

The Effect of Liquid Smoke on Scabies Pain and Wound among Students at Islamic Boarding School

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Abstract-- Scabies is one of the skin diseases frequently experienced by students at Islamic boarding schools. Almost all Scabies medication has a side effect, such as irritation. Liquid smoke from coconut shells contains analgesic, anti-inflammatory, antimicrobial, and antioxidant properties that benefit the process of wound healing. This study aimed to analyze the effect of liquid smoke from coconut shells on scabies pain and wound. This was a quasi-experiment study. The sample used was 60 students at an Islamic Boarding School. The samples were divided into two groups (intervention and control). The independent variable was topical liquid smoke for 14 days, while the dependent variable was the level of pain and the process of wound healing. Data were collected by using a questionnaire and wound observation. The results showed that there were significant differences between the intervention and control groups ($p = 0,000$) based on the Mann-Whitney test. There were significant differences between the treatment and control groups in the wound healing process with erythema criteria ($p = 0,000$), lesions ($p = 0,000$), granulation ($p = 0,000$), and scabies hole closure ($p = 0,000$) based on the Mann-Whitney test. Topical liquid smoke from coconut shells can decrease the level of pain and accelerate the process of scabies wound healing. Future studies can analyze the effect of liquid smoke on other skin diseases.

Keywords-- Liquid Smoke; Pain; Wound; Scabies

I. INTRODUCTION

Scabies is the most common dermatological condition in hot and tropical climate countries, especially in overcrowded and poor settings[1]. Scabies is a highly contagious skin parasitosis caused by *Sarcoptes scabiei var. hominis*, which easily transmitted from person to person, via direct skin contact [2] or indirectly through sharing articles such as clothing, towels, or bedding used by an infested person[3]. Infestation occurs when the pregnant female mite burrows into the skin and lays eggs. After two or three days, the larvae emerge and dig new burrows. Then the mite mature, mate, and repeat this cycle every two weeks[4]. The immune reaction caused by the burrowed mites and its products leads to some typical symptoms, such as pruritus, lesions, and the presence of burrows on the hands and feet[5]. Pruritus is itchy and uncomfortable, which makes one want to scratch. It can lead to inoculation of the skin with bacteria (particularly *Staphylococcus aureus* and *Streptococcus pyogenes*), leading to impetigo (skin sores)[6], [7].

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WHO designated scabies as a neglected tropical disease since 2017[8]. The prevalence of scabies in the world reaches 130 million people[9]. Scabies has a direct effect on the skin, which is estimated to account for 0.21% of disability-adjusted life-years (DALYs) from all conditions, globally. But the indirect effects of scabies complications including, bacterial skin infections, invasive bacterial disease, and auto-immune kidney and heart disease may be far greater. Indonesia is the country with the greatest scabies burden in the world (age-standardized DALYs 153•86) [10]. Scabies is the third among twelve skin diseases with the highest prevalence in Indonesia[11]. Here scabies is mostly experienced by Islamic boarding school students due to less proper sanitary conditions, poor sanitation, malnutrition, and high humidity in the dormitories, and lack of direct sunlight[12]. A previous study mentioned that the prevalence of scabies among Islamic boarding school students in Pasuruan reaches 66.70%, and 73.3% in Lamongan[13].

Many kinds of topical scabicides are available, including permethrin, benzyl benzoate, gamexane, and sulfur ointments. But, the next problem is drug resistance and toxicity, as well as its cost and availability for poor communities[14]. Although permethrin has low toxicity, it is not only expensive but also leaves burning and stinging sensations[15]. So, another scabicide with natural and low-cost ingredients, but as effective as chemical scabicides was strongly needed.

