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Formulation and Effectiveness Test of Starfruit Extract Shampoo (*Averrhoa bilimbi* L.) Against Mortality *Pediculus humanus capitis*

Intan Kurnia Putri[1]*, Maya Uzia Beandrade[1], Regina Ananda[1], Reza Anindita[2]
[1]Department of Pharmacy; [2]Department of Medical Laboratory Technology, Sekolah Tinggi Ilmu Kesehatan Mitra Keluarga, Bekasi, West Java, Indonesia.

Corresponding author*
intan.kurnia.p@stikemitrakeluarga.ac.id

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Abstract

One of the skin infections that cause health problems in children is pediculosis capitis, which is caused by head lice (*Pediculus humanus capitis*). One of the efforts to prevent pediculosis can be by testing the formulation of an anti-head lice shampoo using the natural ingredient of star fruit (*Averrhoa bilimbi* L), which contains flavonoid compounds, alkaloids, and saponins. The purpose of this study was to determine the physical stability and effectiveness of the killing power of anti-head lice shampoo preparations with variations in the concentration of star fruit extract formula 1 (F1) 1.5%; formula 2 (F2) 2%; and formula 3 (F3) 2.5% against head lice *Pediculus humanus capitis***.** This type of research is a *mixed method* (quantitative and qualitative) with an experimental design. The variation in the head lice anti-head shampoo formula is F1 1.5%, F2 2%, and F3 2.5%. Phytochemical screening tests include flavonoid compounds, alkaloids, and saponins. Physical stability tests were carried out for four weeks, including organoleptic, homogeneity, pH, viscosity, and foam height. The lethality test was carried out on the head lice *of Pediculus humanus capitis.* The data analysis is descriptive and comparative with the *One Way* ANOVA test. The phytochemical screening test of star fruit extract obtained positive results for flavonoids, alkaloids, and saponins. The organoleptic test of F1 shampoo 1.5%, F2 2%, and F3 2.5% showed white, thick results and a distinctive lemon aroma. The viscosity test was F1 1.5% (2,007-2,020 cP), F2 2% (2,020 cP), and F3 2.5% (2,020 cP). The homogeneity test obtained homogeneous results in all three formulas. The results of the foam height test were F1 1.5% (7.17-9.50 cm), F2 2% (7.67-9.83 cm), and F3 (7.83-9.80 cm). The results *of the One Way* Anova test showed a significance value of 0.012 < 0.05, or there was a significance influence of the shampoo formula of F1 1.5%, F2 2%, and F3 2.5% against the pH value of head lice anti-head shampoo stored for four weeks. The shampoo of star fruit extract affected the death of head lice for 10 minutes with an effective formula at a concentration of 2.5%. The physical evaluation of the head lice shampoo preparation showed good stability. The comparative test results showed that the pH of the shampoo preparation stored for four weeks could be unstable.

Keywords: belimbing wuluh; Extracts; formulations; shampoos; *Averrhoa bilimbi* L.

INTRODUCTION

Pediculosis capitis infection, known as head lice, is a skin infection in the neck caused by the bite of *Pediculus humanus capitis*. This disease is a public health problem that affects 6-12 million people every year worldwide and mainly occurs in children (Dalming *et al*., 2022). According to Valencia *et al.* (2017), The most common cases are found in children between 3 and 11 years old. Pediculosis can cause skin irritation, allergic reactions, and bacterial infections due to excessive scratching and sleep disturbances (Fox *et al*., 2020)**.**

The prevalence of Pediculus capitis is common in developed and developing countries. Studies in Ethiopia show that women are more infected than men (Massie *et al*., 2020). The prevalence of Pediculus humanus capitis in Asia is 15.1%, in Europe is 13.3%, in South America is 44.1%, in Malaysia is 35%, while in Indonesia, it is estimated to be 15% in school children (Massie *et al*., 2020). In one of the studies conducted by Anindita et al. (2024) at one of the Al-Muhajirin Islamic boarding schools, Central Cikarang, it was reported that 36 out of 41 respondents (87.8%) were positively infected with head lice.

Until now, head lice treatment has been carried out with chemical drugs containing hexachlorocyclohexane, lindane, pyrethrins, permethrin, and malathion. These drugs are toxic, have harmful side effects, and can trigger head lice resistance if used irrationally (Agistia *et al*., 2023). To address these problems, it is necessary to find natural ingredients to be formulated as shampoo preparations that can potentially be more effective and safe in killing head lice (Nurhaini *et al*., 2020).

