (g)
1	Banana stem extract	4 gr	8 gr	16 gr
	Hpmc *	2 gr	2 gr	2 gr
	Polyethylene glycol *	6 gr	6 gr	6 gr
2	Methylparaben *	0,16 gr	0,16 gr	0,16 gr
	Propylparaben *	0,16 gr	0,16 gr	0,16 gr
	Aqua ad	200 ml	200 ml	200 ml

TABLE 1: Composition of the gel formulation derived from the stem extract of Musa Cavendish

*: Gel matrix, F1: Gel containing 10% MUCASE, F2: Gel containing 20% MUCASE, F3: Gel containing 40% MUCASE

HPMC: hydroxypropyl methylcellulose

Creating dual wound dressings with dimensions of 10 cm x 10 cm from the gel formulation included soaking sterile gauze in a chitosan solution for 24 hours as a natural polymer for supporting antimicrobial efficacy and promoting mild wound healing. Dry it at 60-65°C for an hour to remove excess water, before creating dual wound dressings from the Musa Cavendish extract gel formulation, and apply 2 grams of gel (Figure *2* for comparison). The gauze was then sterilized using an autoclave. The remaining extract has an average of 1 gram after direct wound application around once daily, used over seven days to optimize and ensure the consistency of treatments. The positive results suggest that the wound may have absorbed some effective MUCASE extracts or experienced other processes during the application.

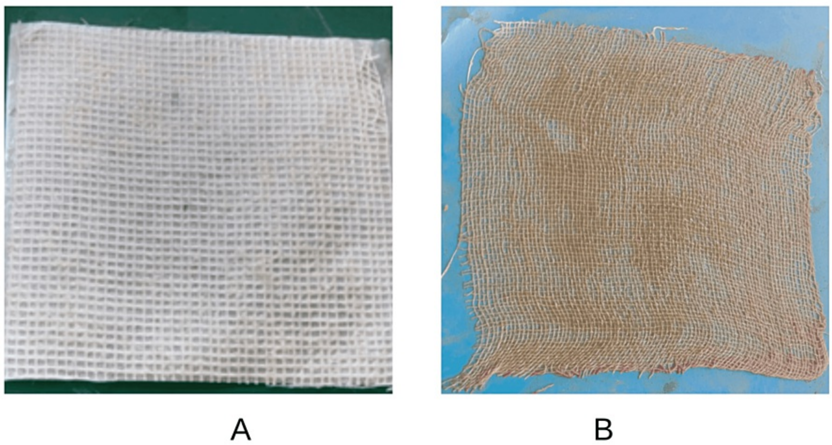

FIGURE 2: Comparison

a: Sofratulle® dessing; b: MUCASE dressing

Surgical procedure on animals and evaluation of wound healing activity parameters

For the animal study, fifteen male Wistar rats (*Rattus norvegicus*) were procured from Akafarma Sunan Giri Laboratory, Ponorogo, East Java, Indonesia. The rats weighed between 140±30 grams, and their average age was nine weeks old. The animals underwent acclimatization for seven days and were divided into five groups spaced in different rooms. Random numbers were generated using the standard function = RAND() in Microsoft Excel (Microsoft Corporation, Redmond, Washington, United States). They were kept in controlled environments with a 12-hour light/dark cycle, had their temperature regulated, and were fed and hydrated in the afternoon during this acclimatization phase. All animal care procedures adhere to ethical guidelines to minimize animal suffering. The rats were split into five randomly homogeneous groups, designated Groups A, B, C, D, and E, with three rats in each group. Group A: Ten percent of MUCASE was administered to three rats. Group B: A 20% dosage of MUCASE was administered to three rats. Group C: A 40 % dose of MUCASE was administered to three rats. Group D: As a positive control, three rats received Sofratulle®

treatment. Group E: Three rats were given an HPMC basic formula as a negative control.

Before conducting the surgical procedure, the animals were anesthetized using inhaled ether. Subsequently, the dorsal area of the rat, designated for the procedure, was shaved using an electric clipper, moving from head to tail, and the area was adjusted to a size of 4 x 4 cm. The skin was then cleaned with cotton soaked in 70% alcohol. On the first day of the experiment, a 1.5 cm long and 0.2 cm wide surgical straight incision was created on the rat's back using a sharp surgical knife. Following the incision surgical, the splints were not applied to this minor incision wound size in rats due to several reasons: size and proportion, technical challenges, and animal welfare considerations; therefore, in this study, only topical treatment approaches are used, while splints are commonly used in wound management for larger wound animals or humans. Following the incision, the skin was cleaned with 0.9% saline, and a 2 × 2 cm bilayer, Sofratulle®, and Musa Cavendish's extract was directly applied onto the incision wound with gentle pressure to secure the layer in place over the wound site and to ensure uniform coverage and contact of the treatment with the wound surface while minimizing disruption to the healing process. The rats were divided into pre-established groups and dressed with sterile gauze and adhesive plaster. Every two days, the dressing was replaced until the wound healed.

Furthermore, exudation measurement, wound healing percentage, and contraction during seven days were the primary criteria assessed in this investigation. The measurements of exudation, bleeding, adhesive, and odor of the dressing were monitored by macroscopic examination and graded on a four-point scale of 0-low (0% - 25%), 1-moderate (26% - 50%), 2-high (51% - 75%), and 3-very high (76%-100%). Meanwhile, measuring wound closure or wound contraction, by taking pictures of the rats after the experiment and on the day of surgery; a ruler is positioned next to the wound site for proper scaling. Image software was used to measure the wound area at each point, and Microsoft Excel was used to enter the results [20,21]. Furthermore, according to previously established definitions, the percentage of wound healing was measured using millimeters from the wound edge, and the percentage of wound duration was calculated based on the amount of time required for healing from the day of incision with the following formula: wound healing time = (initial radius-final radius) [22]. The area of wound closure/wound contraction was calculated (%) with the following formula: % wound contraction = {(initial wound area − current wound area)/initial wound area} × 100 [23]. Wound area data are expressed as mean ± standard deviation.

Phytochemical composition of Musa Cavendish

In the pursuit of understanding the phytochemical composition of Musa Cavendish, several studies aimed to comparatively evaluate the content within its peel and stem, employing various extraction methods detailed in Table *2*. This investigation sheds light on the diverse array of phytochemicals in the stem extract, encompassing compounds such as tannins, saponins, flavonoids, steroids/terpenoids, phenolics, catechin, and gallocatechin. The extraction results revealed a rich profile of phytochemicals, providing valuable insights into the botanical constituents of Musa Cavendish. By seamlessly integrating the details from Table *2*, these findings illuminate the distinct characteristics of the stem's phytochemical composition, offering a comprehensive understanding of the plant's chemical constituents. This comparative analysis is a crucial step towards unraveling the wound healing potential applications and benefits associated with the diverse phytochemicals in Musa Cavendish.

