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Effect of Aloe Vera Gel Extract to The Physicochemical Properties and Effectiveness of Burn Cream Formulation

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Abstract. Aloe chinensis Baker is commonly cultivated in Indonesia especially in Pontianak and Bogor. Aloe vera gel contains various anti-inflammatory compounds. The objectives of this study are to determine the effects of Aloe vera gel extract additions to the formulations of burn cream and to obtain the best formulation in healing burn wounds on outer epidermis through testing on white mice. Aloe vera gel extract was prepared with a rotary evaporator for 90 minutes at 40 °C and 110 mBar. The basic formulation of the burn cream included oil phase and water phase. There were six concentrations of Aloe vera gel extract added to the above burn cream at 0%, 2.5%, 5%, 7.5%, 10% and 12.5%. The resulting formulations produced pHs that were within the acceptable range of skin physiology (4-8). The viscosities were in good consistencies that were easily applied on skin without drips. They also exhibited fineness values of 9-10 μ , refractive indices ranging from 51.5 to 78.3, and opaque color of milky white. Biological experiments showed that burn cream sample with Aloe vera gel extract at 5% concentration to be the most effective by healing 2nd degree burn wounds the fastest during 20-day trials.

1. Introduction

Aloe vera is one of medicinal herbs that were widely used in the western society in the middle ages, and the production of its extract become one of the largest botanical industries in the world [1]. This plant belongs to the *Liliaceae* family and is distributed throughout the world. There are 350 species of Aloe, and the one that is commonly cultivated in Asia, including in Indonesia, is *Aloe chinensis Baker*. This species is commercially cultivated in Kalimantan Barat (West Kalimantan) Province and locally known as Aloe vera Pontianak [2].

Aloe vera is used in cosmetic, food, and pharmaceutical industries. In cosmetic and toiletry industries, it is incorporated as the basic ingredient in skin moisturizer, soap, shampoo, sunscreen lotion, makeup cream, perfume, shaving cream, and many more. Aloe-based pharmaceuticals come in topical (gel and cream) and oral (tablet and capsule) forms [3].

Tri Yuni Hendrawati Studied (2018), Aloe vera gel extract is mucilaginous gel obtained from parenchymatous cells called aloe vera gel that is colorless and tasteless. Aloe vera is Aloe vera gel contains the main ingredients of aloin, emodin, and sap, in addition to other compounds, such as essential oil. Aloin is an active compound that has antiseptic and antibiotic properties. The phenolic



compounds found in Aloe vera have been determined to include aloin A and B, aloenin (B), and chrysophanol [4].

Aloe vera is known to have healing properties including antioxidant, anti-inflammatory, anti-diabetes, burn reliever, anti-aging, and anti-cancer [5]. Aloe vera gel exhibits strong anti-inflammatory effects because of the presence of anthraquinones and kromon. Oral intake of aloe vera gel at 2% has been reported to effectively relieve the severity of pain and reduce the wound size in stomatitis aphthous patients. The anti-inflammatory effect of aloe vera has also been shown to reduce joint pain. Aloe vera gel is more effective in fighting inflammations caused by prostaglandin synthesis and leucocyte infiltration, but less effective against allergen-induced ones [6].

Burn wound is a damage on skin caused by exposure to fire or other causes such as hot water, high electrical current, chemicals, and radiation. The damage may reach other tissues under the skin. Burn wound is a type of trauma with high mortality rate that requires a specific management from the initial to the follow-up stages. Burn wound can also cause necrotic coagulations on skin and exposure of deeper tissues, as well as effects on other organs [7].

