



The Effect of Herbal Spray Extract of Moringa Leaves (*Moringa oleifera* Lam) and Betel Leaves (*Piper betle* Linn) to Wounds in Dairy Cattle

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Abstract | This study aims to determine the effect of herbal spray extract of moringa leaves (*Moringa oleifera* Lam) and betel leaves (*Piper betle* Linn) on healing wounds in dairy cattle and determine the herbal spray's compounds. This study was conducted in August 2022, located in Cendana District, Enrekang Regency. The study method was a completely randomized design (CRD). The variables observed were the measurement of wound area (cm), wound drying time (days), wound healing time (days), the content of saponins (exist/not exist), tannins (%), flavonoids (ppm), and pH on herbal sprays. The results revealed that the measurement of wound area in dairy cattle after herbal sprays at P0=0.66 cm, P1=2.22 cm, P2=0.06 cm, and P3=0.00 cm; wound drying time was faster at P0=11 days, P1=9 days, P2=8 days, and P3=5 days; and significantly faster wound healing time at P0=14 days, P1=12 days, P2=11 days, and P3=10 days. The compounds of the herbal spray, saponins at P0 = Not exist, P1 = Exist, P2 = Exist, and P3 = Exist; tannin content at P0=0.00%, P1=1.11%, P2=1.12%, and P3=1.27%; flavonoid content at P0 = 0.00 ppm, P1 = 276.74 ppm, P2 = 288.43 ppm, and P3 = 292.97 ppm, and for pH values at P0 = 7.50, P1 = 5.74, P2 = 5.69, and P3 = 5.62. It can be concluded that the best treatment in this study was P3 with a concentration of 50 ml of moringa leaves extract and 30 ml of betel leaves extract.

Keywords | Betel leaves, Dairy cows, Herbal spray, Moringa leaves, Wounds

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INTRODUCTION

Medicinal plants have tremendous potential to treat various diseases. Using medicinal plants as traditional medicine is believed to be quite effective and safe

because they do not cause side effects and are economically affordable for the community (Dewoto, 2007). Different plant species have been used universally to manufacture traditional medicines to cure several diseases and for other plant biospecies (Popoola and Obembe, 2013). Treatment

using the latest therapies or based on conventional can treat wounds. About 80% of the world's population uses traditional medicine to treat various skin diseases (Hashary, 2022).

The Moringa plant is a medicinal plant that grows in the lowlands and highlands. Moringa is widely planted as a boundary or fence in the yard or field. Moringa leaves can be harvested after the plants have grown 1.5 to 2 meters, which usually takes 3 to 6 months. Harvesting is done by picking the stems of leaves from the branches or cutting the branches at a distance of 20 to 40 cm above the ground (Kurniasih, 2014). Besides being consumed, Moringa leaves are also used as medicines and water purifiers.

The Moringa plant (Figure 1) has been known since ancient times as a traditional medicine with many benefits. Compounds in Moringa leaves (*Moringa oleifera* Lam) that play a role in wound healing include flavonoids, saponins, tannins, antibacterial, antiseptic, antimicrobial, and polyphenolic compounds. In addition, Moringa leaves also contain gallic acid, quercetin glycosides, and chlorogenic acid, which are very useful for herbal ingredients (Nurcahyati, 2014). This plant can grow anywhere and has been widely consumed in various rural and urban areas in developing countries, such as countries on the continents of Africa and Asia, because of its medicinal benefits and nutritional content (Eyarefe *et al.*, 2015). In addition, the Moringa plant originates from the Indian subcontinent and has been naturalized in tropical and subtropical regions worldwide.



Figure 1: Moringa plant.

Likewise, the betel plant (Figure 2) has green leaves shaped like a heart with vine roots. The lamina on the betel leaf has a soft texture, including the surface. It is about 160–170 μm thick with finger-shaped cylindrical trichome fibers.

The trichome fiber is approximately 30 μm long and about 5 μm thick. Betel leaf stomata have a cyclocytic type. The leaves have different tastes and smell in each region where they grow (Mujahid and Akhtar, 2014).



Figure 2: Betel plant.

Betel plants are primarily spread in tropical and subtropical regions of the world. More than 700 species of *Piper betel* have spread in both parts of the world. Of these, 30 species have been recorded in India, 18 in Sri Lanka, and three are endemic. *Piper betel* is cultivated in India, Sri Lanka, Malaysia, Indonesia, the Philippine Islands, and East Africa (Berawi *et al.*, 2019). The parts of betel leaf used are leaves, roots, stems, stalks, and fruit (Santhakumari *et al.*, 2003). The betel plant (*Piper betle* Linn) has been used by the Indonesian people as a traditional medicine for a long time. The betel plant has antibacterial power; this ability is due to various substances, such as flavonoids, saponins, and tannins, which can accelerate the wound healing process. The antibacterial properties of betel leaves have been proven based on research results (Kursia *et al.*, 2016).