Compound examination	Reagent	Description		Test location, a,b,c, and reference
		Banana peel	Banana stem	
Alkaloid	Meyer's test	(-)	(-)	[24]
	Dragendorff's test	(-)	(-)	[24]
Flavonoid	Bate Smith & Metcalf's method	(+)	(+)	[24]
	2,2-diphenyl-1-picrylhydrazyl, the ferric thiocyanate	(+)	(+)	[25]
Tannin/Polyphenol	(+)FeCl3	(+)	(+)	[24]
Saponin	Forth TEST	(+)	(+)	[24]
Steroid/Terpenoid	Concentrated HCL + Sulfuric acid	(+)	(+)	[24]
Catechin	Folin–Denis method	(+)	(+)	[26]
Phenolics	The ferric thiocyanate	(+)(+)	(+)	[26]
	2,2-diphenyl-1-picrylhydrazyl and the ferric thiocyanate	(+)	(+)	[25]
Gallocatechin	The ferric thiocyanate	(+)(+)	(+)	[26]

TABLE 2: Phytochemical assessment of Musa Cavendish extract

Examination locations a: Agricultural Technology Laboratory, Lampung State Polytechnic, 2022 [24]; b: São João do Polêsine (RS, Brazil) [25]; and c: Laboratory of Biostructural Chemistry, Graduate School of Life Sciences, Tohoku University, Japan [26]

Analytical statistics

For every piece of quantitative data gathered, the arithmetic mean and standard deviation were calculated. It carefully measured the wound length throughout four intervention sessions spanning seven days. These measurements were then used to calculate the percentage of wound healing. To ensure data reliability, it performed the Shapiro-Wilk test to check for a normal distribution. Additionally, Levene's test was applied to confirm the consistency within each group and in cases where a significant difference was found through Levene's test, Welch's One-Way ANOVA was employed. If Welch's One-Way ANOVA revealed notable results, the Games Howell post-hoc test was conducted to identify specific groups that showed significant differences within the sample. These statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 26 (Released 2019; IBM Corp., Armonk, New York, United States). It maintained a significance threshold of $p < 0.05$ throughout our analysis.

Results

The quantitative data analysis, utilizing MUCASE at concentrations of 20%, 40%, and Sofratulle®, demonstrated in Table *3* a consistent reduction in overall exudation concerning incision wound interventions in comparison to MUCASE 10% and the negative control, achieving statistical significance ($p < 0.05$).

Parameters	Groups	N	Weight/gr average	Days after wound Induction (scale (%± SD))			
				One day	Three days	Five days	Seven days
Exudation (volume, type, and odor)	MUCASE 10	3	161	1 (45.67 ±3.79)	1 (40.7± 2.1)	0 (27.3±1.5)	0 (8.7± 1.2)
	MUCASE 20	3	170	1 (48.33 ± 2.89)	0 (23±2.65)	0	0
	MUCASE 40	3	162	1 (42.33±2.52)	0 (20.33 ±2.52)	0	0
	Sofratulle	3	168	1 (46±3.61)	0 (20.67±3.79)	0	0
	Negative control	3	137	1 (46±3.61)	1 (34.33±4.04)	0 (28.67±3.06)	0 (16.67± 2.31)

TABLE 3: Exudation parameters of incision lesions after topical treatment with MUCASE 10, MUCASE 20, MUCASE 40, Sofratulle and negative control (n = 15) in rats

The peak of exudation was observed on the first day during the secondary dressing change, with a higher occurrence in areas treated with MUCASE 20%, 40%, and Sofratulle® (nine rats) compared to negative control and MUCASE 10% (six rats). Subsequently, a decline in exudation was noted as the healing progressed over the subsequent days (Figure 3).

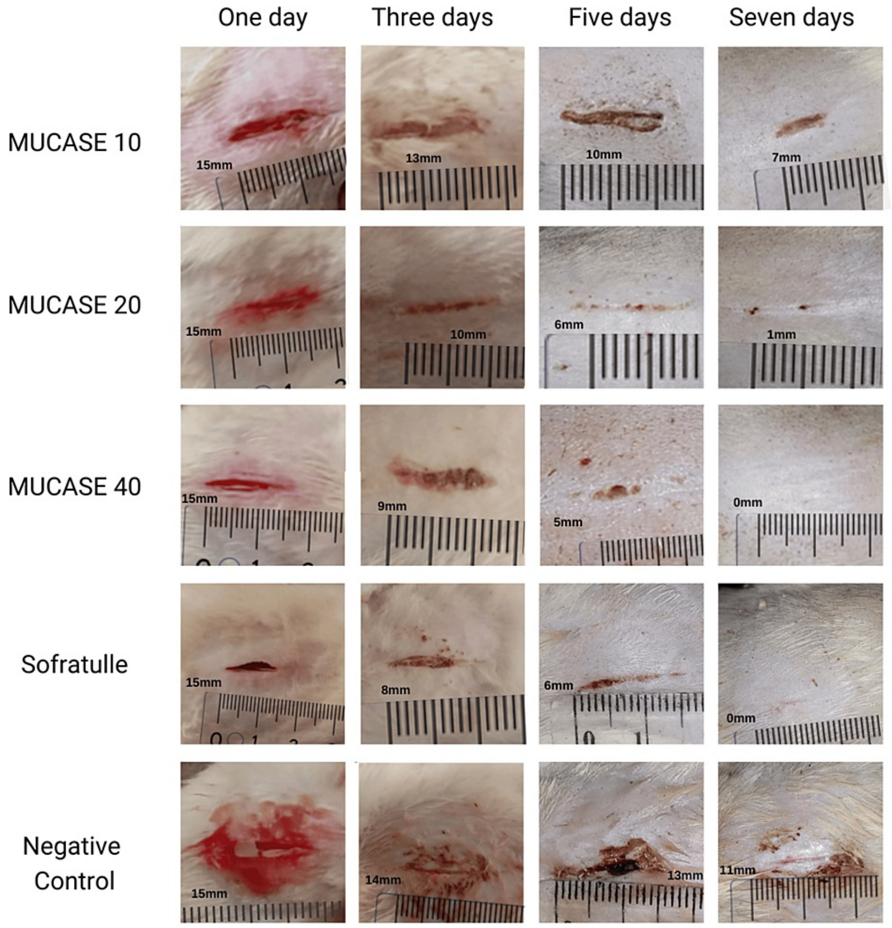

FIGURE 3: Arrangement of rat illustrations

When the wounds were scabbing, the figures were measured by carefully observing the wound under good lighting to identify its boundaries and gently removing a portion of the scab if safe for wound length or contraction measurements. Then, using a ruler, document its observations and track its changes over time.

Throughout the randomization-controlled research framework involving five pharmaceutical interventions over three days, no persistent bleeding occurred during the healing period. The frequency and duration of dressing changes exhibited no discernible difference within the confines of the study between wounds covered with MUCASE 20%, 40%, and Sofratulle®, MUCASE 10%, and wounds treated with the negative control.