Some of the results of publications in Indonesia regarding natural ingredient extracts that have been proven effective in killing head lice include lime and noni fruits with concentrations of 25%, 50%, and 75% (Sayekti *et al*., 2020), Star Fruit (*Averrhoa bilimbi* L.) (Fitriati *et al*., 2023), lemon fruit (*Citrus limon*) with concentrations of 25%, 50%, 75%, and 100% (Hayati &

Nopitasari, 2020); (Haifania *et al*., 2022); Susanty *et al.* (2020); Yadnya *et al.* (2023), Eucalyptus oil with concentrations of 25%, 75%, and 100% (Aripin et al., 2022), soursop leaves with concentrations of 10% and 15% (Samosir et al., 2023), kirinyu leaves with concentrations of 8%, 16%, 24% (Putra & Sawu, 2022), bintaro fruit seeds with a concentration of 40% (Supriati et al., 2023), lemon oil with concentrations of 5% (Arrizqiyani et al., 2018) and 10% (Maulidah, 2018). There are several research publications in Indonesia regarding natural ingredient extracts that have been formulated and effective as shampoo preparations against head lice, including green betel leaf with a 30% formula (Susanti et al., 2024), lime leaf with a 9% formula (Warahmah, 2021), eucalyptus oil with a formula of 15%, 20%, 25%, 30% (Dalming et al., 2022).

According to previous studies, lemon oil is a natural ingredient that kills head lice at 5% and 10% concentrations. Other natural ingredients are more dominant and influential at concentrations above 25%. Therefore, it is necessary to test new natural ingredients that are more stable and effective to use as an anti-head lice shampoo preparation. One of these natural ingredients is star fruit. Based on a preliminary study, star fruit extract with concentrations of 1.5%, 2%, and 2.5% can kill head lice for 10 minutes. For this reason, it is necessary to test the physical stability and effectiveness of the killer power of star fruit extract shampoo preparations against head lice *Pediculus humanus capitis*. The novelty of this research lies in the formula of star fruit extract with concentrations of 1.5%, 2%, and 2.5% and the addition of lemon oil with a concentration of 10% for each formula. This study aims to determine the physical stability and effectiveness of star fruit extract shampoo against head lice.

MATERIALS AND METHODS

Sample preparation

Sample preparation included plant determination, wet sorting, dry sorting, drying, and powder making. Extraction was carried out using the maceration method and evaporated using the rotary evaporator method.

Phytochemical screening

This study's phytochemical screening of star fruit was based on the procedure carried out by Kusuma et al. (2023) and Masaenah et al. (2019). Qualitative phytochemical screening tests include Flavonoid, alkaloid, and Saponin tests.

Formulation Shampoo Starfruit Extract

The formula for making star fruit extract shampoo was based on Dalming *et al*. (2022). The shampoo's formula is shown in Table 1.

Table 1. Formulation of Shampoo Extract Starfruit.

Ingredients	Formula		
	F1	F2	F3
Star fruit extract	1,5%	2%	2,5%
Lemon Oil	10%	10%	10%
Natrium lauryl Sulfat	15%	15%	15%
Cocamide DEA	8%	8%	8%
NaCl	5%	5%	5%
Na-CMC	1%	1%	1%
Citric acid	0,1%	0,1%	0,1%
Propilen glikol	1%	1%	1%
Glycerine	1%	1%	1%
Propil Paraben	0,5%	0,5%	0,5%
Methyl paraben	0,02%	0,02%	0,02%
Aquadest	Ad 150 mL	Ad 150 mL	Ad 150 mL

Based on Table 1, the formulation of shampoo has been modified, namely, changes in the concentration and use of natural ingredients. In this study, natural ingredients were star fruit extract at concentrations of 1.5%, 2%, and 2.5% and lemon oil at a concentration of 10%.

Shampoo Making

Star fruit extract shampoo was developed by Na-CMC using aqua dest, which contains citric acid and is heated to form mucilage (mixture 1). Add DEA cocamide, propylene glycol, glycerin, propylparaben, and methylparaben in a mixture of 1 stirred until homogeneous. Sodium lauryl sulfate mixed with NaCl was stirred until evenly combined (mixture 2). Then, mix star fruit extract and lemon oil into mixture 2, stirring until homogeneous. Mix mixture one and mixture 2, stir using a mixer for 5 minutes, then suffice with aquadest and stir again using a mixer for 5 minutes until homogeneous.

Evaluation of Physical Stability of Shampoo
Organoleptic test
The organoleptic test was carried out by visual observation of the colour, smell, and shape of the shampoo preparation at room temperature with a storage period of 4 weeks (Nurhaini *et al*., 2020).

Homogeneity Test
This test was carried out by applying shampoo preparation to the watch glass. The ingredients were observed to be mixed uniformly, and no coarse particles were seen (Dalming *et al*., 2022).

Foam Height Test
The foam height measurement is done by making a solution of shampoo preparation in aquades, shaking in a container and then measuring. The size of the foam height that meets the requirements is in the range of 1.3 cm – 22 cm (Agistia *et al*., 2023).

Viscosity Test
Viscosity testing was carried out using Brookfield viscometers. A shampoo preparation of 150 mL is placed under the viscometer with *a spindle* at the appropriate speed. The viscosity value of shampoo preparations ranges from 400 – 4,000 cps (Dara *et al*., 2021).

pH Test
The pH value measurement is done by dipping the pH meter in the shampoo preparation and then observing the number listed on the pH meter. The pH value requirement of the preparation is 5 – 9 (Agistia *et al*., 2023).