The severity of burn wound can be classified into three classes:

a. 1st degree

Damages are limited to the epidermal layer indicated by skin redness. Pains disappear in 48 to 72 hours and wounds heal without scar.

b. 2nd degree

Damages to the whole epidermis and some dermis include pain and skin redness, edema, and presence of bullae. 2nd degree burn is further classified into:

1. Superficial, which includes skin redness, edema, and presence of bullae. Pain is due to a significant number of undamaged basal cells. Vasodilation exists and heals within two weeks without or with minimal scar.
2. Deep, in which damages to the whole epidermis and some dermis are indicated by moist but pale wounds. The pain is less than superficial 2nd degree with healing in several weeks to months with scar.

c. 3rd degree

Damages to the whole dermis or deeper appear as peeling epithelium and white area caused by dermal protein coagulation. Narrowing area of dry burned dermis called eschar exists with no blood perfusion nor pain. Spontaneous healing may occur.

Appearance of a granular tissue after the second week requires closing with skin graft, but when left untreated causing the formation of a contracture (a thick and narrow scar tissue) (Sudjatkiko, 2007).

Cream is a form of traditional medicine in a semi-solid state made from extract dissolved or homogeneously dispersed in the basic form of balm or cream that is used for topical treatments [8]. Ashni Studied (2013), topical formulation for cream have three main function, such as to have hydrate skin because of their omellent properties, to protect from external environment or heal an intact or injured area of the skin, to deliver medication to the skin [9].

Mice are mammals that have an important role in human lives for their involvement in scientific endeavors because of their high adaptability. The type of mice that is commonly used as an animal model in laboratories, as well as pets, is the white mice (*Rattus norvegicus*). The advantages these animals have over other species include ease of handling and care because of its small size, health and cleanliness, high reproductive capacity with short gestation period, and their production and reproductive characteristics are similar to other mammals [10].

The objectives of this study is to determine the effects of aloe vera gel extract concentrations in burn cream on the burn wound healing upon treatment with the cream, and to obtain the best formulation for burn cream.

2. Experiment Method

2.1 Materials and equipment

The materials include gel extract from *Aloe Chinensis Baker* ([Semplak-Bogor]), Triethanolamine, Tween 80, liquid Paraffin, Methyl Paraben ([BP/USP], [Rasula Pharmaceutical & Fine Chemicals-India]), Propyl Paraben ([BP/USP], [Rasula Pharmaceutical & Fine Chemicals-India]), Propylene Glycol ([USP/EP], [SKC-Korea]), Tocopherol, Dimethyl SulfurOxyde ([Merck]), EDTA ([Merck]), NatriumDihydrogen Phosphate ([Merck]), distilled water, and laboratory white mice (*Rattusnorvegicus*) ([Sparague Dawley-IPB]).

The equipment used includes standard glass apparatus, scale, blender, knife, plastic tub, spoon, water bath, spatula, graduated cylinder, glass pipettes, mortar and pestle, pH meter, centrifuge, rotary vacuum evaporator, viscometer, chromometer, refractometer, and micrometer.

2.2 Method

The study took place in the Applied Chemical Engineering Laboratory, Engineering Faculty, UniversitasMuhammadiyah Jakarta.

The steps in this study went as follows: (1) Aloe vera gel extraction consisting of peeling the rind of clean Aloe vera leaves, blending the remaining gel, and filtering the resulting puree; (2) Purification of Aloe vera gel extract using a rotary vacuum evaporator at 110 mBar and 40°C for 90 minutes. This process started with 1100 mL of filtered puree and ended up with 600 mL of Aloe vera gel extract, which translated into a 54% yield; (3) Base cream and burn cream preparation. The base formula of the burn cream comprised of 14.5 grams stearic acid, 0.9 mL triethanolamine, 3 mL liquid paraffin, 4.9 grams Polysorbate 80 (Tween® 80), 0.1 gram Nipagin™, 0.05 gram Nipazol™, 0.5 mL tocopherol, 5 mL Propylene Glycol, 0.1 gram Dimethyl Sulfur Dioxide, 0.1 ml EDTA, and 8 ml distilled water; (4) Burn cream quality testing was performed by physical and chemical analyses for pH, color, viscosity, density, degree of fineness, and refractive indices; (5) In testing the effectiveness of the cream it is carried out by simple random sampling. The study was divided into seven groups, namely 7 groups treated with Aloe vera burn cream with variations in the concentration of Aloe vera gel which was added 0% (without Aloe vera gel), 2.5%, 5%, 7.5%, 10%, 12.5%, and 100% (pure Aloe vera gel without cream additives). Each group consisted of 2 white rats (*Rattus norvegicus*). (6). Making burns. Burns are made on the back of the rat's body. Then the area is cleaned and shaved with a distance of ± 5 cm. The area to be injured is sterilized by using alcohol and leave to dry. Then rats were anesthetized using ketamine as much as 0.3 cc. After the rats fainted to give burns on the back, metal iron with a size of 2 cm x 2 cm was attached which had been dipped in hot water ± 90 -100 °C. Metal iron is attached to the wound area for 40 seconds, then washed with sterile water and dried (Samsudin et al., 2018); (7) Burn wound treatments by applying burn cream samples were conducted as described in step 5. Application was performed once a day for 20 days and effects were recorded. The parameter observed was the wound healing.

