

Type of Manuscript:

ANTI-DANDRUFF SHAMPOO EMULGEL VCO (Virgin Coconut Oil) : FORMULATION AND STABILITY STUDY

A. Mumtihanah Mursyid^{1*}, Audia Triani Olii¹, Risda Waris², Asni Amin²

¹Departement of Pharmaceutics, Faculty of Pharmacy, Universitas Muslim Indonesia, Makassar

²Departement of Pharmacognosy-Phytochemistry, Faculty of Pharmacy, Universitas Muslim Indonesia, Makassar

*Corresponding author:

Department of Pharmaceutics,
Faculty of Pharmacy

Universitas Muslim Indonesia, Makassar

Urip Sumiharjo Street KM 5, Makassar, Indonesia, 90231

E-mail address: mumtihanah.mursyid@umi.ac.id

Tel: + 628114457476.

ABSTRACT:

VCO (Virgin Coconut Oil) acts as an antifungal, especially pityrosporum ovale, which can be formulated into an emulgel form of anti-dandruff shampoo. This study aimed to determine the formulation and stability test for emulgel shampoo made from natural VCO with various emulsifiers, namely F1 (SLS with HPMC gel base), F2 (SLS with carbopol gel base), F3 (stearic acid: tea with HPMC gel base), and F4 (tween 80: span 80 base gel HMPC). The results obtained that F1, F3, and F4 separation occurred, while F2 did not occur. F2 continued with physical evaluation and stress condition. The results of the evaluation showed that the organoleptic properties and homogeneity did not change in terms of color, smell and texture. The type of emulsion formed is o/w. The foam of the shampoo preparation is formed in the range 2.9- 4.3 cm and stable for more than 15 minutes. In the dirt dispersion test, the shampoo preparation has the ability to clean as seen from the dispersal of the ink into the water. Before the stress condition, the average pH was 4.94 ± 0.03 and the viscosity was 32.8 ± 4.80 , while after stress conditions the average pH is 4.91 ± 0.04 and the viscosity is 25.92 ± 3.97 . The results of data analysis using ANOVA showed that the pH and viscosity of the preparation showed insignificant results. It can be concluded that VCO can be formulated into pharmaceutically stable shampoo preparations using sodium lauryl sulfate emulsifier with carbopol gel base.

KEYWORDS: Emulgel, shampoo, anti-dandruff, VCO (Virgin Coconut Oil).

INTRODUCTION :

Dandruff (also called syntax and fatigue), with the scientific name *Pityriasis capitis*, is excessive exfoliation of the dead skin on the scalp. Dandruff sufferers usually complain because the scalp becomes more oily, hair becomes brittle and falls out¹. Dandruff is a disorder in the form of excessive sloughing of dead skin on the scalp, sometimes accompanied by pruritus and inflammation. The cause of dandruff can be in the form of excessive sweat gland secretion or the role of microorganisms in the scalp that produce a metabolite that can induce the formation of dandruff on the scalp². The microorganism suspected as the main cause of dandruff is *Pityrosporum ovale*. This fungus is actually a normal flora on the scalp, but in conditions of hair with excess oil glands, this fungus can thrive³.

One of the hair care efforts that can be done is to use shampoo. Shampoo is used to remove unwanted particles, such as oil and dandruff, without exfoliating excessive sebum as it can cause hair to become unruly⁴. The shampoo is a formulation that comprises surfactant as a main ingredient and additional ingredients that are functioned to improve the working power of the shampoo⁵.

Medicinal plants have been a major source of cure for human diseases since time immemoria⁶. One of the natural resources or plants that can overcome these problems and has been widely used by the community is VCO (Virgin Coconut Oil) which is obtained from refining pure coconut oil. A recent survey conducted by MARDI (The Malaysian Agricultural Research and Development Institute) revealed that VCO is very effective against dandruff. In vitro studies show that the added value of this VCO product has a broad spectrum of antimicrobial activity against gram-positive bacteria such as *Staphylococcus aureus*, *Listeria monocytogenes*, *Streptococcus pyogenes* and *Bacillus cereus*; Gram-negative bacteria, such as *Escherichia coli*, *Vibrio cholerae* and *Salmonella typhi* and the fungi *Candida albicans*, *Candida krusei*, and *Pityrosporum ovale*⁷.