Liquid smoke is a result of the pyrolysis process of wood which contains as main components phenol 11.68%, 4-methylphenol 4.74%, dodecanoic acid 30.02%, methyl esters 5.16%, tetradecanoic acid 4.78 %, and 2-methoxy-4-methylphenol as much as 3.20%[16]. Liquid smoke is produced from coconut (*Cocos nucifera L*) shells containing lignin, cellulose, and other ingredients. If it is burned, it can produce phenol compounds (phenylpropanoid), carbonyl, and acid groups that can be used as an antioxidant, anti-inflammatory, and antiseptic, anesthetic, and analgesic[17]. These substances can prevent the formation of spores, inhibit the life and growth of bacteria, viruses, and fungi. Liquid smoke showed termicidal activities by damaging bacterial walls and inhibiting its growth [18]. A previous study found that topical liquid smoke has an analgesic effect and a promising therapeutic effect for traumatic ulcer healing processes [19], [20]. Subsequently, topical liquid smoke was expected to reduce pain and accelerate the wound healing process among individuals with scabies. This study aimed (1) to analyze the effect of topical liquid smoke on the level of pain among Islamic boarding school students with scabies; and (2) to analyze the effect of topical liquid smoke on the process of wound healing among Islamic boarding school students with scabies.

II. METHODS

This was a quasi-experiment pretest-posttest with a control group design. There were two groups, one intervention group (topical liquid smoke) and one control group (standard intervention on Islamic boarding school health care center).

The population were students with scabies recorded at Islamic Boarding School, Bungah district, Gresik regency, East Java, Indonesia (N=60). All the population was gathered as samples, divided into an intervention group (n=30) and control group (n=30), according to their dormitory, to prevent bias. During the intervention period, both groups were asked consistently not to use any medication and not to exchange any personal things (such as clothes, towels, soap, etc.) with their friends.

The independent variable was topical liquid smoke. Pure liquid smoke was diluted in water at a ratio of 1:10. A diluted liquid smoke was then topically applied on scabies wound two times a day, in the morning and the evening (every 12 hours). It was repeated every day for 14 days. The dependent variables were the level of pain and the process of wound healing. The level of pain was assessed by using the Numeric Rating Pain Scale (NRPS)–Wong Baker Facial

Pain Scale (FPS)[21]. The process of wound healing was divided into two phases: 1) proliferation, and 2) inflammation[22]. For the inflammation phase, there were two indicators: erythematous papules and lesion. Erythematous papules were noted as present or absent. If present, the researcher also measured their diameter. The lesions were classified as 3=no lesion; 2=lesion with no pus; and 1=lesion with pus. For the proliferation phase, there were two indicators: granulation and scabies burrow. Granulation was categorized as 3=granulation on all parts of the lesion; 2=granulation on half of the lesion; 1=no granulation at all. Scabies burrows were classified as: 3=all closed; 2=half closed; and 1=not closed yet[23], [24].

An ethics committee from Universitas Airlangga approved this research (reference number 1396-KEPK). All the respondents were given information about the study. Written informed consent was obtained from the Islamic boarding school's administrator who acts as the guardian of the students, who gave permission for students' participation.

Descriptive statistics were used to summarize the characteristics of the samples. Frequencies were reported for categorical variables, and the mean was reported for continuous variables. A statistical analysis by using Wilcoxon signed rank test was performed to determine the differences between pre and posttest scores for each group. The Mann-Whitney U test was performed to determine the differences of posttest scores between the intervention and the control group. We considered $p < 0.05$ to be statistically significant.

III. RESULTS

More than half the respondents in the intervention group were female (56.7%), experiencing scabies less than 1 year (63.3%), taking no medication (96.7%), and reporting exchanging personal things with others (96.7%). Most respondents in the control group were female (80%), experiencing scabies more than 1 year (63.3%), none of them taking medication (100%), and all of them reported sharing personal things with others (100%).