Shampoo effectiveness test against head lice Pediculus humanus capitis
The treatment design in this study included positive control using *peditox (Permethrin 1%),* negative control (sterile aquades), F1 shampoo 1.5%, F2 2%, and F3 2.5%. Each treatment was placed in a petri dish containing five lice with three repetitions so that the total sample was 75 head lice. All treatments were observed for 10 minutes, and the number of flea deaths was recorded during each treatment.

Data Analysis
Data analysis was carried out using descriptive and comparative analysis. Descriptive analysis was carried out on the data from the phytochemical screening test results of star fruit extract, organoleptic test, homogeneity test, foam height test, and viscosity test. Using the One-way ANOVA test, a comparative analysis was carried out on the pH test data and shampoo's killing power against fleas.

RESULTS AND DISCUSSION

The results of the determination test of star fruit extract conducted at PT Palapa Muda Perkasa, Depok City, identified that star fruit came from the species *Averrhoa bilimbi* L. and the Oxalidaceae family, as seen in Table 2.

Table 2. Determination f Starfruit Extract.

Local Name	species	family
Belimbing wuluh	*Averrhoa bilimbi* L.	*Oxalidaceae*

Based on Table 2. Samples of star fruit come from the appropriate species and families to be used as samples of natural materials. In the organoleptic test of star fruit extract, the results were brownish-green, aromatic, and in the form of a thick extract shown in Table 3.

Table 3. Results of organoleptic star fruit extract.

Sample	Colour	Smell	Texture
Star Fruit Extract	Brownish green	Aromatic	Viscous

The data in Table 3 are from the Indonesian Herbal Pharmacopoeia Edition II, which states that star fruit extract is thick and dark green, has a distinctive aromatic smell, and is a percentage of the yield. The thick extract was then calculated as a percentage of the yield, as seen in Table 4.

Table 4. Results of Yields of Star Fruit Extract.

Plant Name	Powder Weight	Weight viscous Extract	% yields
Star Fruit	1.200 g	236.4 g	19,7%

Based on Table 4. The yield value of star fruit condensed extract is 19.7% or has met the standard requirements of the Indonesia Herbal Pharmacopoeia Edition II; namely, the yield of star fruit condensed extract is more than 17%. According to Nahor *et al*. (2022), The higher the yield value produced, the greater the potential content of secondary metabolite compounds extracted (Nuraskin *et al*., 2022). The main factors that affect the yield value of viscous extracts are the type of solvent and extraction method. The appropriate solvent type and extraction method will optimally produce the secondary metabolite compounds in the extracted viscous extract (Ramayani *et al*., 2021). The thick extract was then tested for phytochemical screening of alkaloids, flavonoids, and saponins. The results of the phytochemical screening test can be seen in Table 5.

Table 5. Results of Phytochemical Screening Test Star Fruit Extract.

Compound	Reagen	Result	Description
Alkaloid	Reagen Dragendorff	Positive	Brown to orange precipitate
	Reagen Meyer	Positive	White precipitate
	Reagen Wagner	Positive	Chocolate precipitate
Saponin	HCl 2N	Positive	Stable foam
Flavonoid	Mg powder + HCl Pekat + Amil Alcohol	Positive	Red to orange color

Based on Table 5, star fruit extract is positive for alkaloids, flavonoids, and saponins. Physical evaluation testing of star fruit extract shampoo preparations was carried out with a storage period of 4 weeks for Formula 1 (F1) 1.5%, Formula 2 (F2) 2%, and Formula 3 (F3) 2.5%. The results of the organoleptic test are shown in Table 6.

Table 6. Results of the Organoleptic Test of Sedioan Anti-Lice Shampoo.

Sunday	F1	F2	F3
0	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous
1	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous
2	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous
3	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous
4	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous	Colour: White Smell: lemon oil Shape: Viscous

Based on Table 6, the three formulas showed no change in colour, odour, and shape during four weeks of storage. The shampoo preparation has a white colour, a distinctive smell of lemon oil aroma, and a thick shape. Homogeneity testing of the shampoo preparation was also carried out after four weeks of storage. The results of the homogeneity test can be seen in Table 7.

Table 7. Results of Homogeneity Test of Anti-Flea Shampoo Preparation.

Sunday	F1	F2	F3
0	Homogeneous	Homogeneous	Homogeneous
1	Homogeneous	Homogeneous	Homogeneous
2	Homogeneous	Homogeneous	Homogeneous
3	Homogeneous	Homogeneous	Homogeneous
4	Homogeneous	Homogeneous	Homogeneous

Based on Table 7, the shampoo preparation showed homogeneous results and no coarse particles. The homogeneity test is one of the physical evaluation tests on shampoo preparations to see a homogeneous arrangement with no coarse grains (Asjur *et al*., 2022). A homogeneous shampoo preparation indicates that all ingredients have been mixed well during the preparation process. Research by Basir et al. (2024) shows that the shampoo preparation of Salak Pondoh fruit peel extract produces a homogeneous preparation. However, in the study, Nurhaini *et al*. (2020) reported that the manufacture of anti-tick shampoo with soursop extract showed non-homogeneous results marked by coarse granules. This is due to the destruction and development of carbopol; too little water is used so that the shampoo preparations produced are not homogeneous.