One of the contents of VCO (Virgin Coconut Oil) is lauric acid which contains monolaurin compounds, because these compounds cause VCO to provide antimicrobial potential, either for bacteria or fungi by damaging the lipid components of cell membranes⁸. Based on research it was found that at a concentration of 2% VCO it had an inhibitory power against the fungus that causes dandruff, namely *Pityrosporum ovale* of 23.40 mm⁹.

Gel are an excellent formulation for several route of administration such as oral, topical, nasal, gel can be a clear formulation when all of particles are dissolve in dispersing medium but this cant occur in all gels some are therefore turbid¹⁰. The choice of the polymer as a gelling agent depends on its ability to obtain desired release profile and its muco-adhesive property¹¹. Emulgel is a gel with a liquid in the form of an emulsion, usually to deliver the oil which is the active substance in the preparation, by reducing the oily impression when applied to the skin for the purpose of local use. Emulgel also has beneficial properties such as good consistency, longer contact time, moisturizing, easy absorption, easy distribution, easy removal, water soluble, and miscible with other excipients¹².

MATERIALS AND METHODS :

Tools and materials

The tools used in this study were glassware, pestle, stirring rod, porcelain dish, hair dryer, incubator, refrigerator, electric stove (water bath), mortar, mixer, pH meter, plastic pot, dropper pipette, analytical balance. , and a Brookfield viscometer (DV-P prime).

The materials used in this study were adeps lanae, aquadest, wool yarn, carbopol, HPMC, stearic acid, Tween 80, span 80, methyl paraben, sodium lauryl sulfate, propyl paraben, propylenglikol, TEA, and VCO (Virgin Coconut). oil)

METHODS OF PREPRATION

Prepration Sample

The sample used in this study was fresh coconut meat made in the form of VCO (Virgin Coconut Oil) obtained from Lemito District, Pohuwato Regency, Gorontalo City.

Optimization Of Anti-Dandruff Shampoo

Table 1. Optimizing the design of anti-dandruff shampoo formulations made from natural VCO (Virgin Coconut Oil)

No.	Ingredients	Concentration (% b/b)	Formula				Function
			1	2	3	4	
1	VCO oil	10	√	√	√	√	Active substance
2	Sodium lauryl sulphate	10	√	√	√	√	Emulsifier & foamer
3	HPMC	2	√	-	√	√	Gel base
4	Carbopol	2	-	√	-	-	Gel base
5	Tween 80 & Span 80	5	-	-	-	√	Emulsifier
6	Stearic Acid	4	-	-	√	-	emulator
7	TEA	2	-	-	√	-	Emulsifier
8	TEA	0.0007	-	√	-	-	Developer
9	Propylene glycol	10	√	√	√	√	Humectants
10	Methylparaben	0.18	√	√	√	√	Preservative
11	Propylparaben	0.02	√	√	√	√	Preservative
12	Aquadest	Add 100	√	√	√	√	Solvent

Several optimization formulas were made, In formula 1 HPMC was dispersed with hot water, then crushed until completely dispersed, then added methyl paraben and propyl paraben which had been dissolved into propylene glycol, then added sodium lauryl sulfate which had been dissolved in water first, then added VCO Blend until completely homogeneous. Formula 2 was given the same treatment as formula 1, the difference was that HPMC was replaced with carbopol as a gel base. In formula 3 HPMC is dispersed with hot water, then the oil phase and water phase are separated, then each phase is heated to a temperature of 70 °C. The oil phase and water phase were mixed, then stirred until homogeneous and allowed to stand for a while until the temperature dropped, then the gel base was added to the emulsion mass formed. Mix until the desired emugel shampoo is formed. Formula 4 was given the same treatment as formula 3, the emulsifier stearic acid and TEA were changed to tween 80 and span 80.