Wounds are the loss or destruction of a portion of body tissue. A wound is disrupted by living tissue's cellular, anatomical, and functional continuity due to external action, with or without losing the underlying connective tissue. The

wound is a state of damage to some body tissues. Sharp or blunt trauma, temperature changes, chemicals, explosions, electric shocks, or animal bites can cause this condition. The wound healing process begins with restoring damaged tissue as close to its original state as possible, and wound contraction is the shrinkage of the wound area (Begashaw *et al.*, 2017). Wounds cause the inside of the animal's body to be exposed to the outside of the body; if left untreated, infection can occur, and wound healing will be hampered (Wombeogo and Kuubire, 2014). Wound healing is the process of trying to repair the damage that occurs to the skin. Animal wound healing is generally done by administering chemical drugs in ointments, sprays, powders, tablets, pastes, and drops. Still, in this case, we will use moringa and betel leaves as the main ingredients in treating wounds in livestock, especially dairy cows. Wound healing can delay livestock recovery, which may increase the cost of maintenance (Proios *et al.*, 2021). One of the actions in treating wounds is that many people use traditional medicine from nature; this is one reason people use it because it is easily accessible, can be made in-house, and can also be grown by the users (Balqis, 2016). Small wounds that go untreated for days can become severe microbial infections that cause septicemia and can even be fatal to livestock (Basha *et al.*, 2019).

Dairy cows can produce milk, which is the main product. Besides making milk the main product, dairy cows can produce calves and meat from rejected cows (Taslim, 2011). Dairy cows are more efficient in converting feed into animal protein and calories (Suryowardojo, 2012) than other cows. Dairy cattle are very suitable for cultivation in areas with cold temperatures to prevent stress due to heat stress so that dairy cattle production can be optimal. One of the obstacles in the maintenance of dairy cows is that cattle experience scratches on their body parts caused by the poor building of the stables and the condition of the floor of the cage, which causes the dairy cows to be injured.

Dairy cows are prone to injuries due to the unfavorable conditions of the stables, so they have the potential for injuries, especially those raised intensively. Therefore, in this study, it was applied to dairy cattle. This is important considering that moringa leaves (*Moringa oleifera* Lam) and betel leaves (*Piper betle* Linn) are often found around and can be cultivated by the community as natural medicines that can be applied by traditional breeders and can be developed by the industry for broader utilization.

Giving herbal spray containing extracts of moringa leaves (*Moringa oleifera*) and betel leaves (*Piper betle*) for wound healing in dairy cows is an interesting approach in veterinary medicine. Both plants have several potential benefits thanks to their active compound content. Combining Moringa and Piper betle leaves in an herbal spray can reduce

inflammation around the wound, speeding up the healing process. Antimicrobial compounds from both leaves help prevent bacterial infections that are often problematic in animal wounds. Both plants' nutrients and active compounds support tissue regeneration and faster wound healing. The use of both plants is supported by traditional medicine practices and several scientific studies that show their benefits in wound healing. Overall, administering herbal spray containing Moringa and Piper betle leaf extracts can improve dairy cows' wound healing by combining both plants' anti-inflammatory, antimicrobial, and nutritional benefits. However, it is important to continue with further research and careful supervision in practical application to ensure optimal results and animal safety.

The application of medicinal plant products that have the potential to heal wounds with antimicrobial effects is clinically and economically beneficial to humans (Hemmati *et al.*, 2018). Poor wound healing can cause physical pain and discomfort and also bring a series of psychological problems to livestock. In addition, wounds that are difficult to cure can further deteriorate livestock's quality of life and bring heavy economic burdens (Yang *et al.*, 2013). Attempts to overcome the problem of wound healing in livestock require preparations with good penetrating power and prolonged contact time. Moringa leaf extract and piper betle has advantages such as easy application on the skin, can be used on wet skin and even wounds, and ease of washing after application compared to ointments, gels, or pastes (Wijaya *et al.*, 2014). Herbal medicine is often used as an alternative or complement to conventional medicine. Still, there are some limitations, such as the use of doses that are by drug use standards so as not to cause side effects in livestock, and drugs must be appropriately processed to reduce the risk of contamination with hazardous chemicals. Therefore, it is essential to carry out regular checks and discuss potential interactions and side effects with health professionals.