The normality test results, indicating a value of $p > 0.05$, confirmed the normal distribution of the data. However, the Levene test revealed non-homogeneity in some data ($p < 0.05$). Subsequently, Welch's One-Way ANOVA was employed, revealing a significant mean difference among the treatment groups ($p = 0.004 < 0.05$). According to this statistical analysis, the application time of MUCASE 10%, 20%, 40%, Sofratulle®, and negative control dressings gradually decreased as the epithelialization process advanced, with the dressing completely absorbed after application. The primary dressing was changed every two days following the previous day's discharge, with no significant variation in the application time of the five dressings. On average, wound healing durations were 0.79 ± 6.70 days for MUCASE 40%, 20%, and Sofratulle®, 6.67 ± 8.31 days for MUCASE 10% and 13.67 ± 7.16 days for negative control. Wound closure was initiated on the second day and concluded by the sixth day. They indicated a notable disparity in the time required for wound healing, even in the latter stages of the process (Table 4).

Mean, standard deviation, and p-value for WSA after the treatment (mm^2)					p-value
	One day	Three days	Five days	Seven days	
Mucase 10%	15.67±0.577	14.33±1.155	12.33±1.155	6.67±2.309	0.013 [a]
Mucase 20%	15.67±0.577	12.67±0.577	7.00±1.000	1.03±0.950	0.000 [a]
Mucase 40%	15.33±0.577	10.33±0.577	4.33±0.577	0.33±0.577	0.000 [a]
Sofratulle®	15.33±0.577	10.67±1.155	5.00±1.000	1.00±1.000	0.000 [a]
Negative control	16.00±1.000	15.00±1.000	14.67±1.155	13.67±1.155	0.268

TABLE 4: Following the intervention, the mean and standard deviation of wound surface area (WSA) with a 95% confidence interval for each group

WSA: wound surface area

[a]Statistically significant via Welch's One-Way ANOVA <0.05

Examination of significant differences between certain pairs of groups among the five treatment groups revealed significant differences among specific groups (Table 5). A significant distinction was observed between the negative control group and the 20%, 40%, and Sofratulle® groups ($p < 0.05$). At the same time, no significant difference was identified between the negative control group and the 10% group ($p > 0.05$). Nonetheless, the MUCASE 40%, MUCASE 20%, and Sofratulle® groups exhibited no significant differences ($p > 0.05$). The differences between the control and treatment groups emerged from the second day of observation, remaining significant until the seventh day. On the third day, MUCASE 20%, MUCASE 40%, and Sofratulle® dressings outperformed negative control and MUCASE 10%. Despite varied recovery stages, the healing process commenced on the first day and continued until the fourth day. Rapid tissue formation occurred from the fifth to the seventh day, resulting in wound healing and hair regrowth. The results suggest that the three phases of wound healing in rats with incision wounds can be expedited using MUCASE as a topical dressing. Wound improvement became evident on the fifth day, with MUCASE 40% and Sofratulle® dressing groups exhibiting superior wound healing.

(I) Intervention level		Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
MUCASE 10 %	MUCASE 20%	3.167	2.025	0.537	-2.93	9.26
	MUCASE 40%	4.667	2.047	0.195	-1.50	10.84
	Sofratulle®	4.250	1.989	0.246	-1.73	10.23
	Negative control	-2.583	1.154	0.224	-6.20	1.03
MUCASE 20%	MUCASE 10 %	-3.167	2.025	0.537	-9.26	2.93
	MUCASE 40%	1.500	2.427	0.971	-5.70	8.70
	Sofratulle®	1.083	2.379	0.991	-5.97	8.14
	Negative control	-5.750*	1.742	0.041	-11.30	-0.20
MUCASE 40%	MUCASE 10 %	-4.667	2.047	0.195	-10.84	1.50
	MUCASE 20%	-1.500	2.427	0.971	-8.70	5.70
	Sofratulle®	-0.417	2.398	1.000	-7.53	6.70
	Negative control	-7.250*	1.768	0.010	-12.89	-1.61
Sofratulle®	MUCASE 10 %	-4.250	1.989	0.246	-10.23	1.73
	MUCASE 20%	-1.083	2.379	0.991	-8.14	5.97
	MUCASE 40%	0.417	2.398	1.000	-6.70	7.53
	Negative control	-6.833*	1.700	0.012	-12.25	-1.42
Negative control	MUCASE 10 %	2.583	1.154	0.224	-1.03	6.20
	MUCASE 20%	5.750*	1.742	0.041	0.20	11.30
	MUCASE 40%	7.250*	1.768	0.010	1.61	12.89
	Sofratulle®	6.833*	1.700	0.012	1.42	12.25

TABLE 5: Examination of significant differences between specific pairs of groups among the five treatment groups (MUCASE 10, 20, 40, Sofratulle®, and negative control) via Games Howell post hoc analysis

Wound contraction results over seven days, as depicted in Figure 4 and Table 6. It indicated the average percentage of wound contraction to the initial wound on days one, three, five, and seven as 19% ± 0.12%, 26% ± 0.17%, 27% ± 0.13%, and 71% ± 0.36%, respectively. On the first day, MUCASE 40% displayed a more significant contraction percentage (33%) compared to MUCASE 20% (17%) and MUCASE 10% (9%), despite subsequent contraction decrease. Nevertheless, a significant difference was observed on the first day when comparing MUCASE 40% and Sofratulle® (31%) with negative control (6%). Three days later, MUCASE 40%, MUCASE 20%, MUCASE 10%, Sofratulle® (37%), and negative control (2%) achieved maximum contractions of 33%, 39%, 36%, 37%, and 2%, respectively. Although MUCASE 40% exhibited the most significant contraction on the third day, no appreciable difference in wound contraction was observed between these groups on the fifth and seventh days. On the seventh day, distinct differences in the wound contraction of MUCASE 20% (58%) and negative control (15%) were noted, while MUCASE 40%, Sofratulle®, and MUCASE 20% demonstrated no significant alterations throughout the observation period. The wound area consistently diminished over time, with no appreciable variation in wound contraction among the three groups on the seventh day.

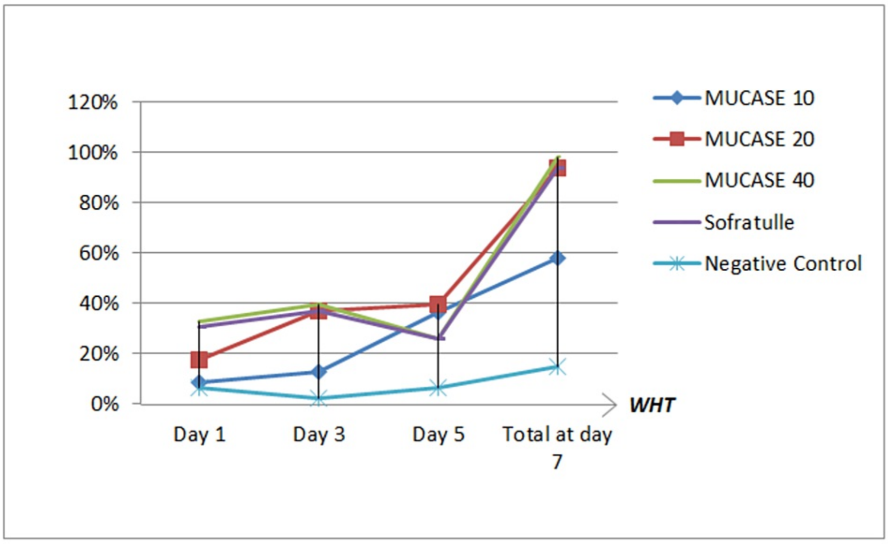

FIGURE 4: Illsutrates wound contraction after each group between days one and seven (n = 5) for the experimental groups (MUCASE 40%, 20%, 10%), Sofratulle®, and negative control. On the seventh day, there was no noticeable distinction between the Sofratulle®, MUCASE 40%, and 20% groups. However, significant differences were identified when comparing these groups with the MUCASE 10% and negative control groups.