Formulas that meet the requirements are followed by physical evaluation and stress conditions.

Evaluation of Physical Preparation of Shampoo

a. Organoleptic

The prepared shampoo was inspected visually for clarity, colour and presence of any particle¹³
The organoleptic test was carried out visually and directly seen the shape, color, smell¹⁴.

b. pH

This is done by measuring the stock shampoo is put in a 250 mL beaker, then dipped the cathode rod of the pH meter tool into the preparation, then press measure. The tool will read the pH of the preparation being tested. Record the results obtained. The higher pH level may damage the hairs and make them rough, the ideal pH level for shampoos is between 5-7¹⁵

c. Viscosity and flow type test

The viscosity test was carried out by placing the shampoo preparation into a 250 mL measuring cup then measuring the viscosity using a Brookfield Viscometer equipped with a spindle that was suitable for the preparation and a speed of 50 rpm (revolutions per minute) and the results were recorded¹⁶. Determination of flow type is done by measuring the viscosity of the preparation with various speeds, namely 5, 10, 20, 50, and 100 rpm, then the data obtained are recorded.

d. Homogeneity test

Homogeneity test is carried out by means of smearing the preparation on a piece of glass or other suitable transparent material, observing that the smear of the preparation must show a homogeneous arrangement and no coarse grains are seen¹⁴.

e. Spreadability test

To determine the Spreadability the gel formulation was placed between the horizontal plates (20×20 cm²) after 1 minute¹⁷. The preparation of shampoo as much as 0.5 grams is placed carefully on a transparent glass, let the preparation spread to a certain diameter. Than was covered with

transparent glass and given a load (ain area after being given a load. With a dispersion range of 5 - 7 cm¹⁸.

f. Type of Emulsion

Test the type Emulsion is carried out using the electrical conductivity method. The shampoo preparation was put into a beaker and then tested for conductivity with a multimeter. If the needle moves to the right then the type of emulsion formed is o/w and vice versa if the needle does not move then the emulsion formed is w/o.

g. Dirt Dispersion Test

The dirt dispersion test was carried out by mixing 2 drops of shampoo with 10 mL of distilled water, then adding red ink to the measuring cup, then shaking it 10 times. A shampoo that has good quality, as evidenced by the red ink dispersed in the shampoo solution so that the water is red while the foam remains white¹⁹.

h. Cleaning Ability Test

The cleaning ability test was carried out by attaching 0.5 g of adeps lanae (assumed to be sebum) onto 5 g of wool yarn. Then, the wool yarn that has been added with adeps lanae is put into a bottle containing 200 mL of water containing 1 g of shampoo. Furthermore, shaking was carried out for an interval of 4 minutes (each minute was shaken 50 times). The wool thread is drained, then dried with a hair dryer. The dried samples were then weighed. Furthermore, the cleaning ability is calculated by the following formula¹⁹ :

$$DP = 100 (1 - T/C)$$

Information:

DP = *Detergent Power*

T = weight of fat remaining on wool yarn

C = fat weight

i. Foam Ability and Foam Stability Test

The foam ability and foam stability test was carried out by placing 50 mL of 1% shampoo solution in a glass, then closing the glass with a glass cover, and shaking it 10 times. The total volume of foam was measured every 1 minute, for 4 minutes¹⁹.

j. Stress condition

Stability evaluation under imposed conditions was carried out for 10 cycles. One cycle is equivalent to storage at 5 °C for 12 hours and at 35 °C for 12 hours. After that, several physical parameters were measured again to obtain optimal stability²⁰.