3. Result and discussion

Analyses of Aloe vera gel extract resulting from rotary vacuum evaporation process yielded pH of 4.7, color of 0.4708, viscosity of 3.47 cP, density of 0.9940 g/mL, and refractive index of 1.1. Visual observation resulted in white color of the burn cream. The results of physical and chemical analyses are presented in Table 1.

Table 1. Results of Physical and Chemical Characterization of Burn Cream with Aloe Vera

No	Parameter	Unit	Results at Various Concentration of Aloe Vera Extract (%)						
			0	2.5	5	7.5	10	12.5	100
1.	pH	-	7.25	7.83	7.85	7.89	7.85	7.8	4.7
2.	Colour		0.13069	0.59079	0.5591	0.66823	0.50224	0.74852	0.4708
3.	Viscosity	cP	20,000	14,800	14,600	15,000	18,000	18,800	3,47

5.	Density	g/ml	0,7713	0.6463	0.6353	0.638	0.6887	0.6510	0.9940
6.	Fineness	μm	9	12	12	12	12	11	-
7.	Refractive Index		78.3	59.4	69.8	51.5	56.6	701	11

3.1 The effects of Aloe Chinensis Baker gel extract concentration on pH

The pH of the burn cream at 0% Aloe vera gel extract was 7.25, whereas that at 12.5% was 7.8. However, the highest pH of 7.89 occurred at 7.5% concentration. The effect of Aloe vera gel extract addition at various concentrations on pH is described in Figure 1.

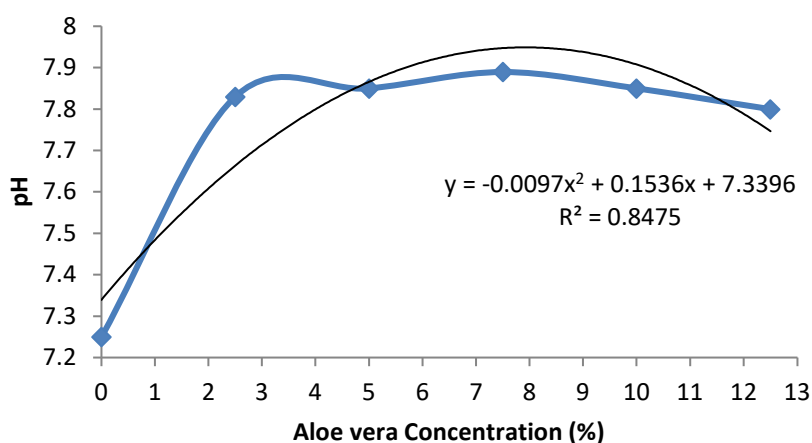


Figure 1. The effect of Aloe vera gel extract on the pH of burn cream samples

Further analyses with 2nd order polynomial regression yielded a correlation formula of $y = -0.0097x^2 + 0.1536x + 7.3396$ with $R^2 = 0.8475$, while y represents pH and x represents concentration of Aloe vera gel extract.