WHT: wound healing time

Postwounding days	Percentage wound contraction (mean ± SEM)				
	MUCASE 10	MUCASE 20	MUCASE 40	Sofratulle	Negative Control
1	15.67 ± 0.33	15.33 ± 0.33	15.33 ± 0.33	15.33 ± 0.33	16.00 ± 0.58
3	15.00 ± 0.50	14.00 ± 0.00	12.83 ± 0.33	13.00 ± 0.50	15.50 ± 0.58
5	13.33 ± 0.67	9.83 ± 0.44	7.33 ± 0.33	7.83 ± 0.60	14.83 ± 0.60
7	9.50 ± 1.00	4.00 ± 0.58	2.33 ± 0.17	3.00 ± 0.00	14.67 ± 0.67

TABLE 6: Percentage wound contraction

Each value is the mean ± SEM, standard versus n=15, SEM: standard error of mean

Discussion

Wound healing, tissue regeneration, and recovery from injury involve strategies such as wound contraction to expedite healing [20]. Recent studies highlight the potential of herbal or synthetic composites, including plant-derived materials, in enhancing wound healing efficiency [4-6]. However, limited scientific literature exists on the therapeutic effects of topical agents in skin wound healing [27]. Incision wounds demand careful attention to prevent infection and necessitate specialized treatment [20,28]. This study compares the impact of varying MUCASE concentrations on incision wound healing, revealing that MUCASE at 40%, 20%, and 10% accelerates healing compared to controls.

Incision wounds often penetrate deep dermal layers, affecting hair follicles and tissue glands [29]. Complete wound healing within six days was observed for MUCASE 40%, 20%, and Sofratulle®, contrasting with 6.67 ± 8.31 days for MUCASE 10% and 13.67 ± 7.16 days for negative control. Notably, 40% of MUCASE exhibited the most efficient healing. Different concentrations of MUCASE influenced wound contraction, aligned with its protective effects against oxidative damage and antibacterial, antifungal, and antioxidant properties [24-26,30].

With the increasing prevalence of antibiotic resistance, effectively treating wound infections has become a significant challenge in wound recovery [30]. In this context, using natural compounds such as MUCASE has proven promising in reducing exudation, potentially preventing infection, and as a natural wound healing agent. Flavonoids, for example, have been studied extensively for their wound-healing effects, including increasing collagen synthesis and angiogenesis and inhibiting microbial growth and inflammation [24,25]. Tannins/polyphenols have astringent properties that aid wound contraction and promote tissue repair [24]. Saponins exhibit antimicrobial and anti-inflammatory activity, contributing to wound sterilization and reduction of inflammation [24]. Steroids/terpenoids have been reported to accelerate wound healing by increasing fibroblast proliferation and collagen synthesis [24]. Catechins, phenolics, and gallocatechins are potent antioxidants that scavenge free radicals, thereby protecting cells from oxidative damage and promoting tissue regeneration [24-26].

Wound contraction, a vital healing aspect, was effectively enhanced by MUCASE 40%, 20%, and Sofratulle®. While MUCASE 40% demonstrated superior healing and early contraction, MUCASE 20% also proved effective. Scab formation and epithelial cell coverage in the MUCASE 40% group expedited healing, contrasting with prolonged scarring in the MUCASE 10% and negative control groups. Sofratulle® was deemed safe and effective, albeit costlier than MUCASE. Rivaling the efficacy of Sofratulle®, MUCASE, especially at 40% and 20%, emerges as a cost-effective and potent incision wound care dressing.

Treating incision wounds with Sofratulle® is safe and effective, albeit more expensive than MUCASE dressings. Cost-effectiveness studies reveal that reasonably priced topical medicines are economically superior to Sofratulle® [14]. In providing efficient and reasonably priced incision wound care, MUCASE, especially at concentrations of 20% and 40%, emerges as a potential competitor to Sofratulle®. The study's focus on minor incision wounds limits the exploration of hyperpigmentation and hypertrophic scarring, common in larger burn wounds treated with Sofratulle®.

Several limitations need to be considered in this study. Firstly, the relatively small size of the research groups and using rats as a model may limit the generalization of these findings to the human population. Therefore, multi-center studies involving more extensive human samples are required to validate and support our research findings. Second, the straight incision wound depth was only evaluated, not including the skin tension; therefore, future research can benefit from using objective assessment instruments like the laser Doppler and tensiometer with circle wound or another type of incision and excision wound, which can improve accuracy and group comparison. Following this, due to the minor incision wound size in rats then, the splints were not applied due to several reasons: size and proportion, technical challenges, and animal welfare considerations; therefore, in this study, only alternative approaches are used, while splints are commonly used in wound management for larger wound animals or humans. Additionally, although wound areas were randomly selected, there is a possibility of variation in incision wound depth around the rat's back, which could affect the results. This study also did not include a long-term evaluation, so differences in scar quality cannot be discussed in detail.

Conclusions

In conclusion, the study addressed the need for innovative wound healing strategies, emphasizing plant extracts, mainly from Musa Cavendish banana stems. The study demonstrated that MUCASE, especially at concentrations of 40% and 20%, accelerates wound healing, reduces exudation, and enhances wound contraction in incision wounds compared to lower concentrations and a negative control group. To facilitate efficient and swift wound healing, MUCASE concentrations exceeding 20% and Sofratulle® are suitable as wound dressings. Although both options exhibit advantages, MUCASE could be a cost-effective and potent alternative to commercial wound dressings, offering potential benefits in antibacterial, anti-inflammatory, and antioxidant properties. Despite some limitations, this study contributes valuable insights into the application of plant extracts in wound care, emphasizing the need for further research to establish MUCASE's efficacy in larger-scale and long-term clinical settings.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Nuraini K. Amanah, Sugeng Mashudi, Siti Munawaroh, Auliya W. Azzarin, Fadhilah N. Karimah

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Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue. **Animal subjects:** Ethical approval for the research was secured from the Institute of Health Science Ethical Clearance Committee in Strada Indonesia, Kediri, Indonesia. Issued protocol number 3946/KEPK/X/2023. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** The Funding from the Indonesian Ministry of Education and Culture, Director of Learning and Student Affairs Number 0596/E2/KM.01.01/2023. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Intellectual property info:** We could plan the product and article copyright to the Directorate General of Intellectual Property (DJKI) after the article is published. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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PROPOSAL
P2MW SKEMA MANUFAKTUR DAN TEKNOLOGI TERAPAN