RESULT :

The results of organoleptic testing and homogeneity can be seen in the following table 2
Table 2. Observations of organoleptic tests and homogeneity optimization of anti-dandruff shampoo formulations made from natural VCO (Virgin Coconut Oil)

Formula	Checking type			
	Smell	Color	Consistency	Homogeneity
F1	Typical	Clear	Liquid	Inhomogeneous
F2	Typical	White	Thick	Homogeneous
F3	Typical	White	Congested	Homogeneous
F4	Typical	Clear	Liquid	Inhomogeneous

Organoleptic testing aims to see the physical stability of the shampoo preparation by looking at changes in color, odor and consistency of the preparation during storage. While the homogeneity test aims to see the distribution of particles from the preparation²⁰. The results of organoleptic testing and homogeneity can be seen in the following table:

Table 3. Observations of organoleptic tests and homogeneity of anti-dandruff shampoo preparations made from Natural VCO (Virgin Coconut Oil)

Replication	Condition	Checking type			
		Smell	Color	Consistency	Homogeneity
F2R1	Before	Typical	White	Thick	Homogeneous
	After	Typical	White	Thick	Homogeneous
F2R2	Before	Typical	White	Thick	Homogeneous
	After	Typical	White	Thick	Homogeneous
F2R3	Before	Typical	White	Thick	Homogeneous
	After	Typical	White	Thick	Homogeneous

Determination of the type of emulsion aims to determine the type of emulsion formed from shampoo preparations. This determination uses the conductivity method which is based on the principle that water conducts electricity when the water phase acts as the external phase while the oil acts as an external phase. If the needle moves, the emulsion type is o/w and the needle does not move, the emulsion type is w/o²¹. The results of the emulsion type test can be seen in the following table:

Table 4. The results of determining the type of emulsion for anti-dandruff shampoo preparations made from natural VCO (Virgin Coconut Oil)

Replication	Condition	
	Before	After
F2R1	o/w	o/w
F2R2	o/w	o/w
F2R3	o/w	o/w

pH testing aims to determine the safety of the preparation when used. pH that is not in accordance with the pH of the skin can cause irritation when used. The pH of shampoo that is too acidic or too alkaline will irritate the scalp²². The pH test results can be seen in the following table

Table 5. Average pH test results for anti-dandruff shampoo preparations made from natural VCO (Virgin Coconut Oil)

Formula	Condition	Average pH
F2	Before	4.94±0.03
	After	4.91±0.04.

The dispersion test was carried out to determine the ability of the preparation to spread when applied to the skin. The good spreading ability of the base will provide ease of application to the skin surface. The range of spread is 5 - 7 cm¹⁸. While the viscosity test aims to determine how big the size of a liquid or preparation to be able to flow. According to the Indonesian National Standard²³, a good shampoo viscosity requirement is 400-4000 cP. Rheological behavior of the semisolid is essential to achieve spreading¹⁰. The test results are below:

Table 6. Test results of dispersion and viscosity of anti-dandruff shampoo preparations made from natural VCO (Virgin Coconut Oil) before and after forced conditions

Condition	Average Spread (cm)				Viscosity P
	0	50	100	150	
Before	5.23±0.60	6±0.78	6.53±0.47	6.93±0.56	32.8±4.80
After	5.73±0.37	6.26±0.25	6.8±0.17	7.26±0.23	25.92±3.97

Viscosity testing showed that the three shampoo replications met the range for shampoo preparations, namely 400-4000 cp. During the stability test, the anti-dandruff shampoo preparations made from natural VCO (Virgin Coconut Oil) decreased in viscosity. One of the factors for the decrease in viscosity is temperature. Viscosity will decrease with increasing temperature. High temperatures will increase the distance between particles so that the forces between particles will decrease. The greater the distance, the lower the viscosity⁴.

Result of viscosity test can be seen in the diagram :