The third formula's foam height test, conducted over a 4-week storage period, showed promising results and still

fell within the range of shampoo preparations' foam height requirements. This test aims to assess a shampoo preparation's ability to produce foam. Table 8 shows the results of measuring the height of the shampoo preparation's foam.

Table 8. Foam High Test Result.

Week to	Average value High foam anti-flea shampoo		
	F1	F2	F3
0	7,17 ± 0,24	7,67 ± 0,62	7,83 ± 0,24
1	7,67 ± 0,24	7,83 ± 0,24	8,50 ± 0,00
2	8,00 ± 0,00	8,67 ± 0,62	9,33 ± 0,62
3	9,50 ± 0,71	9,67 ± 0,24	9,80 ± 0,00
4	9,50 ± 0,00	9,83 ± 0,24	9,80 ± 0,24

Based on Table 8, the foam height test measurement results obtained a value that tends to increase; this can be affected by the difference in speed during shaking. The foam height test showed the surfactant's ability to form a foam (Salsabila et al. 2022). Overall, the height value of the foam preparation of star fruit extract shampoo has met the requirements set by SNI, which is 1.3 – 22 cm.

The shampoo preparation's viscosity testing showed stable results after four weeks of storage at room temperature. The results are in Table 9.

Table 9. Viscosity Test.

Week to	Average viscosity value		
	F1	F2	F3
0	2.007 ± 9,43	2.000 ± 0,00	2.000 ± 0,00
1	2.007 ± 9,43	2.020 ± 0,00	2.020 ± 0,00
2	2.020 ± 0,00	2.020 ± 0,00	2.020 ± 0,00
3	2.020 ± 0,00	2.020 ± 0,00	2.020 ± 0,00
4	2.020 ± 0,00	2.020 ± 0,00	2.020 ± 0,00

Based on table 9. The average viscosity value of shampoo preparations was obtained at F1, which was 2,010-2,020 cps, and F2 and F3 were 2,020 cps. The viscosity test is carried out to determine the viscosity value of a shampoo preparation and is related to the amount of resistance of a liquid to flow (Slamet et al. 2020). According to Hidayah *et al*. (2021), The viscosity value of the anti-dandruff shampoo preparation of jamblang fruit extract is 1589 – 1849 cps. The results of this test are also by the research of Rasyadi et al. (2023), who reported that the anti-dandruff shampoo preparation of Arabica coffee leaf ethanol extract had an average viscosity value of 1,247 – 3,011 cps with storage for six weeks. Basir *et al*. (2024) stated that carbopol is a gelling agent with high activity. The influence of room temperature causes the particles of shampoo preparations to tend to combine to form a tighter structure, which affects the increase in shampoo viscosity.

pH testing conducted during four weeks of storage showed results that entered the pH requirement range of the shampoo preparation and were declared to have a suitable pH value. The pH test of the preparation aims to determine the level of acid and alkalinity of the preparation to ensure the safety of the shampoo preparation so that it does not irritate the scalp (Salsabila *et al*., 2022). The results of the measurement of the pH value of the preparation can be seen in Table 10.

Table 10. pH test.

Weeks to	$\bar{x}$ ± SD			Sig *One Way* ANOVA
	F1	F2	F3	0.012
0	8,19 ± 0,05	8,50 ± 0,12	8,64 ± 0,27	
1	8,49 ± 0,34	8,34 ± 0,12	8,35 ± 0,08	
2	8,34 ± 0,35	8,57 ± 0,14	8,57 ± 0,12	
3	8,46 ± 0,21	8,56 ± 0,11	8,57 ± 0,12	
4	8,42 ± 0,03	8,65 ± 0,24	8,58 ± 0,04	

Based on table 10. It was obtained that each formula has a stable pH value and enters the range of requirements according to SNI, namely 5.0 - 9.0 (Firdaus dan Arief, 2019). The results of this study are by Ningrum *et al*. (2023), with coconut water extract remaining stable because it meets the requirements of the pH range of SNI shampoo preparations, namely pH 5-9. However, the One-Way ANOVA test results showed a value of Sig. 0.012 < 0.05 or a shampoo formulation treatment of F1 1.5%, F2 2%, and F3 2.5% has the potential to cause a change in pH in the shampoo preparation of star fruit extract. The potential for pH changes is influenced by sodium lauryl sulfate foaming agents with pH 7.5 – 8.5 and DEA cocamide (Lara *et al*., 2023).