MATERIALS AND METHODS

PLACE AND TIME

This research was carried out in August 2022 in Lebang Village, Cendana District, Enrekang Regency, South Sulawesi Province, while the herbal spray content was tested at the Animal Feed Chemistry Laboratory, Department of Animal Nutrition and Animal Feed, Faculty of Animal Husbandry, Hasanuddin University and at the Biochemistry Laboratory, FMIPA Hasanuddin University.

TOOLS AND MATERIALS

This study used scales, jars, stirrers, filters, blenders, spray bottles, measuring cups, rulers, stationery, and cameras. Materials used in the study were moringa leaves, betel leaves, 70% alcohol, dairy cows, gloves, and cotton.

This study used a completely randomized design (CRD), which consisted of four treatments and five replications. There are the treatment groups:

P0= 70% Alcohol (Control)

P1= 50 ml Moringa Leaf Extract and 10 ml Betel Leaf Extract

P2= Moringa Leaf Extract 50 ml and Betel Leaf Extract 20 ml

P3= Moringa Leaf Extract 50 ml and Betel Leaf Extract 30 ml

RESEARCH PROCEDURES

MAKING HERBAL SPRAY FROM MORINGA LEAVES AND BETEL LEAVES:

Moringa and betel leaves are washed with clean water and drained. After draining, they are dried in the sun until half dry and blended into a powder. The moringa leaves used are adjusted to the amount of treatment, which is 50 ml. Then, moringa leaves are used according to treatment starting from 10 ml, 20 ml, and 30 ml, and then 100 ml of alcohol is used for soaking moringa and betel leaves.

The spray is made using the sonication method by putting 50 grams of Moringa leaves and 50 grams of betel leaves into a different small jar, then adding 50 ml of 70% alcohol as a solvent and stirring until dissolved, then filtering to obtain a filtrate. The filtrate was collected in a jar to obtain extracts from Moringa and betel leaves. Furthermore, the extract is put into a spray bottle adjusted to the dosage and ready to be applied to dairy cattle. The measurement protocol on moringa leaves and betel leaves is carried out by measuring the compound levels in the laboratory to see the effectiveness of the leaves. The pictures of herbal sprays from Moringa leaves and betel leaves can be seen in Figure 3.

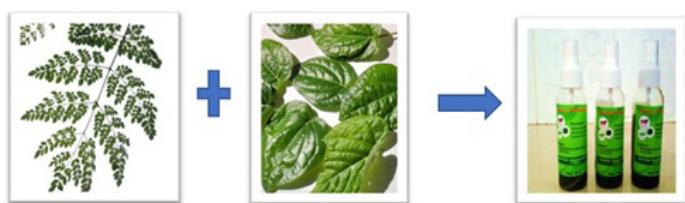


Figure 3: Herbal spray from moringa leaves and betel leaves.

Before being applied to dairy cattle, testing for the levels of saponins, tannins, flavonoids, and pH in herbal sprays was carried out in the following way:

- **Saponin Content:** Testing for saponin content was performed qualitatively, where as much as 1 ml of sample was added to 0.5 ml of aquadest. The solution was put into a tube and then shaken vertically for 10 seconds, and a stable foam formed. If the foam does not disappear, it indicates the presence of saponins (positive).

- **Tannin content:** Testing for tannin content was carried out quantitatively, where the first step was weighing the sample ± 0.5 gram into a 50 ml volumetric flask, then adding hot water to the line and allowing it to cool, shake then filter, then pipette the filtrate as much as 0.5 ml and add as much as 4.5 l of aquadest, add 0.25 ml of folin and 0.5 saturated sodium carbonate solution, homogenize then leave in a dark place for 30 minutes, measure on a spectrophotometer with a wavelength of 680 nm, then make a blank and standard curve using tannin acid.
- **Flavonoid content:** Testing the levels of flavonoid content is carried out quantitatively, where the first step is to weigh the sample 1 gram, add 10 ml of aquadest, and leave overnight, then pipette the solution of approximately 2 ml and react with 100-micron AlCl_3 10% and, 100-micron sodium acetate 1 M, then incubate for 30 minutes, measure the absorbance with a wavelength of 430 nm then make a standard curve using quercetin.
- **pH:** The pH test of the gel preparation was measured using a pH meter immersed in the gel sample. The pH value of the preparation meets the skin pH criteria and does not irritate, namely pH 4.5-6.5 (Okuma *et al.*, 2015, Nikam 2017).