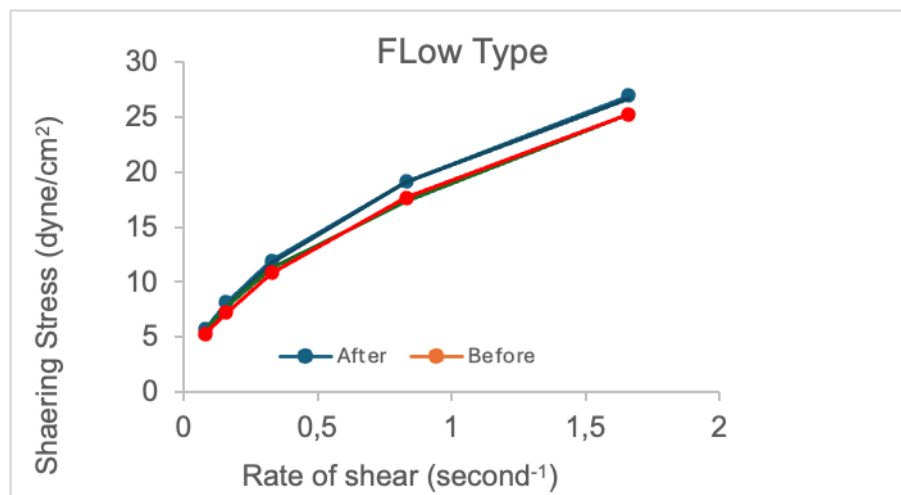


Figure 1. The Rheogram of formula

Foam formation is caused by differences in osmotic pressure in the liquid, dissolved molecules such as surfactants change the surface tension of the liquid which will then form bubbles. On examination of foam height, the results showed the ability of surfactants to form foam. The foam height obtained from the

Three shampoo replications ranged from 3.9 to 4.3 cm, where this number met the requirements for foam height which was 1.3-22 cm¹⁰.

Table 7. The average result of the foam stability test of anti-dandruff shampoo preparations made from natural VCO (Virgin Coconut Oil)

Minute	Foam Abilty (cm)
1	4,3± 1,00
2	4,3 ±0,98
3	4± 0,50
4	3,9± 0,55

The foam stability test was conducted to determine the stability of the foam of the shampoo preparation which was dissolved in water and then shaken, then observed the foam height within a certain time span. According to Preethi, 2013 a good foam is formed 1-6 cm and is stable for more than 15 minutes, after testing the three replications of shampoo preparations the average time required for the foam to disappear is more than 15 minutes. From the results obtained, it can be concluded that the stability of the foam produced from VCO (Virgin Coconut Oil) shampoo is good²⁵.

The dirt dispersion and cleaning ability were tested to determine the shampoo's ability to remove dirt attached to the scalp and the shampoo's ability to clean excess sebum on the scalp. From the test results, it can be concluded that the shampoo has good quality, which is evidenced by the red ink dispersed in the shampoo solution so that the water is red while the foam remains white. Quality shampoo is a shampoo that is easy to rinse and is able to disperse dirt so that it dissolves in water (according to the ideal criteria for shampoo)¹⁹.

The results of observations continued on the ability of shampoo to clean. In this study, sheep fat (*Adeps lanae*) was used as an example of sebum in the evaluation of cleaning ability, because its composition as animal fat is considered close to the composition of sebum. While the woolen thread is used as a hair parable.

DISCUSSION :

In this study VCO (Virgin Coconut Oil) was obtained from Lemito District, Pohuwato Regency, Gorontalo City. Previously, several optimizations of shampoo formulations have been carried out. This optimization aims to find out which formula has the most stable preparation. From the four formulas can be seen in table 1, organoleptic tests and homogeneity tests were carried out. Organoleptic testing aims to see the physical stability of the shampoo preparation. While the homogeneity test aims to see the particle distribution of the preparation.

The results of the organoleptic and homogeneity tests in the table above show that the four anti-dandruff shampoo formulas made from natural VCO have changed in terms of texture and homogeneity, namely F1, F3, and F4.

In F3 the preparation has a dense texture, this is because the use of stearic acid and VCO simultaneously can form solid soap. Fats and soaps from saturated fatty acids and long saturated chains produce hard soaps, where VCO has a large saturated fatty acid content. Stearic acid plays a role in providing consistency and hardness to soap¹⁸.

In F1 and F4 phase separation occurs, this can be caused by the lack of ability of the emulsifier to reduce the surface tension between oil and water, causing separation. While in F2 using carbopol did not experience separation. Carbopol as a gel base, where carbopol can function as an emulsifying agent that helps maintain stability between oil and water. Therefore, based on observations, it can be seen in table 2 that the stable formula is F2.