KAPIIL (Kasa Alami Pisang Anti Inflamasi Luka)

Anggota :

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Anggota I	Auliya Wanda Azzarin	20631950
Anggota II	Fadhilah Nurul Karimah	20631944

UNIVERSITAS MUHAMMADIYAH PONOROGO
2023

I. LATAR BELAKANG

"KAPIIL (Kasa Alami Pisang Anti Inflamasi Luka)" merupakan satu usaha bisnis produk medis karya mahasiswa Universitas Muhammadiyah Ponorogo Fakultas Kesehatan yang memanfaatkan limbah pisang yang dibangun pada akhir tahun 2022. *KAPIIL* didirikan oleh "*tiga sekawan*" yang memiliki visi dan misi terhadap perubahan lingkungan yang sehat dan baik. Berbagai bagian pisang seperti daun, batang semu, empulur dan kulit buah dapat dimanfaatkan untuk aplikasi berbasis makanan yang berbeda seperti agen pendukung, pewarna, pakan ternak dan nutraceuticals (Padam et al., 2014) dan aplikasi berbasis nonpangan seperti pembuatan kantong teh, pupuk hayati, pengolahan air limbah, produksi kertas (Tripathi et al., 2019), tekstil dan komposit (Akinyemi and Dai, 2020). Seperti serat alam lainnya, sifat mekanik serat batang semu pisang sebanding dengan bala bantuan kesehatan tradisional dimana serat nabati, memberikan manfaat tambahan bagi industri sebagai alternatif kesehatan ramah lingkungan (Yan et al., 2016). Selain ramah lingkungan, serat alami memberikan fitur tambahan berupa keterbaruan, ringan, daya serap yang sangat baik, dan sifat mekanik (Dunne et al., 2016). Bahkan, dalam manajemen luka, bagian-bagian pisang memberikan manfaat efisien secara biomedis dalam penyembuhan luka secara cepat dan organik (Sari et al, 2021; Amutha & Selvakumari, 2016; Kundarto et al, 2020). Hasil penelitian menunjukkan bahwa hidrokloid serat pohon pisang (*musa sp*) mampu mempertahankan kelebaban luka neuropathi diabetikum pada stadium 2 (Julianto & juwono, 2016). Hanya saja, belum ada produk yang ditawarkan seperti *KAPIIL* yang ditawarkan oleh beberapa industri medis saat ini. Oleh karenanya, *KAPIIL* mengambil peran untuk memanfaatkan limbah pisang khususnya batang semu pisang (*pseudo-stem*) yang merupakan bagian terbesar dari limbah biomassa yang tersisa setelah pemanenan buah yang dapat menjadi sumber alternatif kesehatan untuk industri berbasis serat (Yan et al., 2016).

Sejarah dan latar belakang didirikannya *KAPIIL* yaitu berangkat dari kepedulian lingkungan sehat terhadap pengelolaan limbah organik dan inovasi dalam pengetasan kemiskinan di Jawa Timur. Tercatat bahwa limbah batang semu pisang merupakan sisa pertanian yang melimpah di setiap kota di Indonesia, sebagai gambaran, data Badan Pusat Statistik (BPS) menunjukkan bahwa pada tahun 2021 produksi pisang tertinggi terdapat di Provinsi Jawa Timur mencapai 2.048.948 ton/tahun dimana angka ini setara dengan 20,35% dari total produksi pisang secara nasional (BPS, 2021). Kabupaten tertinggi produksi pisang di Jatim secara berurutan berada di kabupaten Malang, Pasuruan, Lamongan, Banyuwangi, Lumajang dan Ponorogo, yang akhirnya, potensi limbah pisang setiap kabupaten di Jatim akan meningkat setiap tahunnya jika setiap ton pisang yang dipanen akan menghasilkan sekitar empat ton limbah lignoselulosa (tiga ton batang semu, 160 kg batang, 480 kg daun dan 440 kg kulit pisang), dan sekitar 100 kg buah yang dibuang (Anissa Nurdiawati et al., 2015). Disamping itu, meskipun tingkat kemiskinan di jawa timur per September 2022 menurun 0,10 persen dibandingkan tahun sebelumnya namun Jawa Timur menjadi daerah dengan jumlah penduduk miskin terbanyak di Indonesia (Widi, 2023). Tercatat penduduk miskin di Jawa Timur sebanyak 4,24 juta orang (BPS, 2023). Dengan demikian, diperlukan berbagai inovasi pengelolaan limbah pisang yang juga berkontibusi dalam membangun kemandirian ekonomi masyarakat di Jawa Timur diantaranya dengan produksi produk medis *KAPIIL*.

KAPIIL dikategorikan sebagai usaha produk medis di skala mikro dengan bisnis industri produksi bahan mentah pisang yang dijalankan secara perorangan. Berdasarkan lini produk, *KAPIIL* termasuk kedalam usaha *single line* yaitu usaha yang hanya memanfaatkan limbah pisang menjadi produk medis. Di usianya yang sangat muda, berusaha berkolaborasi dengan pemerintahan Ponorogo terutama dengan dinas kesehatan Ponorogo sehingga KAPIIL bisa berperan sebagai inisiator dan penggerak dalam meningkatkan kesadaran masyarakat terhadap lingkungan dalam hal pengelolaan sampah sebagai produk bermanfaat. Saat ini, *KAPIIL* berusaha menjadikan kesadaran masyarakat akan lingkungan untuk mencapai beberapa tujuan pembangunan berkelanjutan. Oleh karenanya, *KAPIIL* berusaha mewujudkan penanganan perubahan iklim dengan menjadikan komsumsi dan produksi buah pisang yang bertanggungjawab sehingga menciptakan industry dan inovasi, serta lahan kerja dan menciptakan kebermanfaatan bagi pendidikan dan kesehatan bangsa.

II. DESKRIPSI USAHA

A. NOBLE PURPOSE

Tujuan didirikannya *KAPIIL* adalah membentuk inovasi baru di bidang kesehatan dengan memanfaatkan limbah pisang khususnya bagian kandungan gedebong yang memiliki eksplorasi manfaat medis yang luas tentunya mengangkat budaya lokal, bernilai ekonomis, dan ramah lingkungan. Di sisi lain, pemanfaatan limbah pisang tersebut juga sebagai upaya dalam membantu meningkatkan perekonomian masyarakat dengan memberikan lahan kerja bagi masyarakat lokal. Tujuan tersebut merupakan landasan untuk mencapai visi misi *KAPIIL* dalam perubahan lingkungan sehat dan baik.

