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The Potential of a Sumbawa Herbal Oil-Based Oleogel as Burn Wound Dressing

Andi Irma Yuniar, Nurul Wahidah Yasid, Syarifah Fatimah Nissatuljannah, Syamsu Rijal, Armanto Makmun*
Medical Faculty, Muslim University of Indonesia, Makassar, Indonesia
Jl. Urip Sumoharjo Km5 Makassar 90231, Tel. +62-411-455696, Fax. +62-411-455696, Indonesia.

Corresponding author*
armanto.makmun@umi.ac.id

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Abstract

This study aimed to innovate the current Sumbawa oil preparation which is still in the form of liquid into an oleogel so that it is easier to apply and more practical for distribution and storage. Phytochemical analysis of Sumbawa oil showed the contents of phenols, flavonoids, and alkaloids. By adding hydroxyethyl cellulose (HEC) as a gelling agent and glycerin as a humectant, Sumbawa oil can be served in the form of an oleogel. The pH measurement of the Sumbawa oil oleogel at levels of 90%, 95%, and 100% ranged from 7.0–7.3 which is the ideal acidity level for the wound healing process. In the antimicrobial activity test with S. aureus and E. coli, the zone of inhibition ranged from 12.1–14.7 mm which is considered strong. Meanwhile, in in vitro testing of the anti-inflammatory activity using the human red blood cell membrane stabilization method, the stability level of each was obtained to be 78% for 100% Sumbawa oil, 74% for oleogel with 95% Sumbawa oil, and 73% for oleogel with 90% Sumbawa oil. The oleogel morphology observation using a scanning electron microscope showed a good gelation process at 5% and 10% HEC levels.

Keywords: Sumbawa herbal oil; oleogel; burn; wound dressing.

INTRODUCTION

Burns are skin injuries that can cause tissue dysfunction. Thermal, chemical, and electrical burns are the most common types of burns. Globally, more than 300,000 deaths are caused by thermal burns or other types of burns each year. The high mortality rate is due to the challenging burn management. The most common complications include loss of critical skin tissue functions, dehydration, wound infection, other systemic inflammatory responses, sepsis, and multiorgan dysfunction. When the skin tissue is injured, some basic organ functions are affected or even lost completely depending on the severity of the burn (He et al. 2021). Characteristics of disturbed skin include cellular dysfunction, hemodynamic and hematological abnormalities, acid–base disturbances, and hormonal changes. Acid–base disturbances can cause metabolic acidosis in the early period of the burn. Hormonal changes will accumulate at the wound site through the progressive release of various substances, including histamine, kinins, oxygen radicals, and arachidonic acid, or by disrupting the neurohormonal axis (He et al. 2021).

In recent decades several commercial polymer-based gels such as Gelrin C, Mebiol Gel, Hystem hydrogel, and Biogelx products, to name a few, have been developed for biomedical applications. Various cross-linked and conductive hydrogels for effective wound healing along with antibacterial activity have also been reported. Development of low-molecular-weight gels for effective tissue regeneration and wound closure applications can overcome problems with the limitations of polymer gels such as thermoreversibility, processability, bio-compatibility, critical gelation concentration, sol–gel transition temperature (Tgel), and high molecular weight (He et al. 2021). Although studies on hydrogels as wound dressings have been carried out extensively, they were unable to resolve some of the limitations. The characteristics of hydrogels containing water with large pores cause the active ingredients of the drug to be spilled into the body within a few hours, contrary to its intended function as a slow-release mechanism. Hydrogels tend to be too rigid to be injected through a needle and may require surgical implantation. Hydrogels can also be detached from the site of treatment. Hydrogels are not strong enough to protect the proteins and peptides that make up newer drugs and cannot contain the hydrophobic active ingredients of drugs (He et al. 2021).

Several scientists have proposed alternative hydrophobic organic materials to overcome the limitations of hydrogels. Organogels form in situ drug depots when a mixture of polymers, drug-active ingredients, and organic solvents is injected into the body. Gelation occurs when organic solvents are released from the implant. Although slow diffusion of the drug is more effective with organogels, the obvious drawback is that organic solvents are also released into the bloodstream (Guennard, 2023).

Sumbawa herbal oil is one of the traditional Indonesian medicines which is produced on Sumbawa Island by mixing coconut oil and several medicinal plants through a heating process. Sumbawa people use Sumbawa oil as an antispasmodic, antipyretic, and appetite-enhancing drug. In addition, it is also known to cure diseases such as diarrhea, snake bites, wounds, bruises, twists, peeling skin, toothache, stomach pain, digestive disorders, backaches, and skin diseases, reduce symptoms of arthritis, and accelerate the recovery of the mother's condition after childbirth. This is confirmed by the research study of Hadi et al. (2018) who conducted a GC-MS analysis and found that Sumbawa oil contains a number of bioactive ingredients such as hexadecanoic acid, octadecanoic acid, methyl palmitate, linoleic acid, lycopersen, and dodecanoic acid which have antispasmodic, antipyretic, appetite-enhancing, antifungal, and antimicrobial properties. Some of its possible uses are as a hypocholesterolemic, anti-inflammatory, and antidiabetic agent. Research by Halawiya et al. (2017) showed that administration of Sumbawa oil on experimental rats with hypercholesterolemia showed a significant reduction in the total cholesterol levels (Figure 1).