TREATMENT OF TEST ANIMAL GROUPS: The livestock used in the study were female dairy cattle aged 6-15 years in the lactation period and with a body weighting around 400-500 kg/head. The wounds experienced by dairy cows are open wounds that bleed in the shape of a circle and are elongated. Wound care in dairy cattle requires special attention to ensure the healing process goes well and reduces the risk of complications. Specific procedures generally followed in wound care in dairy cattle include conducting an initial examination by thoroughly examining the wound to determine the type and severity of the wound and then identifying whether the wound is shallow, deep, or infected. After identifying the wound, treatment is carried out on the livestock wound using herbal spray from moringa leaves and betel leaves. Wound care in animals must ensure that the treatment chosen is safe, effective, and does not increase animal suffering, with consultation from medical professionals to ensure overall animal welfare. In this case, the treatment for wounds to dairy cows is by spraying the herbal spray evenly on the injured parts of the cattle and doing it three times a day: in the morning, afternoon, and evening; then giving treatment P0, P1, P2, and P3 on the injured parts of the body. The observation parameters in this case are as follows:

- **Wound Size Calculation:** Wound healing was assessed by measuring it daily with a time limit of 14 days to see the difference. During the study, experimental observation techniques were used, where four treatments in

each dairy cow were observed on days 1 and 14 to see macroscopic wound healing.

- Calculation of Wound Drying Time: The method for assessing the drying time of wounds in livestock is based on the condition of the animal's body; where the wound no longer bleeds, the formation of new tissue occurs. The edges of the wound shrink and close, but the scars on livestock will be different from normal skin because the skin is composed of two proteins: elastin, which gives skin strength, and elastin, which gives skin elasticity. The new skin that forms over the scar is substantial but less flexible than the skin around it.
- Calculation of Wound Healing Time: The method for assessing wound healing time is calculated in days based on healing indicators, which measure wound diameter and percentage of healing.

After the wound healing time is obtained, the percentage of wound healing is calculated. The following formula can calculate this:

$$P\% = \frac{do - dx}{do} \times 100$$

Note:

P%: Percentage healing; do: Initial wound size; dx: Area of final wound.

DATA ANALYSIS

The collected data were analyzed using variance analysis with ANOVA using Excel and SPSS. The research data were analyzed using parametric statistics. Results are best interpreted based on statistical inferences related to the effect of herbal spray. The data analysis used in this study is that the data obtained was processed using variance according to a Completely Randomized Design (CRD) with the help of Microsoft Excel and SPSS software. The mathematical model is (Gaspersz, 1991):

$$Y_{ij} = \mu + ai + \epsilon_{ij}$$

Note:

Y_{ij} = Observation value in the i-th treatment and j-th repetition

μ = General average value

ai = The effect of the i-th treatment

ϵ_{ij} = The effect of the i-th treatment error and the jth replication

i = Treatment 1,2,3,4

j = Deuteronomy 1,2,3,4,5

RESULTS AND DISCUSSIONS

The Effect of using Herbal Sprays on Dairy Cattle Wounds
The research results were calculating the size of the wound

area, wound drying time, and wound healing time in the application of herbal sprays from moringa and betel leaf extracts, as well as the results of testing the contents of herbal sprays (Figure 4).

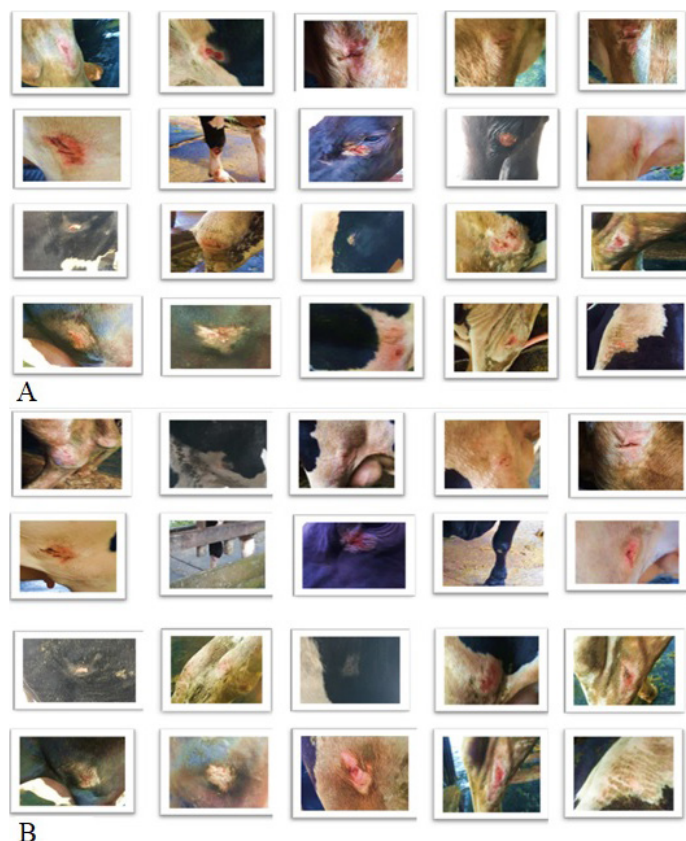


Figure 4: Figure (A) shows the condition of the wound of a dairy cow before being given an herbal spray from Moringa leaf extract and betel leaf extract, while Figure (B) shows the wound condition of a dairy cow after being treated using the herbal spray from Moringa leaf extract and betel leaf extract.

