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Effectiveness test of pencil cactus plant extract (*Euphorbia tirucalli*) on incision wound healing

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Abstract
Cuts or incisions (*Vulnus scisum*) can be caused by sharp objects such as knives, broken glass, and zinc which cause damage to body tissues. In the healing process, wounds must receive treatment and treatment to prevent wider tissue damage, so drugs as inflammatory agents and antibiotics are needed to prevent infection and accelerate wound healing, one of which is Broken Bones. (*Euphorbia tirucalli*). Broken bone plant is one of the plants used as traditional medicine, because the content in this broken bone plant has great potential to be processed and used as medicine. The purpose of this study was to test the effectiveness of plant extracts of fractures on wound healing in white rats and to determine the fastest concentration and time for wound healing in white rats. The research design used was a completely randomized design (CRD). The samples used as many as 12 white rats (*Rattus norvegicus*), in each experimental group as many as 3 tails and the number of groups used is 4 groups With treatment levels P: Povidone Iodine, P1: 7% Broken Plant Extract, P2: Broken Plant Extract Bone 12%, P3: Fracture Plant Extract 17%. Based on observations, the 4 treatments given to cuts were effective in wound healing, but the administration of fracture stem extract showed that a 7% concentration of fracture stem extract was effective in accelerating the healing of cuts, with the fastest time of 5 days.

Keywords: pencil cactus (*Euphorbia tirucalli*), incision-wound

Introduction

Wound is a condition in which tissue damage occurs that disrupts the continuity of body cells, and is caused by various possible causes such as sharp objects, chemicals, explosions, temperature changes, animal bites, and electric shocks (Kurniawaty *et al*, 2018) [13]. There are several effects that arise when the body is injured, such as bleeding, blood clots, disruption of organ function activities, bacterial contamination, and cell death (Zahriana, 2017). The type and shape of the wound varies depending on the cause, there are types of closed wounds such as bruises and there are types of open wounds such as cuts. The shape of the cut is that there is a tear in the skin and underlying tissue, the wound is painful, and the length of the wound is greater than the depth of the wound.

Cuts or incisions (Vulnus scisum) can be caused by sharp objects such as knives, broken glass, and zinc which cause damage to body tissues (Oktaningrum, 2016). The wound healing process is a complex biological process to restore the continuity of damaged tissue, and result in the restoration of tissue integrity. There are four stages of the wound healing process, namely hemostasis, at the beginning of the injury hemostasis aims to stop bleeding marked by platelet aggregation and platelet-mediated vasoconstriction. In the inflammatory stage, the injured tissue cells activate the release of cytokines that induce phagocytosis and initiate repair of the injured tissue. The proliferative stage begins with a new epithelialization and granulation process on the surface of the wound tissue and the formation of vascularization around the tissue to repair the previous injury. The differentiation stage or the remodeling stage is the final stage which is responsible for rebalancing between the synthesis of new collagen and the replacement of damaged tissue (degradation) (Wang *et al*, 2018) [31].

Based on the length of the wound healing process, cuts can be categorized as acute wounds and can also be categorized as chronic wounds, categorized as acute wounds if the healing process takes place according to normal healing rules, but can also be said to be chronic wounds if there is delayed healing. Acute wounds can recover as normal with minimal scarring in the span of 8-12 weeks and the causes are skin contact with hard, sharp surfaces, gunshot wounds, and surgical wounds. While the cause of chronic wounds is the failure of recovery due to physiological conditions such as diabetes mellitus, cancer, continuous infection, and even low treatment measures (Purnama *et al*, 2017) [23]. Sometimes if there is a wound on a part of the body, the healing process can occur naturally or it can be said that the wound heals by itself, but the healing process can also be hampered due to local factors such as wound conditions, infection, trauma, and swelling that can affect healing, and systemic factors such as age, general health and nutrition. In the healing process, the wound must receive care and treatment to prevent wider tissue damage. In addition, in its management, it is a determining factor in the final outcome of the wound healing process, so drugs as inflammatory agents and antibiotics are needed to prevent infection and accelerate wound healing.