F2 was made in 3 replications which were then tested based on nine parameters including organoleptic test, viscosity test, homogeneity test, dispersion test, pH test, dirt dispersion test, cleaning ability test, foam ability test and foam stability. Stability testing was carried out using the stress condition method with storage at a temperature of 5 °C and 35 °C for 10 cycles, each cycle lasting 12 hours. The purpose of the forced condition is to evaluate the preparation and to shorten the testing time¹².

Testing using a conductometer has been used to see the type of emulsion. From testing showed that shampoo in this study was they can conduct electricity. Based on the theory, this indicates the presence of an aqueous phase in the outer phase, the emulsion type is o/w²⁶. The three replications produced an o/w emulsion type both before and after the imposed conditions. These results are in accordance with the purpose of the initial formulation, namely to formulate shampoo preparations into an oil-in-water emulsion type. The first process of emulsion formation is the separation between the water phase and the oil phase. The intermittent shaking causes a radius to form between the oil and water phases. The water phase leads to the oil phase and vice versa so that globules are formed. The process can determine the type of emulsion. The o/w emulsion type is formed because the rate of incorporation of the aqueous phase is faster than the oil phase²⁷.

The results of pH measurements based on the table above using a pH meter for anti-dandruff shampoo preparations made from natural VCO (Virgin Coconut Oil) which were carried out for 10 cycles before and after forced conditions, the resulting pH was still within the physiological pH range of the scalp, namely 4.5-6.5². Although there is a decrease in pH, but the resulting value is not significant, skin pH must be very careful because the more alkaline or acidic the material that hits the skin, the more difficult it is to be neutralized by the skin and the skin will become damaged and become dry, cracked,

sensitive and dry, susceptible to infection. The pH of cosmetics should be the same or as close as possible to the physiological pH of the skin, which is why they are called pH-balanced preparations²¹. The pH test showed that the results of data analysis using ANOVA (Analysis of Variance) did not produce significant changes in the three replication formulas before and after the forced conditions.

From figure 1, rheogram result that shows the type of plastic flow. It is said to be plastic because it shows a curve that does not intersect the 0.0 point but intersects the shear stress axis at the yield value. Although emulgel should have thixotropic flow properties²⁶, this difference does not affect the preparation significantly.

The dispersion test shows that the greater the load power given, greater the additional area of the stockpile¹⁰. The results showed that the dispersion value of the three replications entered the range of 5-7 cm, making it easy to apply on the skin. The results of spreadability and viscosity test showed a change after the forced condition where there was an inverse relationship between the spreadability and viscosity, where the lower the viscosity, the higher the diameter of the dispersion power of the preparation. The results of data analysis using ANOVA (Analysis of Variance), the results obtained that the viscosity of the shampoo preparation did not produce significant changes in the three replication formulas before and after conditions were imposed.

CONCLUSION :

Based on the results of the research conducted, it can be concluded that:

1. VCO (Virgin Coconut Oil) can be formulated into an anti-dandruff emulgel shampoo with natural ingredients using carbopol as a gel base.
2. Anti-dandruff emulgel shampoo made from natural VCO (Virgin Coconut Oil) with a pharmaceutically stable carbopol base.

ACKNOWLEDGMENTS :

The authors would like to acknowledge Indonesian Ministry of Education and Culture, and Faculty of Pharmacy, Universitas Muslim Indonesia.