Observational data and analysis results were tested using the One-Way ANOVA statistical test method with Statistical Product and Service Solution (SPSS), and significant data were then forwarded using Duncan's test. The results of the observed parameters can be seen in Table 1.

The data in (Tables 1 and 2) show that the results of the analysis of the parameters of the application of herbal sprays of Moringa leaf extract and betel leaf as an alternative medicine for wound healing in dairy cows show that the best treatment is in P3, giving 50 ml of Moringa leaf extract and 30 ml of betel leaf extract. This is to the opinion (Wahyudi and Agustina, 2018) that the more Moringa leaf extract is used in healing livestock wounds, the more it will further accelerate the wound healing process, as well as the opinion Pramana *et al.* (2014) that providing high concentrations of betel leaves can accelerate the wound healing process in livestock. Research shows that moringa leaf extract has significant anti-inflammatory effects. For example, a study

Table 1: Average results of observed parameters.

No	Parameters	P0	P1	P2	P3
1	Initial wound area (cm)	1.40 ^a ±0.68	5.90 ^b ±4.03	1.18 ^a ±0.56	1.98 ^a ±1.22
2	Final wound area (cm)	0.66 ^a ±0.37	2,22 ^b ±1.81	0.06 ^a ±0.13	0.00 ^a ±0.00
3	Wound drying time (days)	10.60 ^d ±0.89	9.00 ^c ±1.00	7.80 ^b ±0.83	5,40 ^a ±0.54
4	Wound healing time (days)	13.60 ^c ±0.54	12.40 ^b ±0.54	10.80 ^a ±0.83	10,40 ^a ±0.54

Note: P0: 70% Alcohol (Control); P1: 50 ml Moringa Leaf Extract and 10 ml Betel Leaf Extract; P2: Moringa Leaf Extract 50 ml and Betel Leaf Extract 20 ml; P3: Moringa Leaf Extract 50 ml and Betel Leaf Extract 30 ml.

Table 2: Percentage of cattle wound healing.

No	Treat- ments	Initial Wound Area (cm)	Final Wound Area (cm)	Healing Percentage (%)	Length of Application (Days)
1.	P0	1.40	0.66	53	14
2.	P1	5.90	2,22	62	14
3.	P2	1.18	0.06	95	14
4.	P3	1.98	0.00	100	14

by Sugihartini et al. (2020) indicated that moringa leaf extract could reduce inflammation and accelerate wound healing in test mice. This is due to the content of active compounds such as flavonoids and polyphenols in moringa leaves. Palumpun et al. (2017) research shows that betel leaf extract has strong antiseptic properties. Active compounds such as eugenol in betel leaves help prevent wound infections and support healing. Although research combining moringa and betel leaf extracts in topical formulations specifically for livestock is limited, combining these two plants has been explored. Previous studies have shown that combining herbal extracts often enhances therapeutic effects by synergizing different active compounds. Combining moringa and betel leaves can harness both plants' anti-inflammatory, antimicrobial, and healing benefits. In contrast, the calculation of the area of wounds in dairy cows can be seen in the graph in Figure 5.

Figure 5 shows that the area of the wound in dairy cows decreased in each treatment group at the end of the study at P0=1.40–0.66 cm, P1=5.90–2.22 cm, P2=1.18–0.06 cm, and P3=1.98–0.00cm. This shows that the application of herbal sprays from Moringa leaves and betel leaves on the wound healing of dairy cows gave a positive response due to changes in the size of the initial wound area to the end of the study.

Observation data on wound drying time. The above shows that the average treatment shows the drying time of the wound in treatment (P0) by giving 70% alcohol to dry on day 11 (P1). The wound was sprayed with 50 ml of Moringa leaf extract and 10 ml of betel leaf extract to dry on an average day 9th (P2). The wound was sprayed with 50 ml of Moringa leaf extract and 20 ml of dried betel leaf extract on an average of day 8 (P3). The wound was sprayed with

50 ml of Moringa leaf extract and 30 ml of dry betel leaf extract on an average day 5. Based on the results of an analysis of the use of sprays from Moringa leaf extract and betel leaf as an alternative medicine for wounds in dairy cows, wound drying time is significantly affected. With Duncan's further test, it can be seen that P3 is significantly different from P0, P1, and P2.