Figure 1. Sumbawa Herbal Oil.

Based on research by Permatasari (Permatasari, 2013), the types of plants that are the basic ingredients for making Sumbawa oil found in Sumbawa Besar Regency are 59 plant species from 28 families. Of the 59 plant species, there are several types of plants with the same family, including the Arecaceae family, namely sugar palm, gebang, coconut, and areca nut, the Euphorbiaceae family, namely buffalo patikan, meniran, castor, and katuk/katu, the Zingiberaceae family, namely turmeric, cardamom, galangal, and ginger, and the Piperaceae family, namely betel, pepper, and chili herbs (Halawiya et al. 2017).

Currently, Sumbawa herbal oil is only available in the form of liquid oil packaged in glass bottles. The application in this dosage form is impractical for both wound application and practicality and safety in packaging (Brooks et al. 2016). This study aims to investigate the potential of making an *oleogel* made from Sumbawa herbal oil and the extent to which its effectiveness in overcoming bacterial infections and anti-inflammatory activities serves as an indicator of an effective burn dressing material (Halawiya et al. 2017).

MATERIALS AND METHODS

Experimental Design

The manufacture of the oleogel uses the basic composition of Sumbawa herbal oil, HEC, and glycerin with the following variations in Table 1:

Table 1. Oleogel ingredient composition.

	Sumbawa Oil (mL)	HEC (mL)	Glycerin (mL)
Mix A	95	4	1
Mix B	90	9	1

Observations and Test

Some of the parameters observed and measured in this study are:

- *pH measurement*
  Measurement of the pH of the oleogel using a pH meter.
- *Investigation of the phytochemical content*
  The phytochemical content was measured qualitatively including the contents of flavonoids, alkaloids, saponins, and terpenoids.
- *Observation of the morphology of the oleogel*
  The oleogel morphology was observed using a scanning electron microscope (SEM) to see the characteristics of the gel mixture formed.
- *Observation of the antimicrobial activity*
  To test the antimicrobial activity using the Disk Diffusion method (Kirby-Bauer Test) using *S. aureus* bacteria.
- *Observation of the anti-inflammatory activity*
  To test the anti-inflammatory activity in vitro using the human red blood cell membrane stabilization method with a modification of the method of Shinde et al. (1999). A positive control using diclofenac.

RESULTS

Oleogel pH

We have measured the pH of three groups of samples namely 100% Sumbawa oil (SO), Mix A, and Mix B. As shown in Table 2, the mean pH of SO is 7.3, whereas, the pH of Mix A is 7.1 and Mix B is 7. Based on the measurement of samples, it was found that the pH range of the oleogel is considered neutral. The results of the pH test in the table above show that Sumbawa oil meets good pH standards according to SNI 4085:2017, namely pH 4.0–10.0.

Table 2. pH of the Sumbawa herbal oil oleogel.

Sample	pH			Mean
	Sample 1	Sample 2	Sample 3	
SO 100%	7	7.5	7.3	7.3±0.2517
Mix A	7.2	7.1	7.1	7.1±0.0577
Mix B	6.8	7.0	7.1	7.0±0.1528

Phytochemical Analysis Results

Furthermore, phytochemical analysis was performed to measure the compounds contained in SO. This study showed that SO contained flavonoids, alkaloids, saponins, and terpenoids. The results of the Sumbawa herbal oil qualitative phytochemical analysis are provided in Table 3 and Figure 2. Compounds containing many antioxidants are found in alkaloids, steroids, flavonoids, and saponins (Ahmed et al. 2014). According to the results of phytochemical testing, bioactive components of flavonoids are present in all solvents. These results indicate that Sumbawa oil has antioxidant properties.

Table 3. Phytochemical components of Sumbawa herbal oil.

Components	Presence	Precipitate
Flavonoid	+	Dark red
Alkaloid 1 (Wagner)	+	Brown
Alkaloid 2 (Mayer)	+	White
Alkaloid 3 (Dragendorff)	+	Orange
Saponin	+	Foamy
Terpenoid	+	Orange

Figure 2. Phytochemical analysis of Sumbawa herbal oil.

Oleogel Morphology

There are voids formed both in Mix A and Mix B. At the same time, it showed that the materials which are Sumbawa herbal oil, HEC, and glycerin were well mixed. The SEM images of Mix A and Mix B Sumbawa herbal oil oleogels are shown in Figure 3 and 4.