REFERENCES:

1. Dolih Gozali, Risma Rudathillah, Resmi Mustarichie. Anti-dandruff Shampoo formulation with active substances Ethanol extract of *Brassica oleracea* var *capitata* L. and its verifying activity against fungus *Malassezia furfur*. *Research J. Pharm. and Tech.* 2020; 13(8):3702-3708. doi: [10.5958/0974-360X.2020.00655.1](https://doi.org/10.5958/0974-360X.2020.00655.1)
2. Nurhikma E., Dewi Antari, Selfyana A. Tee. Formulation of Anti-dandruff Shampoo From Cabbage Extract (*Brassica oleracea* Var. *Capitata* L.) Combination of Fragrant Pandan Leaf Extract (*Pandanus amaryllifolius* Roxb), *Journal of Mandala Pharmacon Indonesia*. 2018; 4(1). doi : [10.20961/jkpk.v8i1.72727](https://doi.org/10.20961/jkpk.v8i1.72727)
3. Mahataranti, N., IY Astuti., and B. Asriningdhiani. Anti-dandruff shampoo formulation of Celery (*Apium Graveolens* L.) Ethanol Extract and Its Activity Against *Pityrosporum ovale* Fungus. *Journal of Pharmacy*. 2012; 9(2): 128-138. doi: [10.30595/pji.v9i2.710](https://doi.org/10.30595/pji.v9i2.710)
4. Suryati, Lia and Nyi M. Saptarini. Green Tea Leaf Extract Shampoo Formulation (*Camellia sinensis* var. *assamica*), *IJPST*. 2016; 3(2). doi: [10.15416/IJPST.V3I2.8680](https://doi.org/10.15416/IJPST.V3I2.8680).
5. Ayyappadasan G, Rubavathi S, Kanimozli S. Formulation and Evaluation of Polyherbal-Spirulina Based Conditioning and Antioxidant Shampoo. *Research Journal of Pharmacy and Technology* 2023; 16(5):2317-1. doi: [10.52711/0974-360X.2023.00381](https://doi.org/10.52711/0974-360X.2023.00381)
6. Sandeep D. S, Prashant Nayak, Jobin Jose, Rishal Relita M, Sumana D. R.. Formulation and Evaluation of Antibacterial Herbal gels of *Murraya koenigii* Leaves Extract. *Research J. Pharm. and Tech.* 2017; 10(6): 1798-1801. doi: [10.5958/0974-360X.2017.00317.1](https://doi.org/10.5958/0974-360X.2017.00317.1)
7. Dewi Melani Hariyadi, Noorma Rosita, Isnaeni, Sisunandar Sudarma, Deavisca Rezania. Virgin Coconut Oil Emulgel: Effect of VCO and Carbopol 940 Concentration on Characterization and Antibacterial Activity. *Research Journal of Pharmacy and Technology*. 2022; 15(5):2087-2. doi: [10.52711/0974-360X.2022.00345](https://doi.org/10.52711/0974-360X.2022.00345)
8. Nitbani, F.O, et al. Synthesis and Antibacterial of 1-Monolourin. *Oriental Journal of Chemistry*. 2018; 34(2). doi: [10.13005/ojc/340233](https://doi.org/10.13005/ojc/340233).
9. Ningrum, R., Prasetyo, AB., Kristanti, AN. Celery. Herb Essential Oil In The Formulation; of Antidandruff Hair Tonic Against *Pityrosporum ovale*, *Jurnal Kimia Reset.* 2017; 2(2): 93-97. doi: [10.20473/jkr.v2i2.6197](https://doi.org/10.20473/jkr.v2i2.6197).
10. Priya P. Munshi, D.S. Mohale, R. Akkalwar, A.V. Chandewar. Formulation and Evaluation of Diclofenac gel. *Research J. Pharm. and Tech.* 2011; 4(9): 1394-1399.
11. Shikha Baghel Chauhan. Formulation and Evaluation of Emulgel for the treatment of Acne. *Research J. Pharm. and Tech.* 2020; 13(8):3598-3602. doi: [10.5958/0974-360X.2020.00636.8](https://doi.org/10.5958/0974-360X.2020.00636.8).
12. Satya Lakshmi S, Divya R, Srinivasa Rao Y, Kamala Kumari PV, Deepthi K. Emulgel-Novel Trend in Topical Drug Delivery System - Review Article. *Research Journal of Pharmacy and Technology*. 2021; 14(5):2903-6. doi: [10.52711/0974-360X.2021.00509](https://doi.org/10.52711/0974-360X.2021.00509).
13. Pratiksha V. Shrikhande. Formulation and Evaluation of Polyherbal Topical Anti-Inflammatory Emulgel. *Research J. Pharm. and Tech.* 2013; 6(1): 118-122.