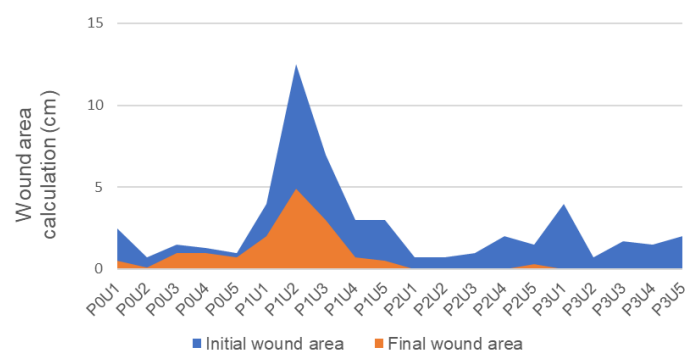


Figure 5: Wound area calculation graph; P0U1: Treatment 0 Replication 1; P0U2: Treatment 0 Replication 2; P0U3: Treatment 0 Replication 3; P0U4: Treatment 0 Replication 4; P0U5: Treatment 0 Replication 5; P1U1: Treatment 1 Replication 1; P1U2: Treatment 1 Replication 2; P1U3: Treatment 1 Replication 3; P1U4: Treatment 1 Replication 4; P1U5: Treatment 1 Replication 5; P2U1: Treatment 2 Replication 1; P2U2: Treatment 2 Replication 2; P2U3: Treatment 2 Replication 3; P2U4: Treatment 2 Replication 4; P2U5: Treatment 2 Replication 5; P3U1: Treatment 3 Replication 1; P3U2: Treatment 3 Replication 2; P3U3: Treatment 3 Replication 3; P3U4: Treatment 3 Replication 4; P3U5: Treatment 3 Replication 5.

Wound healing time observation data shows that the average treatment wound healing time in treatment (P0) with 70% alcohol administration healed on day 14, (P1) Wounds were sprayed with 50 ml moringa leaf extract and 10 ml betel leaf extract healed on an average day 12th, (P2) Wounds sprayed with 50 ml of Moringa leaf extract and 20 ml of betel leaf extract recovered on an average day 11, (P3) Wounds sprayed with 50 ml of Moringa leaf extract and 30 ml of betel leaf extract healed on average day 10. Based on the results of an analysis of the use of sprays from Moringa leaves and betel leaves as an alternative medicine for wounds in dairy cows, it has a significant effect on wound

healing time. With Duncan's further test, it can be seen that P3 is significantly different from P0, P1, and P2.

Based on the results of the tests, the four treatment groups with five repetitions show that wound healing in dairy cows was fastest when sprayed with 50 ml of Moringa leaf extract and 30 ml of betel leaf. In contrast, wound healing took the longest with 70% alcohol (without alcohol) herbal sprays. Figure 6 shows the process of wound healing in cattle.

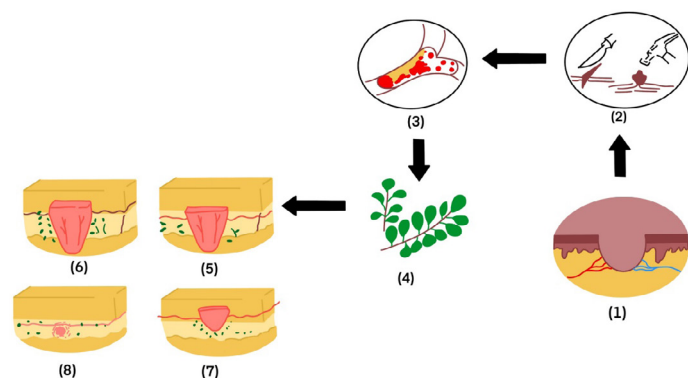


Figure 6: Wound healing process (Waqiah *et al.*, 2023); The process of wound formation in livestock that occurs in the skin layers (1) Wounds caused by sharp or blunt trauma (2) Wounds that result in ruptured blood vessels (3) Wounds can be cured with alternative treatments using extracts from moringa and betel leaves (4) Healing The wound is divided into several phases, the first of which is hemostasis in the process of spontaneously stopping bleeding from damaged blood vessels, in this case the function of tannins in moringa and betel leaves can accelerate the cessation of bleeding in wounds (5) The next phase is inflammatory, the body's natural immune reaction to fight various diseases or harmful microorganisms. In this case, the function of saponins in Moringa and betel leaves can fight microorganisms in the wound (6). The next phase is proliferation, when the wound is rebuilt with new collagen and extracellular matrix tissue. In the proliferative phase, the wound contracts as new tissue forms (7). The final stage of wound healing is strengthening newly formed tissue or the maturation process. In this phase, the scar is entirely covered by a new layer of skin (8).