Tumbuhan Patah Tulang or Pencil cactus (Euphorbia tirucalli) is one of the plants used as traditional medicine. The use of plants as traditional medicine has been known to the public since ancient times. In the current condition, the use of drugs derived from plants is in great demand by the public, even though there are already many finished drugs in circulation. This proves that people are more likely to return to nature (back to nature) in the supply of medicines (Kementan, 2013). The stem, twigs and sap of this broken bone plant are often used and used as medicine. Because the

content in this broken bone plant has great potential to be processed and used as medicine. Based on previous research by Ema *et al* (2016) [5], the results of the methanol extract of fractured plants contained steroids, tannins, and phenolics. Meanwhile, from the antioxidant activity test of fractured plants, it was shown that this plant has the potential to have antioxidant activity. The antioxidant potential of fractured plant extracts can be used as a free radical scavenger from cigarette smoke (Nasir *et al*, 2016) [19]. Furthermore, Melina *et al*. (2017) [14] in their research, twigs of broken bones can be used as an antibacterial against the bacteria Propionibacterium acnes that causes skin disease. In addition, fractured plant extracts can remove enlarged moles, remove warts, remove pierced thorns, and relieve fractures. This healing is due to the catalytic activity found in the sap and twigs (Mutiara, 2019). This fracture plant is also used as an anti-inflammatory due to the presence of flavonoid compounds. Zainal Abidin (2019) [33] used fractured twigs that have the potential as anti-inflammatory through protein denaturation inhibition assays. Christina *et al* (2020) [3] used whole parts of the fracture plant to test inflammatory activity in inflammation inhibition. Another benefit of this broken bone plant can be used as a traditional medicine to heal cuts, as evidenced by a previous study by Siti Qomariah (2014) [27] on the effectiveness of fracture stem extract ointment on wound healing in white rats using the maceration method. Vaseline doses of 5%, 10%, 20%, and 10% povidone iodine, the results of the study showed that with a dose of 10% extracts of fractured plants were able to accelerate the healing of cuts. Furthermore, research by Galuh Ratnawati *et al* (2019) [9] on the effect of bone fracture sap on wound healing in white rats, the concentrations given were 9% fracture plant extract ointment, 23% fracture plant extract ointment, and madecassoll. The results showed that 9% and 23% of fracture plant extracts had the potential to accelerate wound healing, there was no difference between the two concentrations. The latest research by Atma Pekei (2020) [11] on the effectiveness of fracture stem extract on wound healing, fracture plant extract 10%, 20%, positive control and negative control. The results showed that the administration of 10% ointment extract was the optimal dose for wound healing.

Materials and Methods

Tumbuhan Patah Tulang or Pencil cactus (Euphorbia tirucalli) is native to tropical East Africa and is endemic to countries such as Angola, Eritrea, Ethiopia, Sudan, Tanzania. This plant likes open areas that are exposed to direct sunlight. In Indonesia, it is grown as a hedge plant, ornamental plant, medicinal plant, and grows wild. A multi-branched fracture plant, which has a height of 2-15 m with a spread of 2-4 m. The trunk and main branches are woody and can be thickened up to 25 cm in diameter.

This plant grows with several stems with a woody base, many branches, and a poisonous milky gummy (Wal *et al*, 2013) [30]. The broken bone plant has twigs that are cylindrical, pencil-shaped, finely grooved longitudinally, and are green. The branches after growing about an inch will immediately branch into two, and so on so that they look like broken branches. The leaves are rare, found at the tips of young twigs, small, lanceolate in shape, 7-25 mm long, and fall off quickly. Compound flowers, arranged like a bowl, greenish yellow color like twigs. When ripe, the fruit will burst and throw off the seeds. The characteristic feature of fractured plants is that they are only composed of stems that resemble bones (Wal *et al*, 2013) [30]. This plant is one of the plants that have toxic properties to the skin and eyes from the mucus layer. The sap, which is white like milk, is toxic (Julianus *et al*., 2011) [11]. This plant is also known as kayu urip, pacing tawa, tikel balung (Jawa), susuru (Sunda), patah tulang (Sumatera), kayu leso, kayu jaliso, kayu tabar, kayu langtolangan, (Madura). (Toana dan Nasir, 2010) [29].