The results of the shampoo preparation that had been declared stable were then tested for the killing power of the head lice *Pediculus humanus capitis*. The test was carried out on five treatment groups: positive (+) control with Peditox, negative (-) aquades, F1 1.5%, F2 2%, and F3 2.5%. Headlice samples for each group totalled 5 with 3x replication. The results of a 10-minute test of star fruit shampoo against *Pediculus humanus capitis* can be seen in Table 11.

Table 11. Results of the killing power test of star fruit shampoo against head lice for 10 minutes.

No	Treatment	Replication			$\bar{x} \pm SD$	F.count	F table
		1	2	3			
1	Control (+)	5	5	5	$5^a \pm 0$	24,78	3,48
2	Control (-)	0	0	0	$0^b \pm 0$		
3	F1 1,5 %	1	1	1	$1^c \pm 2$		
4	F2 2 %	2	2	2	$2^d \pm 0$		
5	F3 2,5%	3	2	5	$3{,}3^e \pm 1{,}52$		

Based on table 12. The average death of head lice after being given a combination of red ginger extract and star fruit shampoo for F1 1.5% was four lice, F2 2% was eight lice, and F3 was nine lice. As for the negative control, no flea deaths were found, while the positive control used peditox for as many as two ticks. The results of *the ANNOVA one-way* test showed that the F-count was 4.35 while the F table was 3.33 (Fcal>Ftable), or there was a real influence of the combination shampoo on the average death of head lice. The results of this study complement the results of the research of Austin Tee and Badia (2019), which resulted in an average number of deaths of 3 ticks during 15 minutes of treatment with 5% soursop leaf extract shampoo. Research by Agistia et al. (2023) regarding the test of lemongrass oil shampoo preparations with concentrations of 5%, 7.5%, and 10% can produce a flea death time of 3-7 minutes. The 10-minute lime extract shampoo test by Warahmah (2021) showed an average number of deaths of 2-3 lice, while the study by Dalming et al. (2022) using eucalyptus oil shampoo of 15%, 20%, 25%, and 30% for 10 minutes only resulted in the average death of 1 head lice. Based on this, this study is more effective than the previous study because within 10 minutes, with concentrations of 1.5%, 2%, and 2.5%, it produced an average number of deaths of 6-9 head lice. The selection of red ginger and star fruit as vegetable insecticide agents in this study refers to Watcharawit and Soonwera (2013), which reported that *Z. officinale* and *A. bilimbi* produced *Lethal Time* 50 (LT50) values of 13.62 and 13.14 seconds.

The results of microscopic observation of the morphology of head lice before being given shampoo treatment showed the morphology of the body, legs, and antennae that looked normal, while after being given the shampoo treatment showed the body condition of head lice with antennae and legs that tended to be weak and stiff. The results of the morphological observation can be seen in Figure 1.

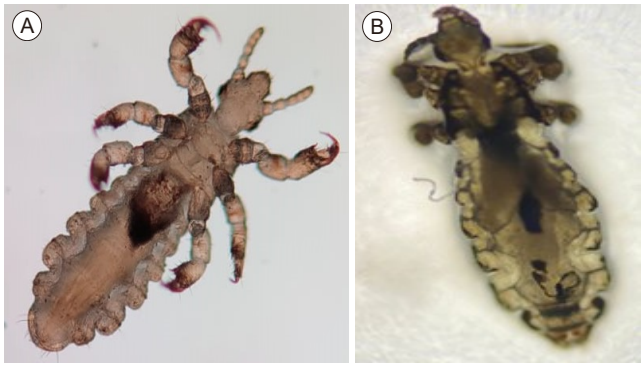

Figure 1. Microscopic morphology of head lice. A. Before treatment. B. After treatment.

Based on picture 1, head lice given a combination of star fruit extract shampoo left a transparent residue on the abdomen. The results of El-Akkad (2016) research stated that *Pediculus humanus capitis* which was treated with several extracts of natural materials underwent morphological changes, including legs and antennae becoming *flaccid/shriveled*, distortion of morphology outside the body, damage to antennae, paws, and sensory hair. According to Nurmasari and Aswan (2024) and Maisura (2023), the content of alkaloids, flavonoids, tannins, and saponins of star fruit functions as stomach toxins that can enter the body of lice through the skin or spiracle. The poison then enters the digestive tract, causing death in head lice. Based on this, it can be seen

that the higher the concentration of star fruit extract shampoo, the more it has a natural effect on the average number of head lice deaths. The effective shampoo formula for killing five head lice is 2.5%, with an average number of deaths of 3 (60%) lice during 10 minutes of treatment.

CONCLUSIONS

The physical stability evaluation test showed that the three formulations of anti-lice shampoo preparations had good organoleptic, were homogeneous, and produced average pH values, foam height, and viscosity within the required range. The results of the *One-Way* ANOVA test showed that shampoo formulation treatment of F1 1.5%, F2 2%, and F3 2.5% has the potential to cause a change in pH. The shampoo preparation of star fruit extract affected the death of head lice for 10 minutes with an effective formula at a concentration of 2.5%.