B. KONSUMEN POTENSIAL

Karakteristik calon konsumen potensial dari kerajinan limbah pisang *KAPIIL* adalah rumah sakit, apotik, klinik, puskesmas, layanan kesehatan lainnya dan masyarakat yang sadar akan pentingnya dalam penggunaan *"green product"* yaitu produk yang ramah lingkungan dan dapat mengurangi pencemaran lingkungan dengan membeli dan cenderung memilih produk tersebut. Beberapa penelitian menyebutkan bahwa secara global terdapat tingginya keinginan konsumen untuk memilih *green product* dibandingkan dengan produk konvensional (Chen & Thai, 2010: Kim & Chung, 2011: Yaday & Pathak, 2016), dan juga dengan menggunakan *green product* konsumen lebih merasakan peningkatan nilai sosial yang mengarah kepada peningkatan kenikmatan pengalaman konsumsi *green product* (Tezer & Bodur, 2020). Dengan demikian produk dari limbah pisang ini memiliki potensi pasar yang luas baik secara nasional maupun global dalam menciptakan konsumsi produk yang ramah lingkungan.

C. PRODUK (DISERTAI FOTO)

Keunikan dan kebermanfaatan dari produk ini adalah menjadikan suatu kemudahan bagi masyarakat khususnya tenaga kesehatan dalam memberikan perawatan luka secara alami, ekonomis, dan ramah lingkungan yang tentunya tidak lepas dari kombinasi unsur pemberdayaan masyarakat dalam rangka peningkatan perekonomian. Berikut beberapa foto produk :

D. SUMBER DAYA

Untuk menjalankan usaha ini, kapasitas dan kapabilitas dari tim "tiga sekawan" yaitu Nuraini K. A. sebagai ketua memiliki kapasitas sebagai ibu rumah tangga dan juga guru di beberapa pondok pesantren dan perawat yang selalu mempromosikan akan kesehatan dan sebagai upaya peningkatan status masyarakat khususnya di Ponorogo. Auliya Wanda A. sebagai divisi administrasi dan pengadaan bahan mentah merupakan perawat yang memiliki kemampuan dalam penjualan produk dan juga merupakan bagian penting dari beberapa lembaga yang ada di Ponorogo yang mana berperan sebagai promotor guna mempercepat pengenalan produk pada masyarakat. Fadhilah Nurul K. sebagai divisi pengembangan dan pemasaran merupakan perawat dengan kapasitas jaring kerjasama khususnya dalam industri farmakologi.

Untuk mendukung proses dan strategi pemasaran, sarana dan prasarana yang digunakan masih tradisional dengan memanfaatkan beberapa bahan serta alat yang tersedia. Adapun segi pemasaran dilakukan secara langsung dan tidak langsung, yaitu bekerja sama dengan pemerintah Ponorogo, Dinas Kesehatan Ponorogo, dan beberapa instansi kesehatan lainnya serta media sosial dan *online market place*. Modal keuangan usaha berasal dari modal tim *KAPIIL* dengan pengelolaan secara mandiri.

III. RENCANA KEGIATAN DAN PENGGUNAAN ANGGARAN

Kegiatan Utama	Rencana							Penanggung Jawab
	Kegiatan	**Nama Barang**	**Kuantitas**	**Satuan**	**Harga Satuan (Rp)**	**Jumlah (Rp)**	**Target Capaian**	
	A	**B**	**C**	**D**	**E**	**F = C x E**	**H = Output A**	
Pengembangan Produk/Riset	a. mencetak repacking dan labelisasi brand produk	Packing Bungkus aluminium	1000	Bungkus	Rp. 1600	Rp. 1.600.000	packing dan labelisasiproduk dan sosialisasi pemasaran	Nuraini K.A
		packing dalam transparan plastik	1000	Bungkus	Rp. 1000	Rp. 1.000.000		
		Kerdus obat	1000	kotak	Rp. 1000	Rp. 1.000.000		
		kertas petujuk penggunaan dan	1000	kertas	Rp. 600	Rp. 600.000		

		informasi obat.						
		Printing label packaging	1000	Kertas	Rp. 400	Rp. 400.000		
	b. Mensosiali Pemasaran produk untuk memperluas	Banner	4	banner	Rp. 100.000	Rp. 400.000		
		Pengambilan dan editing video Pemasaran produk.	1	video	Rp. 200.000	Rp. 200.000		
Produksi	a. filterisasi dan pengolahan limbah pisang	Benzoil alkohol	1	liter	Rp 1.780.000	Rp. 1.780.000	filterisasi pengolahan limbah pisang serta uji sterilisasi dan uji praklinik	Team KAPIIL
		natrium klorida	1500	gram	Rp. 400	Rp. 600.000		
		alkali hidroksida	2	kg	Rp. 280.000	Rp. 560.000		
		bakteri mati/hidup	3000	ml	Rp. 150	Rp 450.000		
		chloramp	250	gram	Rp 7.548	Rp. 1.887.000		

		henicol Elisa kit						
		clotrimazole	250g	gram	Rp 3000	1.500.000		
	b. Uji sterilisasi produk	uji Endotoksi Bakteri/ Enterobacteriaceae obat tradisional	1	paket	Rp. 450.000	Rp. 450.000		
	c. uji praklinik *(in vivo atau in vitro)*	uji invitro	1	paket	Rp. 273.000	Rp. 273.000		
Legalitas, Perizinan, Sertifikat, dan Standarisasi	a. Sertifikat halal	Sertifikat	1	pcs/legalitas	Rp. 300.000	Rp. 300.000	sertifikat halal dan BPOM	Wanda A
	b. BPOM	BPOM	1	pcs/legalitas	Rp. 2.000.000	Rp. 2.000.000		
Belanja ATK dan Penunjang	a. sarana penunjang	**set**	1		Rp. 750.000	Rp. 750.000	sarana penunjang	Fadhilah N.K
Total Keseluruhan						**Rp. 15.000.000**		

IV. PENUTUP

Dari penjelasan isi proposal di atas, kami berharap usaha produk ini dapat berkembang pesat dengan bantuan dana yang tepat. Harapan kami akan maju dan berkembangnya usaha ini berdasarkan pada kualitas SDM yang baik dan terjamin. Selain itu tawaran produk ini juga mendukung tujuan kepedulian kesehatan pada masyarakat khususnya kepada tenaga kesehatan maupun layanan kesehatan.

Business Model Canvas	*Designed for:* KAPIIL (Kasa Alami Pisang anti Inflamasi Luka)	*Designed by :* Nuraini, Auliya, Fadhilah	Date: 16/03/2023	Version:

Key Partners	**Key Activities**	**Value Propositions**	**Customer Relationship**	**Customer Segments**
1. Petani pisang 2. Akafarma 3. Laboratorium 4. Instansi kesehatan dan pemerintah terkait.	1. Bekerja sama dengan petani pisang 2. Solusi bagi seluruh instansi yang berhubungan dengan kebutuhan perawatan luka secara ekonomis, praktis, halal, dan harga terjangkau 3. Sosialisasi penjagaan lingkungan sehat dengan pemanfaatan limbah pisang di tingkat pemerintah dan masyarakat desa	1. Sebagai produk pertolongan pertama dalam penyembuhan luka yang terbuat dari bahan alami diproduksi secara steril, praktis digunakan, halal, terstandarisasi dan harga terjangkau 2. Meminimalisir terjadinya risiko infeksi serta kadungannya dapat mempercepat penyembuhan luka 3. Sebagai upaya membantu masyarakat Ponorogo dalam meningkatkan perekonomian dengan memberikan lahan kerja bagi masyarakat local.	1. Menjaga kualitas *ingredient* dalam cakupan aman dan sesuai SOP pembuatan agar mempertahankan kepercayaan pelanggan terhadap fungsi dan manfaat produk 2. Pengadaan *marketplace* berguna untuk mendapatkan *feedback* dari pelanggan 3. Penjelasan informasi seputar produk supaya produk tidak disalahgunakan	1. Rumah sakit 2. Puskesmas 3. Klinik kesehatan 4. Unit Kesehatan Sekolah 5. Apotik 6. Instansi dan organisasi masyarakat khususnya bidang kesehatan
	Key Resources		**Channel**	
	1. Limbah pisang yang di dapat melalui		1. Komunitas *green medical product*	

<table>
<tr>
<td></td>
<td>petani pisang dan juga UMKM yang memanfaatkan pisang
2. Produk harus memiliki standar legalitas yang sudah teruji dan juga kualitas yang baik dan halal.
3. Fasilitas penggunaan alat aman, steril, dan terjangkau harganya.
4. Distribusi produk bekerjasama dengan beberapa instansi kesehatan dan memanfaatkan jaringan sosial media.
5. Pengujian standarisasi produk guna evaluasi produk dan manfaatnya.</td>
<td></td>
<td>melalui Whatsapp Group (WAG), Instagram, facebook, serta open message di online marketplace lainnya
2. Bekerjasama dengan beberapa instansi dan organisasi khususnya di bidang Kesehatan untuk pengenalan produk melalui sosialisasi
3. Uji keamanan produk, branding, bonus/sample produk</td>
<td></td>
</tr>
<tr>
<th colspan="2">Cost Structure</th>
<th colspan="3">Revenue Streams</th>
</tr>
<tr>
<td colspan="2">1. Biaya produksi
2. Biaya pengembangan produk
3. Biaya uji laboratorium
4. Sertifikasi produk (halal dan BPOM)
5. Biaya pembelian bahan baku yang tidak tetap bisa diatasi dengan bekerjasama</td>
<td colspan="3">1. Arus pendapatan didapatkan melalui penawaran menarik dan pemasaran produk kepada segment customer, dengan memberikan beberapa sampel guna membuktikan bahwa produk ini adalah produk yang aman dengan kualitas baik dan meyakinkan
2. Bekerja sama dengan pemerintah dan instansi Pendidikan dalam mengeluarkan kebijakan serta dukungan penggunaan produk ini di setiap Aid box (kotak P3K)</td>
</tr>
</table>

dengan donasi masyarakat dengan gedebok pisang 6. Biaya penggunaan marketplace 7. Biaya sosial media bisnis.	

Lampiran (binis model kanvas)

1. ***Customer segment***

   Segment pengguna produk ini adalah rumah sakit, apotik, klinik, puskesmas, layanan kesehatan umum, dan masyarakat yang membutuhkan perawatan luka baik melalui operasi kecil atau besar dengan penggunaan "*green medical product*" yaitu produk medis yang ramah di tubuh, lingkungan dan harganya terjangkau dibandingkan produk yang selevel.

2. ***Value proposition***

   Produk ini sebagai produk pertolongan pertama dalam penyembuhan luka yang bersifat ramah lingkungan dengan pemanfaatan bahan-bahan pisang yang mudah ditemukan, utamanya di wilayah Jawa Timur, khususnya di Ponorogo. produk ini diproduksi secara steril, praktis digunakan, halal, terstandarisasi dan harga terjangkau. Selain itu, produk ini memiliki keunggulan dalam penurunan risiko infeksi serta mempercepat proses penyembuhan luka. Di samping itu, dari pengadaan produk ini berusaha turut serta dalam membantu masyarakat Ponorogo untuk meningkatkan nilai perekonomian dengan memberikan lahan kerja bagi masyarakat lokal.

3. ***Channels***

   Koneksi yang berkelanjutan dalam mengembangkan produk ini dilakukan melalui komunitas kesehatan yang mengusung *green medical product* melalui Whatsapp Group (WAG), Instagram, facebook, serta *open message* di online *marketplace* lainnya. Selain itu, uji keamanan produk, *branding* produk, bonus/sample produk, dan sosialisasinya bekerjasama dengan beberapa instansi dan organisasi khususnya di bidang kesehatan seperti dinas kesehatan, rumah sakit, puskesmas, apotik, PMR/UKS sekolah, KADIN, pemerintah desa dan instansi pendidikan dalam distribusi, pengenalan, proses transaksi produk ini.

4. ***Customer relationship***

   Cara yang dilakukan untuk tetap menjalin kepercayaan pelanggan pada produk ini yaitu dengan menjaga kualitas produk, yakni mempertimbangkan *ingredient* produk ini dalam cakupan aman, sesuai SOP pembuatan, produk terstandarisasi dan informasi seputar produk terus disampaikan pada pelanggan dengan tujuan agar tidak terjadi penyalahgunaan produk, di samping itu jalinan komunikasi melalui media sosial dan grup whatsapp bisnis, serta *marketplace* berguna untuk mendapatkan *feedback* dari pelanggan supaya produk ini dapat terus berkembang menjadi produk unggulan khususnya di bidang kesehatan dalam penanganan penyembuhan luka.

5. ***Revenue streams***

Melalui jaringan kerja yang dibangun, arus pendapatan didapatkan melalui penawaran menarik dan pemasaran produk kepada *segment customer* untuk mencoba produk ini dengan memberikan beberapa sampel untuk dibuktikan bahwa produk ini adalah produk yang aman dengan kualitas baik dan meyakinkan. Serta bekerjasama dengan pemerintah dan instansi pendidikan dalam mengeluarkan kebijakan serta dukungan penggunaan produk ini di setiap *Aid Box* (kotak P3K).

6. *Key activities*

Pembuatan produk bekerjasama dengan petani pisang. Memberikan solusi bagi seluruh instansi yang berhubungan dengan kebutuhan perawatan luka secara ekonomis, praktis, halal, dan harga terjangkau. kegiatan utama dirancang melalui platform sosial media bisnis seperti instragram, facebook, dan marketplace. sosialisasi penjagaan lingkungan sehat dengan pemanfaatan limbah pisang di tingkat pemerintah dan masyarakat desa.

7. *Key resources*

-Limbah pisang yang di dapat melalui petani pisang, masyarakat serta dan juga UMKM yang memanfaatkan pisang.

-Produk harus memiliki standar legalitas yang sudah teruji dan juga kualitas yang baik dan halal.

Fasilitas penggunaan alat aman, steril, dan terjangkau harganya.

distribusi produk melalui hubungan kerjasama dengan beberapa instansi kesehatan dan memanfaatkan jaringan sosial media.

Pengujian standarisasi produk selalu dilakukan guna evaluasi produk dan manfaatnya.

8. *Key Partnerships*

Mitra utama dalam usaha ini adalah petani pisang, akafarma, laboratorium, dan instansi kesehatan dan pemerintah terkait.