Euphorbia tirucalli plants can be classified as follows: Kingdom: Plantae, Division: Magnoliophyta, Class: Magnoliopsida, Order: Malpighiales. Family: Euphorbiaceae, Genus: Euphorbia, Species: Euphorbia tirucelli

Fig 1: Tumbuhan Patah Tulang or Pencil cactus (*E. tirucalli*)

It has been previously studied that the sap from the Pencil cactus plant has the benefit of treating acute wounds, infectious diseases, and tumors (Meloreis *et al*, 2015) [16]. And also has antibacterial activity that can prevent infection in wounds (Yi Q *et al*, 2017) [32], and shows an anti-inflammatory effect on fracture plants (E. tirucalli) (Marrakchi *et al*, 2009) [15]. In addition, the broken bone plant (E. tirucalli) contains latex acid which contains euphol, taraksasterol, lactterol, kutschuk (rubber substance), alkaloids, tannins, flavonoids, steroids, triterpenoids, and hydroquinone (Toana & Nasir, 2010) [29].

Wounds are the destruction of part of the body's tissues, this situation can be caused by sharp or blunt trauma, changes in temperature, chemicals, explosions, electric shocks, or animal bites (Sjamsuhidajat, 2017). The wound is a break in tissue continuity due to injury or surgery. Wounds can be classified based on their anatomical structure, nature, healing process, and duration of healing (Kartika, 2015) [12]. Wounds are a condition where the continuity of body tissues is interrupted which can cause disruption of body functions, so that it can interfere with daily activities (Hidayat, 2014). Wounds can be described as a disruption in the continuity of cells followed by wound healing which is the restoration of that continuity (Potter and Perry, 2006) [21].

Although the wound healing process is the same for every sufferer, there are many factors that influence the wound healing process, namely (Morrison, 2004) [17]; Intrinsic factors include general pathophysiological factors (eg, cardiovascular disorders, malnutrition, metabolic and endocrine disorders, decreased resistance to infection) and

normal age-related physiological factors and adverse local conditions at the wound site (eg, excessive exudate, dehydration, wound infection, recurrent trauma, decreased wound temperature, edema, extensive tissue sloughing, and excessive metabolic products). Extrinsic factors include inappropriate wound management (eg, inappropriate wound assessment, use of inappropriate primary wound care materials, and careless dressing change technique.

Wound Healing Process

Perdanakusuma (2007) [20], states that wound healing is a form of business process to repair the damage that has occurred. The main component in the wound healing process is collagen in addition to epithelial cells. Fibroblasts are the cells responsible for the synthesis of collagen. The physiology of natural wound healing will undergo phases such as the following:

Hemostasis Phase

Wounds bleed due to broken or torn blood vessels. In this phase, thrombosis will occur due to the release of atherosclerosis in the blood vessels. In several processes, namely blood clotting, platelet and plasma aggregation, which causes the formation or dissolution of platelets (Putri, 2004) [2].

Inflammatory Phase

This phase starts from the occurrence of the wound until the fifth day. After the injury, the broken blood vessels constrict and retract accompanied by a hemostatic reaction due to the aggregation of platelets which together with the fibrin mesh coagulate the blood. In the inflammatory phase, the process of angiogenesis occurs, where new blood vessels begin to grow in the injured wound and play a very important role in the proliferative phase. Fibroblasts and endothelial cells convert molecular and soluble oxygen with superoxide, which is an important compound in resistance to infection and provides oxidative signals to stimulate further growth factor production. In the process of inflammation is a fight against infection and as a bridge between injured tissue and for the growth of new cells (Suriadi, 2004) [28].

Proliferation Phase

The proliferative phase is characterized by the formation of granulation tissue in the wound, in this phase macrophages and lymphocytes still play a role, the predominant cell types undergo proliferation and migration including epithelial cells, fibroblasts, and endothelial cells. In the proliferative phase, fibroblasts are the main synthetic elements in the repair process and play a role in the production of protein structures used during tissue reconstruction. In particular, fibroblasts produce large amounts of collagen. Fibroblasts will usually be seen around the wound. In this phase, angiogenesis also occurs, a process in which the capillaries of new blood vessels grow or the formation of new tissue (tissue granulation). Clinically there will be redness of the wound. Then in the wound contraction phase, the contraction here is functioning in facilitating wound closure (Suriadi, 2004) [28]. Fibroblasts (connecting tissue cells) that migrate to the wound area starting in the first 24 hours after surgery. In normal soft tissue (without injury), exposure of fibroblasts is very rare and usually hides in the supporting tissue matrix. After an injury occurs, fibroblasts will actively move from the tissue around the wound into the wound area, then will develop (proliferate) and secrete several substances (collagen, elastin, hyaluronic acid, fibronectin, and proteoglycans) which play a role in building (reconstruction) new tissue.