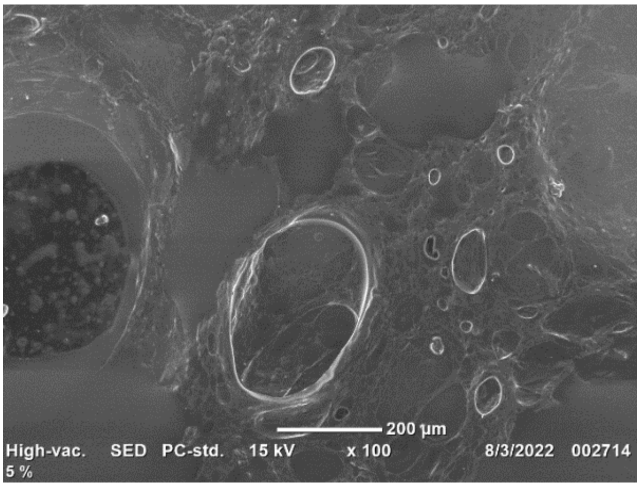

Figure 3. Mix A morphology.

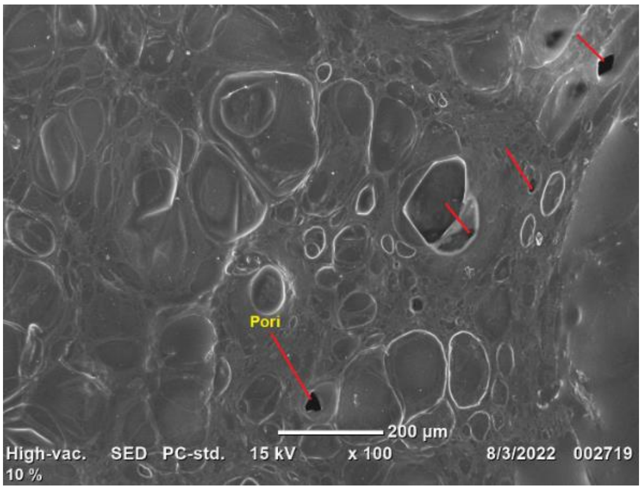

Figure 4. Mix B morphology.

Antimicrobial Activity

The antimicrobial activities of SO, Mix A and Mix B are shown by the large inhibition zone against *S. aureus* bacteria. The wider the zone of inhibition the better the antimicrobial activity. Table 4. shows that SO has an inhibition zone against *S. aureus* by 14.7 mm, while those of Mix A and Mix B were 12.6 and 12.1 mm respectively.

The criteria for the strength of antibacterial activity are categorized based on the diameter of the inhibition zone formed, namely a diameter of the inhibition zone of 5 mm or less is categorized as weak, an inhibition zone of 5–10 mm is categorized as medium, an inhibition zone of 10–20 mm is categorized as strong and an inhibition zone of 20 mm or more is categorized as very strong (Dimpudus et al. 2017).

Table 4. Inhibition zone of *S. aureus.*

Sample	Inhibition zone			Mean
	Sample 1	Sample 2	Sample 3	
SO 100%	15.3	14.1	14.8	14.7±0.6028
Mix A	13.1	12.5	12.2	12.6±0.4583
Mix B	12.4	12.2	11.1	12.1±0.4163

Anti-inflammatory Activity

Table 5 shows the results of an in vitro anti-inflammatory assay using human red blood cell membrane stabilization. The data in Table 5 show that in liquid form, Sumbawa herbal oil's capacity in the prevention of lysis was 78.577% while that of Mix A, oleogel which contains 95% of Sumbawa herbal oil, is 74.165% and that of Mix B, oleogel which contains 95% of Sumbawa herbal oil, is 73.629%.

Table 5. Prevention of lysis in percentage.

Sample	Absorbance	Prevention of Lysis (%)
SO 100%	0.280	78.577
Mix A	0.338	74.165
Mix B	0.345	73.629
Diclofenac	0.351	73.145
Negative control	1.307	0.000

CONCLUSIONS

Based on the results of the measurement of the pH of the oleogel, a range of 7.0–7.3 was obtained. This acidity level is an ideal condition that helps the wound healing process, where the best pH range is 7.15–8.9. The natural pH of the skin is acidic and the range is 4–5.5. Maintenance of this pH is very important to maintain the balance of the skin flora and to avoid the proliferation of pathogens. Thus, the Sumbawa oil-based oleogel has the potential to help form an environment that supports accelerated wound healing.

The antimicrobial activity also shows good results where the inhibition zone ranges from 12 to 14 mm which is considered strong. Antimicrobial properties have an important role in promoting wound healing. Common wound healing inhibitor can be caused by the presence of *S. aureus*.

Based on the results of the study, the oleogel made from Sumbawa oil has the potential to be used as a burn treatment material because it has a good pH and good antimicrobial and anti-inflammatory properties. Further study including but not limited to scratch assay for wound healing, in-vivo experiment, and oleogel stability over time is needed.

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