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REFERENCES

Agistia, N., Nofriyanti, N., & Dewi, R. S. (2023a). Formulasi dan Uji Aktifitas Antikutu Kepala (Pediculus humanus capitis) Sediaan Sampo Minyak Sereh Wangi (Citronella oil). *JOPS (Journal Of Pharmacy and Science)*, *6*(2), 151–159. https://doi.org/10.36341/jops.v6i2.3578

Agistia, N., Nofriyanti, N., & Dewi, R. S. (2023b). Formulasi dan Uji Aktifitas Antikutu Kepala (Pediculus humanus capitis) Sediaan Sampo Minyak Sereh Wangi (Citronella oil). *JOPS (Journal Of Pharmacy and Science)*, *6*(2), 151–159. https://doi.org/10.36341/jops.v6i2.3578

Anindita, R., Nuraini Wahyu, E., Perwitasari, M., Dwi Nathalia, D., Uzia Beandrade, M., Kurnia Putri, I., & Rizki Amalia Harahap, N. (2024). Monitoring Pediculosis Capitis in Students At Al-Muhajirin Islamic Boarding School, Cikarang Pusat, West Java, Indonesia. *International Islamic Medical Journal*, 84. https://doi.org/10.33086/iimj.v5i2.5783

Aripin, J.N. Wardani, K.P.D. Almanfaluthi, L.M. Hikmawati,I. (2022). Combination Between Eucalyptus Oil and Lime on the Mortality of Pediculus humanus capitis. 18 (1): 27-36 https://doi.org/10.22435/blb.v18i1.5357

Arrizqiyani, T. Khusnul, Virgianti, D.P. (2019). Uji Efektivitas Formula Pedikulosida Berbahan Aktif Minyak Atsiri Terhadap Mortalitas Kutu Kepala (*Pediculus humanus capitis* De Geer) Secara In Vitro. The Journal Of Muhammadiyah Medical Laboratory Technologist, 2 (1): 1-11.

Asjur, A. V., Saputro, S., Musdar, T. A., & Ikhsan, M. K. (2022). Formulation and Effectiveness Test of Anti-dandruff Shampoo Essential Oil Celery (*Apium graveolens*) Against *Candida albicans* Fungus. *Jurnal Sains Dan Kesehatan*, *4*(5), 481–487. https://doi.org/10.25026/jsk.v4i5.1265

Aswan, M.S. dan Nurmasari, F. Efektivitas ekstrak Jahe Merah (Zingiber officinale var. rubrum) dan Cabe Jawa (Piper retrofractum) sebagai Insektisida Alami Hama Kutu Putih (Paracoccus marginatus) pada Tanaman Singkong (Manihot esculenta). BIOSAPPHIRE: Jurnal Biologi dan Diversitas. 3 (1): 56-64. https://doi.org/10.31537/biosapphire.v3i1.1745

Austin Tee, S. and Badia, E. (2019). The Effectiveness Of Shampoo Hair Extract Of Sirsak Leaf Extract (*Annonna muricata* L.) In Vitro. *8 (2)*: 1-9. https://poltek-binahusada.e-journal.id/wartafarmasi

Basir, H., Sri Wahyuni, Y., Puspita Sari, R., Husna, A., & Farmasi Yamasi Makassar, A. (2024). Pemanfaatan Limbah Kulit Buah Salak Pondoh (Salaccae edulis Reinw) Menjadi Sediaan Sampo Dan Aktivitasnya Terhadap *Staphylococcus Epidermidis* dan *Candida albicans*. *Jurnal Kesehatan Yamasi Makassar*, *8*(1), 102–116. http://journal.yamasi.ac.id

Dalming, T., Ma, D., & Larasati Milenia, A. (2022). *Formulasi dan Uji Efektivitas Sampo Minyak Kayu Putih (Melaleuca cajuputi) Sebagai Pedikulosida*. *1*, 10–17. https://doi.org/10.22216/jk.v5i2.5717

El Akkad, D. M. H. El-Gebaly, N.S.M. Yousof, and Mousa A. M. Ismail. (2016) Electron Microscopic Alterations in *Pediculus humanus capitis* Exposed to Some Pediculicidal Plant Extracts. Korean J Parasitol Vol. 54, No. 4: 527-532. http://dx.doi.org/10.3347/kjp.2016.54.4.527

Firdaus, F. F., & Arief, A. E. (2019). Formulasi Sediaan Sampo dari Minyak Atsiri Akar Wangi (Vertiveria Zizaniodes) Sebagai Anti Kutu. *Journal of Herbs and Farmacological*, *1*(2), 56–61. http://ojs.stikes-muhammadiyahku.ac.id/index.php/herbapharma

Fitriati, R., Kusuma Putri, O., Farmasi Bhumi Husada Jakarta, A., & Timur, J. (2023). Uji Insektisida Alami Estrak Kental Buah Belimbing Wuluh (Averrhoa bilimbi) Terhadap Lalat Rumah (Musca domestica) dengan Metode Semprot Natural Insectisida Test of Belimbing Wuluh (Averrhoa bilimbi) Fruit Central Extract Against House Birds (Musca domestica) by Semprot Methods Correspounding Author. In *Jurnal OSADHAWEDYAH* (Vol. 1, Issue 2). https://nafatimahpustaka.org/osadhawedyah