The use of herbal sprays from extracts of moringa leaves and betel leaves in the wound healing of dairy cows can be seen in Figure 7.

CONTENT OF HERBAL SPRAY

The research results were in the form of ingredients contained in the herbal spray, including saponins, tannins, flavonoids, and pH, as shown in Table 2.

Based on the data in Table 3, it can be obtained that the saponin content at P0 is harmful, which means there is

no saponin content in it, while P1, P2, and P3 are positive, which means they contain saponins. Saponins can be cleaners and antiseptics, which kill germs or prevent the growth of microorganisms that usually occur in wounds so that the wound does not get a severe infection. When interacting with bacteria, saponins can increase the permeability of bacterial cell membranes, resulting in hemolysis of bacterial cells. Saponins are also immunostimulants that stimulate T lymphocytes, activating macrophages in the wound area to defend themselves from infection (Wijaya, 2014). Figure 8 shows the structure of saponins.



Figure 7: Using herbal sprays of Moringa leaf extract and betel leaf on injured dairy cows by spraying them on the wound to speed up wound healing.

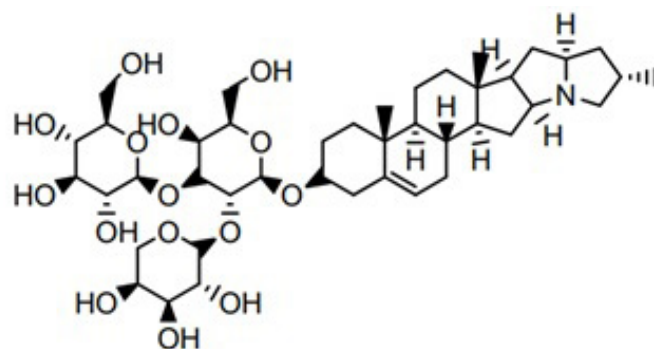


Figure 8: Structure of saponins (Rustamadji, 2004).

Table 3: Lab test results for herbal spray content.

Treatments	Saponins	Tannins	Flavonoids	pH
P0	Negative	0.00	0.00	7.50
P1	Positive	1.11	276.74	5,74
P2	Positive	1,12	288,43	5.69
P3	Positive	1.27	292.97	5,62

P0: Treatment 0; **P1:** Treatment 1; **P2:** Treatment 2; **P3:** Treatment 3; **ppm:** Parts per million.

Saponins have a relatively high molecular weight and a sizeable biological role because they function as protein precipitators and metal chelators. Therefore, saponins are predicted to act as natural antioxidants that can block the effects of free radicals on the skin (Rustamadji, 2004). Antioxidants can act as hydrogen radical donors or free radical acceptors to delay the initiation stage of free radical formation. Based on this, herbal sprays from moringa and betel leaf extracts have good properties in healing wounds in livestock.

The tannin content in the results of the herbal spray test found that P3 contained the largest tannin, namely 1.27%, which means that the higher the tannin content in the treatment of wounds, the faster the wound healing process. Tannins function as an astringent, which can cause skin pores to shrink, stop exudate, and light bleeding. Tannins also have antibacterial properties by precipitating proteins because tannins are suspected to have the same effect as phenolic compounds (Berawi *et al.*, 2019). When a wound occurs, the tannins will help stop the bleeding so the blood does not come out (Hidayat, 2014). Figure 9 shows the structure of tannins.

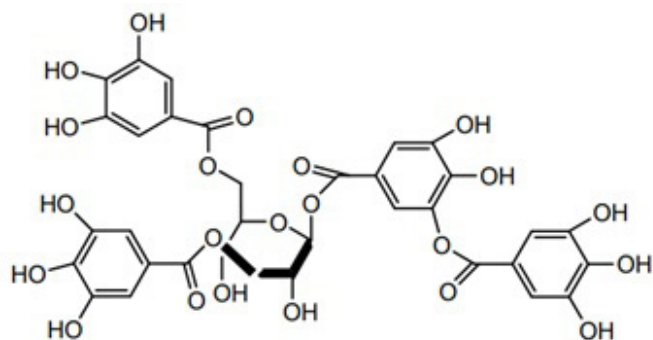


Figure 9: Tannin structure (Rustamadji, 2004).