From the picture above shows the addition of aloe vera gel extract to the wound cream affects the pH value. If the pH of the cream is too acidic it can cause irritation, while the pH that is too alkaline causes scaly skin [11]. Based on the results of the pH analysis, it was found that the pH value ranged from 7.25-7.89 which meets the topical pH requirements, namely 4-8 [12]. According to Hasniar, et al. (2015), pH values can be affected due to chemical changes in active substances or additives, carrier or environmental influences and the effects of carbon dioxide (CO₂).

3.2 The effects of Aloe AloeChinensis Baker gel extract concentration on viscosity

Data analyses with 2nd order polynomial regression yielded a correlation between Aloe vera gel extract concentration and viscosity. The formula for this correlation is $y = 122.29x^2 - 1482.9X + 19129$ with $R^2 = 0.7946$, with y representing viscosity and x representing concentration of Aloe vera gel extract (Figure 2).

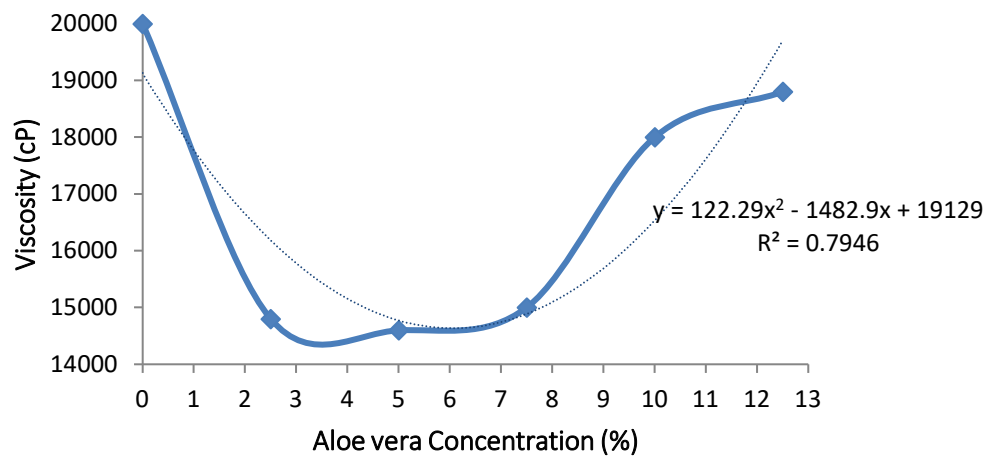


Figure 2. The effect of adding Aloe vera gel extract on the viscosity of burn cream samples.

Factors that determine the viscosity of creams are ingredients classified into the oil phase, especially cocoa fat, stearic acid, and cetyl alcohol [13]. The picture above shows a minimum viscosity value of 14600 cP and a maximum value of 18,800 cP.

3.3 The effects of Aloe vera gel extract concentration on density

Data analyses with 2nd order polynomial regression yielded a correlation between Aloe vera gel extract concentration and density. The formula for this correlation is $y = 0.002x^2 - 0.0298x + 0.7461$ with $R^2 = 0.6356$, with y representing density and x representing concentration of Aloe vera gel extract (Figure 3). The picture above shows the minimum density value is 0.6353 g/ml and the maximum density 0.7713 g/ml. For cream density testing there's no specific fixed standard. That's why the validation using acceptable range. By visual observation observation does not visible the difference.