Fox, K., Larkin, K., & Sanchez, A. (2020). Global Trends in Genetic Markers of Pediculus humanus capitis Resistance Mechanisms. In *Current Tropical Medicine Reports* (Vol. 7, Issue 2, pp. 65–73). Springer. https://doi.org/10.1007/s40475-020-00204-3

Hidayah, H., Arifiantika, N., & Mursal, I. L. P. (2021). Formulasi dan Evaluasi Fisik Sediaan Sampo Antiketombe Ekstrak Buah Jamblang (Syzygium cumini L.). *Jurnal Buana Farma*, *1*(4), 8–13. https://doi.org/https://doi.org/10.36805/jbf.v1i4.264

Kusuma, M. H. P., Rakhmatullah, A. N., & Yunarti, A. (2023). Uji Aktivitas Antioksidan Ekstrak Etanol 70% Buah Belimbing Wuluh (Averrhoa bilimbi L.) Menggunakan Metode DPPH.

Jurnal Surya Medika, *9*(1), 27–33. https://doi.org/10.33084/jsm.v9i1.5130

López-Valencia, D., Medina-Ortega, Á., & Vásquez-Arteaga, L. R. (2017). Prevalence and variables associated with pediculosis capitis in kindergarten children from Popayán, Colombia. *Revista Facultad de Medicina*, *65*(3), 425–428. https://doi.org/10.15446/revfacmed.v65n3.58812

Maisura, N. 2023. Efektivitas Sediaan Spray Bioinsektisida Dari Kombinasi Ekstrak Daun Belimbing Wuluh (*Averrhoa bilimbi* L.) Dan Ekstrak Kulit Jeruk Nipis (*Citrus aurantifolia*). *Skripsi*. Fakultas sains dan Teknologi Universitas Islam Negeri Ar-Raniry Darussalam: Banda Aceh

Masaenah, E., Rizky, F.. (2019). Aktivitas Ekstrak Etanol Buah Belimbing Wuluh (Averrhoa bilimbi L) Terhadap Penurunan Kadar Glukosa Darah Mencit Jantan (Mus musculus). *Jurnal Farmamedika*, *4*(2), 37–47.

Mutiara Haifania, Fitrianti Darusman, & Anan Suparman. (2022). Kajian Bentuk-Bentuk Sediaan Farmasi sebagai Pedikulisida. *Bandung Conference Series: Pharmacy*, *2*(2). https://doi.org/10.29313/bcsp.v2i2.4187

Nahor, E. M., Maramis, R. N., Dumanauw, J. M., Rintjap, D. S., Politeknik, K. A. M. A., Kementerian, K., & Manado, K. (2022). Comparison of the yield of wuluh star fruit (averrhoa bilimbi l.) plants extract with maceration method. *e-PROSIDING SEMNAS Dies Natalis 21 Poltekes Kemenkes Manado*

Nasional, T., Dirjen, S. K., Riset, P., Pengembangan, D., Massie, M. A., Wahongan, G. J. P., & Pijoh, V. (2020). Prevalensi Infestasi Pediculus humanus capitis pada Anak Sekolah Dasar di Kecamatan Langowan Timur. *Journal Biomedik* , *12*(1), 24–30https://doi.org/10.35790/jbm.12.1.2020.26934

Ningrum, Y. D. A., Roffada, R.-, & Lara, S. P. (2023). Formulasi dan Uji Karakteristik Fisik Sediaan Sampo Ekstrak Air Kelapa Mengunakan Metode Freeze Drying. *INPHARNMED Journal (Indonesian Pharmacy and Natural Medicine Journal)*, *7*(1), 27. https://doi.org/10.21927/inpharnmed.v7i1.3188

Nuraskin, C. A., Reca, R., & Mardelita, S. (2022). Identifikasi Metabolit Sekunder Ekstrak Buah Belimbing Wuluh Geothermal Non-Geothermal Aceh Besar. *Jurnal Mutiara NERS*, *5*(2), 120–126. https://doi.org/10.51544/jmn.v5i2.3020

Nurhaini, R., Zukhri, S., Setyaningtyas, O., & Hidayati, N. (2020a). Formulation of An Anti-lice Shampoo Soursop Leaves Extract (Annona muricata L). *Journal of Physics: Conference Series*, *1477*(6). https://doi.org/10.1088/1742-6596/1477/6/062007

Nurhaini, R., Zukhri, S., Setyaningtyas, O., & Hidayati, N. (2020b). Formulation of An Anti-lice Shampoo Soursop Leaves Extract (Annona muricata L). *Journal of Physics: Conference Series*, *1477*(6). https://doi.org/10.1088/1742-6596/1477/6/062007