Maturation Phase

This phase is the last and longest phase of the wound healing process. This phase lasts from 3 weeks to 2 years. At the end of this healing, a mature scar has a strength of 80% of normal skin (Perdanakusuma, 2007) [20]. In the maturation or remodeling phase, there are many matrix components. Hyaluronic acid, proteoglycan, and collagen components are deposited during repair to facilitate adhesion to cellular migration and tissue support. Collagen fibers increase gradually and become thicker and then supported by proteinases for repair along the wound line. Collagen is the most important element in the matrix. Collagen fibers spread out by being attracted to and fused together, gradually supporting tissue recovery. Collagen remodeling during scar formation occurs in continuous collagen synthesis and catabolism (Suriadi, 2004) [28]. The role of sapogenin compounds in the wound healing process of white rats. Some sapogenins work as antimicrobials (anti-bacterial and anti-viral) increase the immune system, blood sugar levels, reduce blood clots, and sapogenins are also beneficial in influencing the formation of collagen (the initial stage of tissue repair) by inhibiting the production of excessive wound tissue and Sartika, 2010). The content of sapogenin compounds contained in the sap stimulates the formation of new epithelial cells and supports the re-epithelialization process, because the faster the re-epithelialization process, the faster the wound size will decrease, thereby shortening the wound healing process (Prasetyo *et al*, 2010) [22].

White Rat (Rattus norvegicus)

Selection of Male White Rats as Experimental Animals Rats are widely used in research as "mouse models" because of the similarity of DNA organization and gene expression where 98% of human genes have genes comparable to mouse genes, similarities in the reproductive system, nervous system, diseases (cancer, diabetes), and even anxiety (Center for Livestock Research and Development, 2016). According to Smith & Mangkoewidjojo (1988) in Dahlia (2014), the activity of white rats is not disturbed by the presence of humans around them. White rats can live alone in cages and these animals are larger than mice, so for laboratory experiments white rats are more profitable than mice. The age of 2.5 months rats has similarities with young adult humans and has not experienced the intrinsic aging process. According to Ngatidjan (2006) in Dahlia (2014), the use of male white rats as experimental animals because male white rats can provide more stable research results because they are not influenced by the presence of the menstrual cycle and pregnancy as in female white rats. Male white rats also have a faster drug metabolism rate and a more stable biological body condition than female rats

Research Methods

The type of research used is an experimental design using a non-factorial completely randomized design (CRD). This study used 4 treatments with 3 replications, each treatment contained 3 white rats. With the following treatment levels:

P: Povidone Iodine

P1: Plant Extract 7%
P2: Plant Extract 12%
P3: Plant Extract 17%

Explanation
P: Placebo
P1: Treatment 1
P2: Treatment 2
P3: Treatment 3

This research was conducted at the Biology Laboratory of Manado State University for sample extraction, and at the Pharmacy Laboratory of the Indonesian Christian University of Tomohon to concentrate the results of sample extraction. Research time starts from April-May 2021.
The population in this study were 12 white rats and were randomly selected. The samples used in each experimental group were 3 individuals and the number of groups used was 4 groups. Before carrying out the experiment, the rats were adapted and reared, fed and watered ad libitum. Ad libitum is the provision of feed in unlimited quantities. Following are the sample criteria: The population in this study were 12 white rats and were randomly selected. The samples used in each experimental group were 3 individuals and the number of groups used was 4 groups. Before carrying out the experiment, the rats were adapted and reared, fed and watered ad libitum. Ad libitum is the provision of feed in unlimited quantities. Following are the sample criteria: 1) Inclusion Criteria. The general characteristics of the subjects of this study were white rats with male sex, 3-4 months of age, healthy condition, active movement, eating, drinking, no body defects, body weight 100-250 grams. 2) Some of the subjects who did not meet the inclusion criteria were sick rats and dead rats.