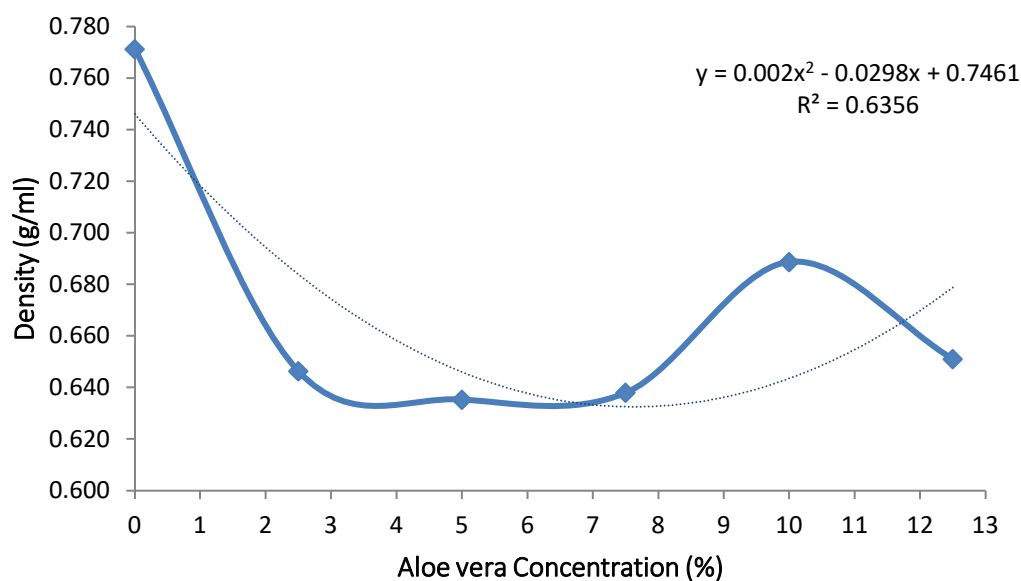


Figure 3. The effect of Aloe vera gel extract on the density of burn cream samples

3.4. The effects of Aloe vera gel extract concentration on fineness

Data analyses with 2nd order polynomial regression yielded a correlation between Aloe vera gel extract concentration and fineness. The formula for this correlation is $y = -0.0571x^2 + 0.8286x + 9.4286$ with $R^2 = 0.8442$, with y representing fineness and x representing concentration of Aloe vera gel extract (Figure 4). The picture above shows the minimum fineness value is 9 μ and the maximum fineness 12 μ . For cream fineness testing there's no specific fixed standard. That's why the validation using acceptable range. By visual observation observation does not visible the difference.

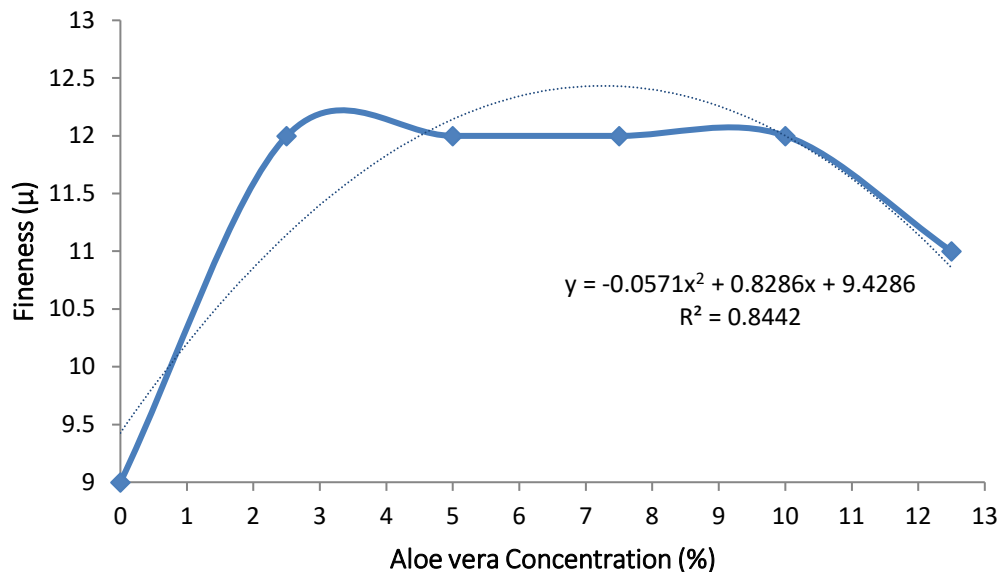


Figure 4. The effect of adding Aloe vera gel extract on the fineness of burn cream samples