Putra, J.H.S. and Sawu, E. (2022). Mortalitas Kutu Rambut (*Pediculus humanus*) Pasca Treatment Larutan Daun Kirinyuh (Chromolena odorata). JUSTEK: JURNAL SAINS DAN TEKNOLOGI. 5(2): 442-449. https://doi.org/10.31764/justek.vXiY.ZZZ

Ramayani, S. L., Nugraheni, D. H., & Wicaksoni, A. R. E. (2021). The Influence of a Method of The Extraction of Against The Level of The Total content of phenolic and total flavonoid leaves taro (Colocasia esculenta L.). *Journal of Pharmacy*, *10*(1), 11–16. https://doi.org/10.37013/jf.v10i1.115

Rasyadi, Y., Agustin, D., & Gunawan, O. (2023a). Formulasi Sediaan Shampo Ekstrak Etanol Daun Kopi Arabika (Coffea arabica L.) dan Evaluasi Fisiknya. In *Jurnal Ilmiah Farmasi* (Vol. 3, Issue 4).

Rasyadi, Y., Agustin, D., & Gunawan, O. (2023b). Formulasi Sediaan Shampo Ekstrak Etanol Daun Kopi Arabika (Coffea arabica L.) dan Evaluasi Fisiknya. *Jurnal Ilmiah Farmasi*, *3*(4), 111–120. https://doi.org/https://doi.org/10.36805/jbf.v3i4.891

Rohadi, D., Indriaty, S., Sekolah, D. R., Farmasi, T., & Cirebon, M. (2018). Formulasi Sediaan Sampo Ekstrak Etanol Daun Kangkung (Ipomea Aquatica Forssk) Formulation Of Shampoo Preparation Water Spinach Leaf Ethanol Extract *(Ipomea aquatica Forssk)*. *1*(1).

Salsabila, H. G., Zamruddin, N. M., & Herman, H. (2022). Optimasi Konsentrasi Basis HPMC Sediaan Sampo Antiketombe Ekstrak Daun Belimbing Wuluh (Averrhoa bilimbi L.) Kombinasi Ekstrak Daun Pandan Wangi (Pandanus amaryllifolius Roxb). *Proceeding of Mulawarman Pharmaceuticals Conferences*, *15*, 94–99. https://doi.org/10.25026/mpc.v15i1.624

Samosir, F.A.H.H. Darlan, D.M. Nasution, L.U.H. Panggabean, G.A. (2023). Pemanfaatan Daun Sirsak (Annona muricata) sebagai Sampo Anti Kutu Kepala (Pediculus humanus capitis). SCRIPTA SCORE Scientific Medical Journal, 5 (1): 45-49. https://doi.org/10.32734/scripta.v5i1.10530

Sayekti, F. D. J., Qurrohman, M. T., Priyandari, D. A., & Srikandini, C. (2020). Pengaruh Kombinasi Buah Jeruk Nipis dan Buah Mengkudu Terhadap Mortalitas Pediculus humanus capitis. *At-Taqaddum*, *12*(1), 47. https://doi.org/10.21580/at.v12i1.5148

Slamet, S., Dewi Anggun, B., & Pambudi, D. B. (2020). Uji Stabilitas Fisik Formula Sediaan Gel Ekstrak Daun Kelor (Moringa Oleifera Lamk.). *Jurnal Ilmiah Kesehatan*, *XIII*.

Sri Supriati, H. Abdullah, A. dan Medatua. (2023). Uji Efektivitas Ekstrak Etanol 96% Biji Buah Bintaro (*Cerbera manghas*) Terhadap Kutu Rambut (*Pediculus humanus capitis*), FARMASI Scientific Journal & Research Report, 1(1): 21-26.

Susanti, M.R. Musyarrafah, Andriana, A. and I Gede Angga Adnyana. (2024). Formulasi Dan Uji Efektivitas Sampo Ekstrak Daun Sirih Hijau (*Piper betle* L.) Terhadap Mortalitas Kutu Kepala Manusia (*Pediculus Humanus Capitis*). MAHESA: MALAHAYATI HEALTH STUDENT JOURNAL, 4 (6): 2398-2407. Doi: https://doi.org/10.33024/mahesa.v4i6.14543

Syafira N Dara, & Dr. Suryati, ST., M. Meriatna., ST., MT, N. za,S. T. M. T. (2021). Pengaruh Komposisi Ekstrak Mengkudu (Morinda citrifilia L.) Sebagai Antibakteri pada Shampo Herbal Berbasis Methyl Ester Sulfonat (MES). *Chemical Engineering Journal Storage*, *1*(1), 67–42.

Warahmah, M.N. (2021). Pembuatan Sampo Anti Kutu Rambut Dari Ekstrak Daun Jeruk Nipis (*Citrus aurantifolia*). *Skripsi.* Fakultas Sains dan Teknologi: Universitas Islam Negeri Alauddin Makassar

Watcharawit, R. and Soonwera, M. (2013). Pediculicidal effect of herbal shampoo against Pediculus humanus capitis in vitro. Tropical Biomedicine 30(2): 315–324