Table 1. The level of pain

Categories	Intervention group (n=30)				Control group (n=30)			
	Pre		Post		Pre		Post	
	n	%	n	%	n	%	n	%
None	-	-	16	53.3	-	-	-	-
Mild	4	13.3	14	46.7	4	13.3	-	-
Moderate	21	70.0	-	-	20	66.7	10	33.3
Severe	5	16.7	-	-	6	20.0	20	66.7
Wilcoxon	p=0.000				p=0.001			
Mann-Whitney	p=0.000							

Table 1 shows that most of the respondents, both in the intervention and the control group reported moderate pain in the beginning. After the intervention, a few more than half the respondents in the intervention group (53.3%) reported no pain, while respondents in the control group mostly (66.7%) reported severe pain. The statistical analysis by using Wilcoxon signed rank test which compares respondent's level of pain between pre and posttest in each group had shown that there were significant differences, both in the intervention ($p=0.000$) and control ($p=0.001$) group. The Mann-Whitney Test was used to compare the level of pain on posttest between the intervention and control group. The result had shown $p=0.000$ ($p < 0.05$) which means there was a significant difference in the level of pain between the intervention and the control group after topical liquid smoke treatment.

Table 2. The process of wound healing

Categories	Intervention group (n=30)		Control group (n=30)	
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	Pre		Post		Pre		Post	
	n	%	n	%	n	%	n	%
The inflammation phase								
Erythematous papules								
None	-	-	30	100.0	-	-	13	43.3
1-5 mm	28	93.3	-	-	28	93.3	17	56.7
>5 mm	2	6.7	-	-	2	6.7	-	-
Wilcoxon	p=0.000				p=0.000			
Mann-Whitney					p=0.000			
Lesion								
Lesion with pus	6	20.0	-	-	4	13.3	2	6.7
Lesion without pus	24	80.0	-	-	26	86.7	24	80.0
No lesion	-	-	30	100.0	-	-	4	13.3
Wilcoxon	p=0.000				p=0.014			
Mann-Whitney					p=0.000			
The Proliferation Phase								
Granulation								
All areas	-	-	30	100.0	-	-	-	-
Half area	-	-	-	-	-	-	26	86.7
None	30	100.0	-	-	30	100.0	4	13.3
Wilcoxon	p=0.000				p=0.000			
Mann-Whitney					p=0.000			
Scabies burrows								
All closed	-	-	30	100.0	-	-	4	13.3
Half closed	-	-	-	-	-	-	20	66.7
Not closed yet	30	100.0	-	-	30	100.0	6	20.0
Wilcoxon	p=0.000				p=0.001			
Mann-Whitney					p=0.000			

Table 2 showed the process of scabies wound healing, divided into the inflammation and proliferation phase. During the inflammation phase, the majority of respondents both in the intervention and control group reported erythematous papules with a diameter of 1-5mm and lesions without pus on the pretest. After applying topical liquid smoke, none of the respondents in the intervention group reported erythematous papules and lesions. Otherwise, many of the respondents in the control group were still in the same condition as in the pretest. The pretest of the proliferation phase found that all respondents in both groups reported no granulation, and the scabies burrows on their skin were not closed yet. The posttest result revealed that all respondents in the intervention group reported granulation on all areas of their wound, and the scabies burrows on their skin had already closed. The respondents in the control group also experienced progress, but most reported granulations only on half the area of their wound and the scabies burrows were closed.

The statistical analysis by using Wilcoxon signed rank test which compared respondents' scabies wound healing process between pre and posttest in each group had shown that there were significant differences, both in the intervention and control group (erythematous papules, lesions, granulation, and scabies burrows $p < 0.05$). The Mann-Whitney Test was used to compare the wound healing process indicators on the posttest between the intervention and the control group. The result showed $p = 0.000$ ($p < 0.05$) which means there was a significant difference in the process of scabies wound healing between the intervention and the control group after topical liquid smoke treatment.

IV. DISCUSSION

The phenol content in liquid smoke has analgesic properties that can inhibit the formation of inflammatory mediators of the cyclooxygenase and lipoxygenase pathways through the biosynthesis of eicosanoid arachidonic acid

pathways by inhibiting phospholipase C and phospholipase A2[25]. Inhibition of phospholipase C can block the cyclooxygenase enzyme which causes inhibition of prostaglandins so the synthesis of prostacyclin and thromboxane (TXA2) is also inhibited. Inhibition of phospholipase A2 blocks the enzyme lipoxygenase, which causes HPTE (hydroperoxy-eicosatetraenoic acid) to decrease and inhibits the formation of leukotrienes, which can reduce pain[26].