3.5 The effects of Aloe vera gel extract concentration on refractive index

Data analyses with 2nd order polynomial regression yielded a correlation between Aloe vera gel extract concentration and refractive index. The formula for this correlation is $y = 0.4023x^2 - 5.8023x + 77.5$ with $R^2 = 0.5946$, with y representing refractive index and x representing concentration of Aloe vera gel extract (Figure 5). The picture above shows the minimum refractive index value is 51.5 and the maximum refractive index 78.3. For cream refractive index testing there's no specific fixed standard. That's why the validation using acceptable range. By visual observation observation does not visible the difference.

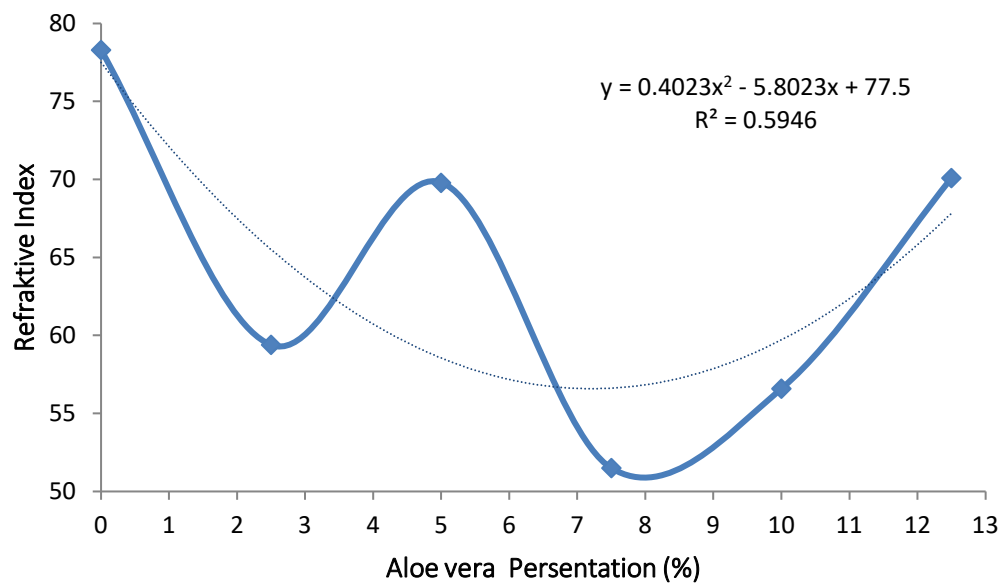


Figure 5. The effect of Aloe vera gel extract on the refractive index of burn cream samples

3.6 The effects of Aloe vera gel extract concentration on color

The results of data analyses on the effects of Aloe vera gel extract concentration on the color of the burn cream are presented in Figure 8. Data analyses with 2nd order polynomial regression yielded a correlation between Aloe vera gel extract concentration and refractive index. The formula for this correlation is $y = 0.019x^3 - 0.0409x^2 + 0.2568x + 0.1375$ with $R^2 = 0.9202$, with y representing the color value of burn cream and x representing the concentration of Aloe vera gel extract (Figure 6). The picture above shows the minimum color value is 0.13069 and the maximum color 0.74852. For cream color testing there's no specific fixed standard. That's why the validation using acceptable range. By visual observation observation does not visible the difference.