Research Variable
The independent variable (independent variable) denoted by the letter 'X' is a variable that affects other variables. The independent variable in this study was the plant extract of fractures. The dependent variable (dependent variable) which is denoted by the letter 'Y' is a variable that is influenced by the presence of an independent variable (independent variable). The dependent variable in this study is wound healing

Research Procedure
Samples of fractured plants were taken from Ongkaw Dua village, Sinonsayang District, South Minahasa Regency and the samples used were stems from Pencil cactus or Patah Tulang plants that were young, light green in color, stems were still soft, and found at the ends of the plant stems. The male white rats (Rattus norvegicus) were taken from Kawangkoan, North Kawangkoan District, Minahasa Regency. Kawangkoan Village.
Diluting the extract with various doses using Aquades solvent, so that the concentrations of 7%, 12%, and 17% were obtained. Calculation of making concentration refers to previous research from Friska (2015).
The implementation stage was started by preparing 12 male white rats which were divided into 4 experimental groups with 3 male rats in each experiment. The detailed research treatment is as follows: 1) 12 white rats were divided into 4 experimental groups with 3 mice each. 2) Rats were placed in cages and fed ad libitum. 3) First, the back of the rat was shaved using a razor blade, the skin was smeared with 70% alcohol. Furthermore, male rats were given cuts using a cutter with a length of 1 cm and a depth of 1 mm. After being given a cut, the rat skin was given 70% alcohol again. 4) The rats' backs were treated with povidone iodine, 7%, 12%, and 17% extract in each experiment. 5) Treatment is given until the wound closes. 6) Observations were made 2 times/day in the morning and evening and the length of the wound was measured using a ruler, then recorded.
Data analysis was carried out with the Analysis Of Variance (Anova) test if the analysis was significantly different then continued with the smallest significant difference test (SDT)

Results and Discussion
The purpose of calculating the yield is to determine the percentage of the resulting extract. The yield calculation refers to previous research from Hasnaeni, *et al* (2019) [10]. The results of the extraction of fractured plants can be seen in full in Table 1

Table 1: Maceration Results of Patah Tulang Plant Extracts

Solvent Type	Simplisia Weight	Amount of Solvent	Extract Color	Thick Extract Weight	Rendeman
Alcohol 95%	150 gram	2000 ml	Brown	28,33	18,88 %

The results of the calculation of the yield of plant extracts of fractures showed that the yield was 18.88%. The higher the yield value, the higher the compound content in it (Dewastisari, 2018) [4]. The measurement of the diameter of the incision wound in white rats was carried out every day, starting from day 1 to day 11, that is, until the wound closed completely. The results of measuring wound diameters are based on average, more details can be seen in Table 2.

Table 2: Average Results of Wound Diameter Measurement

Day	Povidone Iodine	Extract 7%	Extract 12%	Extract 17%
1	10	10	10	10
2	10	9.666	10	10
3	9.666	8.666	9.333	9.666
4	9	5.333	7.666	7.333
5	7.666	3.333	5.666	6.333
6	7.333	1	3.666	5.666
7	5.333	0	2	3.333
8	0	0	1.333	1
9	0	0	0.666	0.666
10	0	0	0.333	0
11	0	0	0	0

From the table above shows that, the average results of the 4 treatments on day 1 are all the same with the average value is 10. On day 2 the 7% extract experienced a decrease in the average value of 9,666, compared to other treatments. which does not experience a decrease in the mean value. On the 3rd day, the 4 treatments experienced a decrease in the average value, the average value of povidone iodine decreased by 9,666, 7% extract 8,666, 12% extract 9,333, and 17% extract 9,666. On the 4th day of the 4th treatment, the average value decreased, povidone iodine decreased by an average value of 9, extract 7% 5,333, extract 12% 7,666, and extract 17% 7,333. On the 5th day, the 4 treatments experienced a decrease in the average value, the average value of povidone iodine decreased by 7,666, 7% extract 3,333, 12% extract 5,666, and 17% extract 6,333. On the 6th and 4th day of treatment, the average value of povidone iodine decreased by 7,333, extract 7% 1, extract 12% 3,666, and extract 17% 5,666. On the 7th day, the 7% extract experienced a decrease in the average value of 0 while the treatment on povidone iodine experienced a decrease in the average value of 5,333, 12% 2 extract, and 17% 3,333 extract. On day 8, povidone iodine decreased by an average value of 0, 12% extract was 1.333, and extract 17%. On day 9, 12% extract decreased by an average value of 0.666, and 17% extract was 0.666. On the 10th day, the 12% extract experienced a decrease in the average value of 0.333, and the 17% extract was 0. On the 11th day, the 12% extract experienced a decrease in the average value of 0. From each treatment based on observations starting from day 1 to on day 11 there was a decrease in the average value of the results of measuring wound diameter.