In a study of liquid smoke content, ammonia, hexane, alcohol, ketone, acid and phenolic compounds were found. Thermal decomposition of coconut skin cellulose produces anhydroglucose, carbonyl compounds, and furans. The decomposition of hemicellulose is similar to cellulose decomposition, producing acetic acid and carbon dioxide. Partial pyrolysis of lignin produces various types of phenolic compounds that are antibacterial[27].

Liquid smoke phenolic compounds have free radical activity and are antioxidants[28]. In addition to phenol compounds, liquid smoke also contains antimicrobial carbonyl compounds. The carbonyl inhibits microbial growth by penetrating the cell wall and deactivating enzymes located in the cytoplasm and cytoplasmic membrane[29]. Antimicrobial properties in liquid smoke can kill *Sarcoptes scabiei*, which is lodged in scabies lesions by damaging cell walls. The destruction of these mites can stop the product of mites that activates the pain response, so the pain level can decrease.

The wound phase in both the treatment and control groups at the time of the post-test was in the inflammatory phase which was characterized by erythema or papules and lesions. The condition of the lesions in each respondent was different, but in each treatment and control group, some respondents had character festering lesions. After being given liquid smoke from the coconut shell for 14 days, the inflammatory phase of the wound in the shorter treatment group marked a reduction in the size of the erythema and lesions that experienced faster granulation, and scabies holes that had closed at the time of the post-test. Whereas the respondents in the control group still had lesions that had not yet experienced granulation and scabies holes that were still open on the 14th day, and 2 respondents had lesions that were still festering. This shows that the inflammatory phase of the treatment group was shorter and entered the proliferation phase more quickly.

Scabies sores in patients begin with erythema or papules which later become primary lesions. Another sign found white distinctive lines as an indication of mites. If the primary lesion is scratched, it can expand the scratches and lesions causing secondary lesions. In more severe conditions, the wound can cause pus[30].

Liquid smoke content can increase fibroblast production and wound contraction. This mechanism can help speed up the wound healing process. Also, flavonoids were found in the liquid smoke which can increase collagen and protein and reduce fat peroxidase in the granulation tissue found in wounds[31].

Other chemical components that have been identified in liquid smoke include phenol compounds, carbonyl, carboxylic acids, furans, hydrocarbons, alcohol and lactone. The quality and quantity of these compounds are influenced by the raw material and pyrolysis process in coconut shells[32]. Organic acids that are antibacterial in liquid smoke content include acetic acid, formate, propionate, butyric, and other acids. Bacterial tests that have been carried out in a study used 2 groups of bacteria namely *B. subtilis* and *S. aureus* which represent gram-positive, and *E. coli* and *P. fluorescens* which represent gram-negative. The addition of liquid smoke showed inhibition of the growth of all four bacteria[33].

Other chemical components that have been identified in liquid smoke include phenol compounds, carbonyl, carboxylic acids, furans, hydrocarbons, alcohol and lactone. The quality and quantity of these compounds are influenced by the raw material and pyrolysis process in coconut shells[16]. The process helps optimize the proliferation phase of the wound, which can improve the healing process.

The liquid smoke that was used as an antimicrobial and antioxidant was a class-2 liquid smoke which has a yellowish color and is clearer than class 3. Class-2 liquid smoke has been tested to inhibit the growth of microbes of *S. aureus*, *E. coli*, and *Candida sp.* This is due to the phenolic content of liquid smoke which has been microscopically proven to cause damage to the microbial cell walls[34].

V. CONCLUSIONS

Topical liquid smoke can decrease the level of pain and improve the healing process experienced by scabies patients. It might be caused by the analgesic, antimicrobial, anti-inflammatory, and antioxidant substances contained in it. The use of coconut shell liquid smoke as an alternative non-pharmacological intervention for scabies needs to be examined more and tested clinically. Islamic Boarding School's students should have a healthy lifestyle and keep their environment healthy to prevent scabies transmission as they share a dorm.

CONFLICT OF INTEREST

The authors reported no potential for conflict of interest.

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