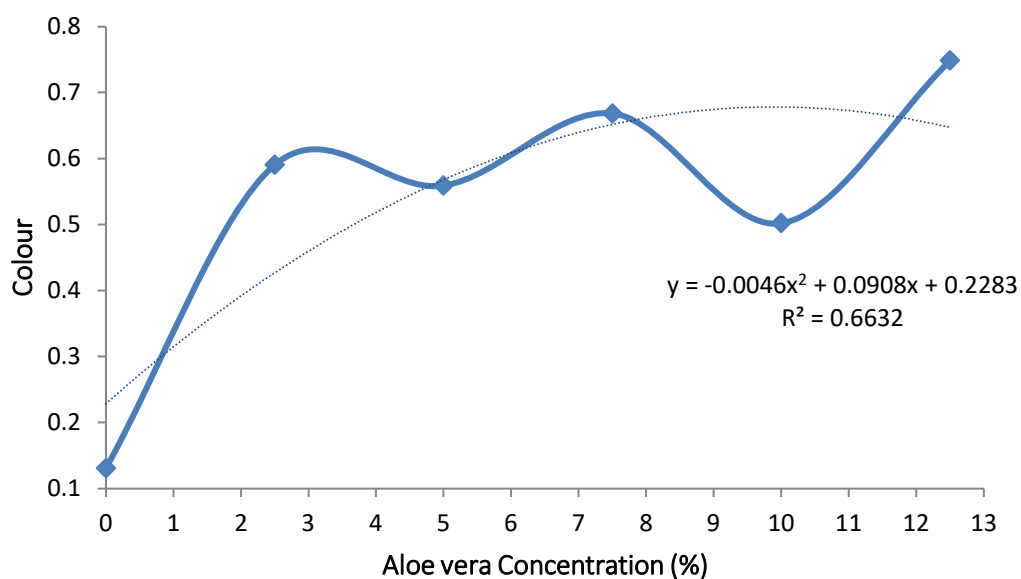


Figure 6. The effect of Aloe vera gel extract to the colour of burn cream samples

3.7 The effects of Aloe vera gel extract concentration on burn wounds

Based on the results of testing physical and chemical properties, the best burn cream is a cream with a 5% aloe vera gel content tested on white mice (*Rattus norvegicus*) until healed and lost his burns for 20 days. Testing the effectiveness of second degree burn creams on white mice (*Rattus norvegicus*) is characterized by skin damage in the epidermis. White mice that were declared cured were those whose burns had a change in the size of the wound. The wound healing process consists of 3 phases, namely the inflammatory phase, the proliferation phase, and the phase of exclusion. The inflammatory phase is characterized by swelling, the proliferation phase is characterized by the formation of exudates and fibroblasts that look like crust at the top of the wound, and the phase of denial which is characterized by the formation of new tissue which means the wound has narrowed or healed [13]. In burn cream with 5% Aloe vera gel content, the inflammatory phase takes place on the first day to day 4, the proliferation phase occurs on day 5 to day 12 and on day 20 the wound has healed.

4. Conclusion

The active ingredient of aloe vera extract (Aloe Vera) was successfully produced by means of a vacuum rotary evaporator at a pressure of 110 mBar temperature of 40°C for 90 minutes by producing a yield of 54.55%, the resulting cream preparation are cream with type M / A obtained from Aloe Vera gel extract with 0%, 2.5%, 5%, 7.5%, 10%, 12.5% enhancements where the cream has met the requirements based on organoleptic test parameters and pH with a tropical pH range of 4-8, based on the results of the analysis of pH 4-8, viscosity 14600 cP, density 0.6463 g/ml, fineness level of 12 micron, refractive index 69.8 colors 0.559104, the analyses of Aloe vera gel extract prepared in a rotary vacuum evaporator yielded pH of 4.7, color difference of 0.4608, viscosity of 3.47 cP, density of 0.97 gr/mL, and refractive index of 1.1. The burn cream formulation that yielded the fastest healing time of 2nd degree burn wounds in 14 days contained 5% Aloe vera gel extract. Physical and chemical analyses of this formulation yielded pH of 7.85, viscosity of 14,600 cPs, density of 0.6463 g/mL, fineness of 12 micron, refractive index of 69.8, and color difference of 0.559104.

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