9. *Cost structures*

Biaya yaitu produksi, biaya pengembangan produk, biaya uji laboratorium, sertifikasi produk (halal & BPOM) serta biaya pembelian bahan baku yang tidak tetap bisa diatasi dengan bekerjasama dengan donasi masyarakat dengan gedebok pisang. biaya penggunaan marketplace, biaya sosial media bisnis.

Dokumentasi Kegiatan

A. BIMBINGAN DENGAN PEMBIMBING DAN MENJALIN KERJASAMA DG MITRA

Bimbingan pertama dengan pembimbing

Sampel pelepah pisang untuk dikonsultasikan ke pembimbing

Bimbingan selanjutnya

Dokumentasi bersama mitra kerja (pemilik kebun pisang)

Dokumentasi bersama Mitra kerja (UD Citra Alam)

Dokumentasi mitra kerja (Klinik Al-manar UNMUH Ponorogo)

B. PENGOLAHAN LIMBAH PISANG

Pemisahan batang pisang dengan bagian yang lainnya

Batang pisang yang sudah ditebang

Penimbangan pelepah pisang

Pemotongan pelepah menjadi bagian kecil

Pencucian pelepah pisang

Penjemuran pelepah dengan sinar matahari (3-5 hari)

Hasil pengeringan 1 day dengan matahari

Pengeringan menggunakan oven

Pelepah pisang yang sudah kering

Proses penghalusan

Pelepah pisang setelah halus

Pengayaan bubuk pelepah pisang

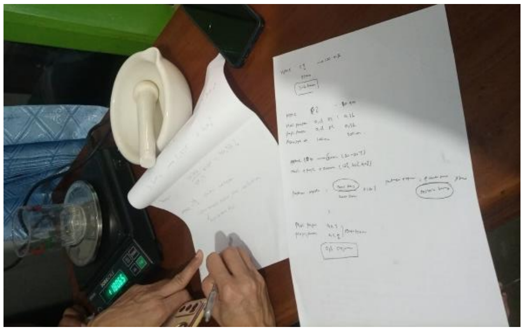
Hasil pengayaan

Bubuk pelepah pisang kepok

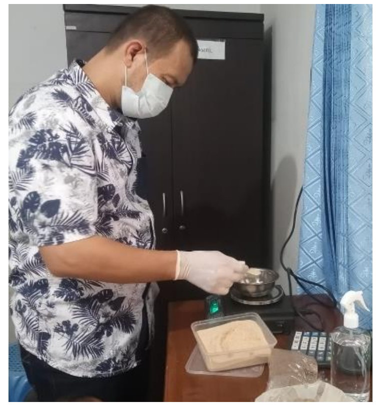
Bubuk pelepah pisang Ulin

Bubuk pelepah pisang Cavendish

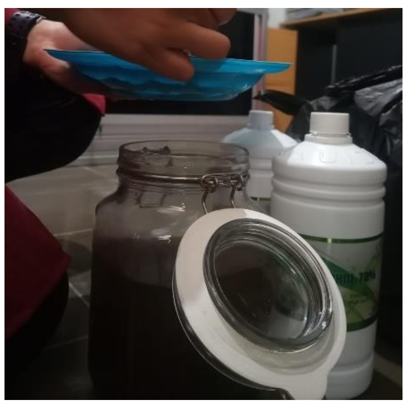
C. PROSES MASERASI



Proses menghitung dosis dan konsentrasi



Bubuk ditimbang sesuai dengan dosis



Pencampuran bubuk dengan alkohol 70%

Setelah dicampurkan, lalu diaduk

Bubuk direndam selama 3 x 24 jam

Setelah direndam 3 x 24 jam, disaring

Sari maserasi pelepah pisang yang diperas

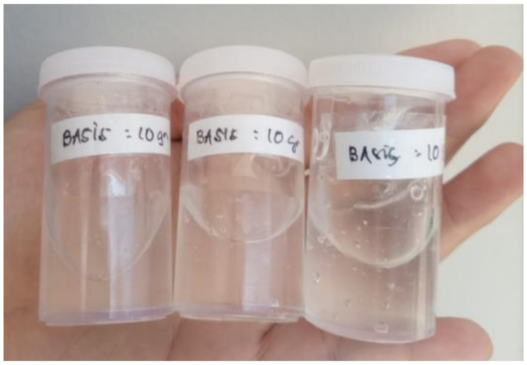
Sari tersebut di kukus hingga mengental

Persiapan bahan membuat gel

Pembuatan basis gel (hpmc)

Ekstrak akan dipindah dalam pot

Ekstrak pelepah pisang yang siap dicampur dengan basis



Basis yang siap dicampurkan dengan ekstrak

Pencampuran ekstrak dan basis

Basis dan ekstrak diaduk supaya rata

Gel berisi kandungan esktrak pelepah pisang siap diujikan

Dokumentasi TIM

D. UJI PRA-KLINIK

Pengondisian lingkungan hidup hewan uji

Pemantauan nutrisi hewan uji

Kondisi kandang hewan uji

Pencukuran bulu hewan uji

Jenis Pisang	Hari Penyayatan/ Day 1	Perawatan Day 3	Perawatan Day 5
Cavendish			
Kepok			
Ulin			

E. SOSIALISASI & PEMASARAN

Bazar I bersama tim lolos p2mw UMPO (Agustus)

Bazar I bersama tim lolos p2mw UMPO (agustus)

Dokumentasi tim saat bazar II (september)

Mahasiswa baru melihat cara rawat luka dengan produk KAPIIL

Mahasiswa baru mencoba melakukan rawat luka dengan produk KAPIIL

Fotobersama mahasiswa baru yang tertarik membeli produk kapil

Fotobersama mahasiswa baru yang tertarik membeli produk kapil

Fotobersama mahasiswa baru yang tertarik membeli produk kapil

Fotobersama mahasiswa baru yang tertarik membeli produk kapil

F. RAWAT LUKA

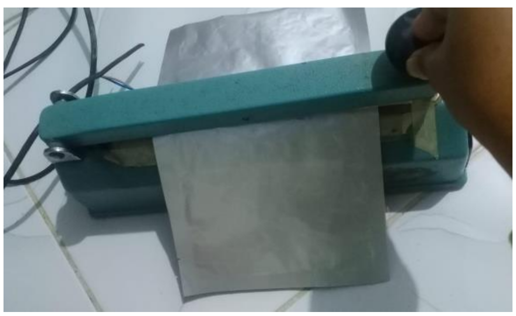
Dokumentasi pasien homecare

Dokumentasi pasien homecare

H. PRODUK DAN PEGEMASAN

Pengolesan obat pada kassa

Kassa yang telah mengandung obat dimasukkan dalam plastik tahan panas dan disterilkan (packaging primer)



Dari packaging yang pertama, kemudian dimasukkan kedalam alumunium foil untuk menjaga ke sterilannya

Bagian packaging sekunder ini terdapat tatacara pemakaian

Tampilan paling luar, packaging tersier