Based on Figure 1, the treatment on povidone iodine showed that the fastest time for wound healing for 1,2,3 repetitions was on the 8th day, 7% extract the fastest time for wound healing on the 5th day of 3 replications, and the longest time on the 7th day. In replicates 1 and 3, the 12% extract had the fastest healing time on the 7th day of replication 2, and the longest was on the 11th day of replication 1, while the 17% extract had the fastest wound healing time on the 8th day of replication 1, and the most 10th day of test 2.

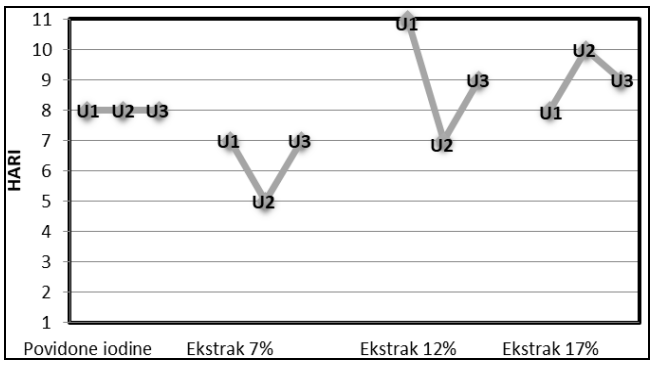

Fig 2: Wound Healing Time

Based on research after making cuts on the rat's back, the wound begins with a bleeding process due to damaged blood vessels, after which a hemostatic process occurs, namely the cessation of blood by constriction of blood vessels and blood clots occur. Blood vessels will spasm, vasoconstriction or narrowing of blood vessels occurs. In the damaged blood vessels, platelets will immediately stick to and form a blockage so that bleeding does not occur again, so that the blockage is stronger, the clotting factor fibrinogen will be converted into fine threads called fibrin threads.

Based on observations on day 1 to day 2 the wound experienced inflammation and swelling at the edge of the wound. The cut turns out to be inflamed which is characterized by redness due to the dilation of the capillaries, the widening of the capillaries aims to clean germs, bacteria, or foreign objects that enter the wound. When bacteria, or foreign objects enter through the wound, directly the mast cells located under the skin, the connective tissue rich in histamine, will release the chemical histamine and will trigger vasodilation of blood vessels in the area. With the dilation of blood vessels or increased permeability, the amount of blood that goes to the wound area will increase, which means the number of white blood cells will also increase. Histamine also has the effect of increasing capillary permeability, which means that the capillary pores will widen and white blood cells can exit through the pores of the blood vessels to eradicate bacteria. The white blood cells involved are neutrophils and macrophages. On the 3rd day of treatment on povidone iodine, 12% extract, and 17% extract were still inflamed and the wound hardened, this was due to blood clots which made the wound harden. However, in the 7% extract in the 2nd replication, there was a wound that was not inflamed and even had a scab, a blood clot that turned into a scab when it dries, indicating that the wound is almost healed, at this stage collagen begins to grow in the wound. Collagen is a protein fiber that gives the skin its elastic texture strength.