Figure 9 shows that the structure of the tannin compound consists of a benzene ring (C6) bonded to a hydroxyl group (-OH). Tannins have a significant biological role because they function as protein precipitators and metal chelators. Therefore, tannins can act as natural antioxidants that can block the effects of free radicals on the skin (Rustamadji, 2004). Antioxidants can act as hydrogen radical donors or free radical acceptors to delay the initiation stage of free radical formation. This shows that herbal sprays from moringa and betel leaf extracts have good properties in healing wounds in livestock.

The content of flavonoids in the results of the herbal spray test found that P3 contained the most significant number of flavonoids, 292.97 ppm, which means that the higher the flavonoid content in the treatment of wounds, the faster the wound healing process. Flavonoids function as antibacterials by forming complex compounds against extracellular proteins that disrupt the integrity of bacterial cell membranes. Flavonoids are phenolic compounds, while phenolic compounds can act as protein coagulators. In addition, flavonoids have anti-inflammatory effects, which function as anti-inflammatories and can prevent stiffness and pain. Flavonoids also function as antioxidants to inhibit toxic substances (Handoko and Andriani, 2015). Figure 10 shows the structure of the flavonoids.

Flavonoids have a basic carbon framework consisting of 15 carbon atoms. Two benzene rings (C6) are bound by a

propane chain (C3), which has the potential as a raw material for medicine (Rustamadji, 2004). Based on this, herbal sprays from moringa and betel leaf extracts have good properties in healing wounds in livestock.

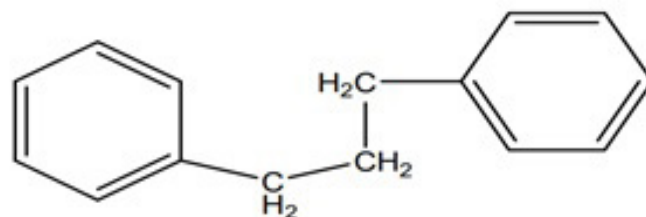


Figure 10: Structure of flavonoids (Rustamadji, 2004).

The pH value in the herbal spray of Moringa leaf extract and betel leaf at P3 is 5.62. This indicates that the pH value meets the skin pH criteria and does not irritate the pH between 4.5 and 6.5 (Okuma *et al.*, 2015, Nikam, 2017).

Wound healing in dairy cows using herbal sprays of Moringa leaf extract and betel leaf in each treatment group was relatively different; this was due to the additional betel leaf extract administration in each treatment, where the higher the concentration of the leaf extract, the faster the wound healing process. This is also because Moringa and betel leaves contain active substances such as saponins, tannins, and flavonoids, which can accelerate wound healing (Handoko and Andriani, 2015). In addition to treating wounds with herbal sprays from moringa leaves and betel leaves, other things that must be considered are environmental and health factors. A clean environment reduces the risk of secondary infection in wounds. Dirty or damp cages can worsen wound conditions and reduce the effectiveness of herbal sprays, while the general health of livestock can affect the response to wound care. Livestock that are in good health tend to have stronger immune systems and can respond more effectively to treatment, as well as the severity of the wound. Deeper or larger wounds require additional treatment in addition to herbal sprays.

CONCLUSIONS AND RECOMMENDATIONS

The best treatment in this study was P3 with a concentration of 50 ml of moringa leaf extract and 30 ml of betel leaf extract. So, it can be recommended that to speed up the process of reducing the area of the wound, speed up the drying time, and wound healing in dairy cattle, herbal sprays of Moringa leaf extract with a dose of 50 ml and 30 ml of betel leaf can be used. Using herbal sprays from moringa and betel leaves in wound management in dairy cattle has potential benefits. Still, it is also faced with limitations and practical obstacles, such as applying herbal sprays to livestock can be challenging to do consistently, especially

if the wound is in a hard-to-reach area or if the livestock is uncooperative. Herbal sprays need to be appropriately stored to prevent damage or decreased effectiveness. Factors such as temperature, light, and humidity can affect product stability. Adopting an integrated approach and considering alternative treatments can help improve the effectiveness of treatment and overcome existing challenges. Further research and careful monitoring will be essential to optimize the use of herbal sprays and ensure animal welfare.

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NOVELTY STATEMENT

Natural ingredients for wound healing show a more holistic and environmentally friendly approach compared to the use of chemical drugs.

AUTHOR'S CONTRIBUTIONS

All authors composted the concept, analyzed field data, and wrote the final manuscript.

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CONFLICT OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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