On the 4th day there were several wounds that were no longer inflamed and formed scabs, namely in povidone iodine replicates 1 and 3, extract 7% replicates 2 and 3, extract 12% replicates 1 and 2, extract 17% replicates 1 and 3, the jam some are still inflamed. On the 5th day of extract 7% replicates 2 wounds had closed. This is due to the collagen that pushes the wound edges to close. Once the damaged tissue is completely healed, the skin will be as strong as it was before the injury. In the 12% extract in replicates 1 and 2, 17% extract in replicates 3, the wound that had formed a scab was now re-inflamed due to the release of the scab. Wound is still raw. The scab that comes off is caused by the rat scratching the wound, maybe because the wound feels itchy, but actually indicates the wound is almost healed. On the 6th day there were more wounds that were still inflamed and there were wounds that were no longer inflamed. Even at 7% extract in replicates 1 and 3 the wound almost closed. On the 7th day, the 7% extract in replicates 1 and 3 had closed, and on the 12% extract in replicates 1, 2, 3 the wound was almost closed. On the 8th day of povidone iodine, extract 12% replicates 2 and 3, extract 17% replicates 1, the wound was closed.

On the 9th day there were still wounds that had not closed, namely in the 12% extract in replicate 1, and 17% extract in replicate 2. On the 10th day the 12% extract in replicate 1 had not closed. On the 11th day all the wounds in the treatment had closed. It can be seen that in povidone iodine, it has the fastest healing time on the 8th day. The 7% extract had the fastest healing time on the 5th day and the longest on the 7th day. The 12% extract had the fastest healing time on the 7th day and the longest on the 10th day. While the 17% extract had the fastest healing time on the 8th day and the longest on the 9th day. Based on the results of this study, it turned out that these 4 treatments were effective in healing

cuts. When compared between Povidone iodine and plant extracts of fractures, both are used as a medicine for cuts, and both have an effect on healing wounds. In the clinical field, povidone iodine has been tested as an antiseptic which has been widely used in medical practice, in contrast to plant extracts of broken bones used as traditional medicine which turned out to be more effective in accelerating the healing of cuts, namely fracture stem extract with a concentration of 7% more effective in accelerating wound healing with the fastest time of 5 days, this is because the 7% extract contains more active substances that can help the wound healing process faster. Compared with research from Esterlina *et al* (2020) [8] using papaya stem extract as a wound healing with the fastest time of 7 days at a concentration of 9%, further research from Ertati (2016) [7] used snail mucus for wound healing with the fastest time of 6 days at a concentration of 75%, research from Muhammad (2017) [18] using ethanol extract of bitter melon leaves as an alternative medicine for wound healing with the fastest time of 9 days at a concentration of 75%, research from Repatri *et al* (2020) [25] using jatropha leaf extract for wound healing with the fastest time of 9 days in 40% concentration. Based on comparisons from several previous studies, fractured plants were more effective in accelerating wound healing. Fracture plant extracts are effective in wound healing, because the fresh and dried stem extracts from fractured plants contain flavonoid compounds, steroids, and tannins (Grace, 2014). In addition, fractured plants contain secondary metabolites consisting of saponins, phenolics, and tannins (Paricia, 2020). The content contained in this fracture plant can help the wound healing process because it functions as an antioxidant and antimicrobial. Saponins help in wound healing by forming collagen in the early stages of tissue repair and can trigger VEGF (Vascular endothelial growth factor) to increase the number of macrophages moving to the wound area so that this will increase cytokinin production and will activate fibroblasts in wound tissue (Aliefia, 2015) [1]. In addition, saponins act as antimicrobials, where saponin compounds increase the immune system, reduce blood clots, help stimulate new epithelial cells and support the reepithelialization process in order to accelerate wound healing. In addition to saponins, tannin compounds are also useful as astringents and antibacterials where these compounds help shrink cell walls so that they inhibit bacterial permeability to grow by stopping bleeding, accelerating healing of inflammatory wounds of mucous membranes, and regeneration of new tissue (Aliefia, 2015) [1]. Steroids also have an effect on wound healing, and as antioxidants, free radical scavengers, reduce lipid peroxidation, reduce cell necrosis, and increase vascularity (Eva, 2017) [6]. Flavonoid compounds have also been shown to accelerate wound healing by increasing the epithelialization process, the formation of granulation tissue which can increase collagen production.

Conclusions

Based on the results of the study it was concluded that:

1. Pencil cactus or Patah Tulang plant extract is effective in wound healing in white rats.
2. There is a concentration of 7% and the fastest time is 5 days of wound healing in white rats.

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