14. Astuti, DP, Patihul, H, & Kusdi, H. Formulation and Physical Stability Test for Hand Antiseptic Gel Preparations Lavender Flower Essential Oil (*Lavandula angustifolia* Miller), *Pharmacy Supplements*. 2017; 15(1): 176-184. doi: 10.24198/jf.v15i1.13252.
15. Rajni Bala, Reecha Madaan, Vibhu, Sandeep Arora. Green Synthesis and Characterization of silver nanoparticles using Kinnow mandarian peels extract and its application in Shampoo Formulation. *Research J. Pharm. and Tech.* 2017; 10(8): 2461-2466. doi: 10.5958/0974-360X.2017.00435.8
16. Punasiya Rakesh, Yadav Amid, Gaurav Krishna, Pillai Sujit. Formulation and Evaluation of Herbal Gel Containing Extract of *Hibiscus syriacus*. *Research J. Pharm. and Tech.* 2014; 7(3): 296-300.
17. Smita Kumbhar, Vinod Matole, Yogesh Thorat, Saili Madur, Smeeta Patil, Anita Shegaonkar. Formulation and Evaluation of Lignocaine Hydrochloride Topical gel. *Research J. Pharm. and Tech.* 2021; 14(2):908-910. doi: 10.5958/0974-360X.2021.00161.X
18. Riski, R, Abdul HU, Rismadani. Anti-Inflammatory Emulgel Formulation From Javanese Ginger Extract (*Curcuma Xanthorrhiza* Roxb), *Journal of Pharmaceutical and Medical Science*. 2016; 1(2): 1-4.
19. Emmawati, T., Bambang Sidharta, Oktavia Eka Puspita & Meyke Herina Syafitr, 2016, Optimization of Formulas and Techniques for Making Fresh Cow's Milk Shampoo Using a Combination of Surfactant and Co- Surfactant, *FKUB Health Magazine*. 2016; 3(2): 93-111.
20. Mursyid, AM. Evaluation of Physical Stability and Diffusion Profile of Gel (Olive Oil) Preparations, *Indonesian Journal of Phytopharmacy*. 2017; 4(1): 205-211. doi: 10.33096/jffi.v4i1.229.
21. Aulton, ME, 2002, *Pharmaceutics: The science of dosage form design*, 2nd end, Churchill Livingstone, Edinburgh, New York.
22. Lukman, A. and Atika Wahyuni. Formulation of Lemon Juice (*Citrus Hystrix* DC) Shampoo and Anti-Dandruff Activity Test Against Dandruff-causing Fungus (*Pityrosporum Ovale*) In Vitro, *Indonesian Pharmaceutical Research Journal*. 2017; 6(1) : 35-41.
23. SNI. 06. 2692. 1992. Liquid Shampoo Quality Standards. National Standardization Council. Jakarta.
24. Wilkinson, J. B. dan Moore, R. J., 1982, *Harry's Cosmeticology*, Ed 7th .
25. Preethi, J. P., Padmini, K., Srikanth, J., Lohita, M., Sweta, K. and Rao, V. P. 2013, "A review on Herbal Shampoo and Its Evaluation". 10th Edition, Chapman and Hall, London.
26. Prabhat Dessai, Gauri M. Mhaskar. Formulation and Evaluation of Ginger officinale Emulgel. *Research J. Pharm. and Tech.* 2019; 12(4):1559-1565. doi: 10.5958/0974-360X.2019.00258.0
27. Suryani, Muhamad Handoyo Sahumena, Sry Yusti Mabilla, Rahmi Ningsih, Andi Nafisah Tendri Adjeng, Muhammad Aswan, Ruslin, Yamin, Michrun Nisa. Preparation and Evaluation of Physical Characteristics of Vitamin E Nanoemulsion using virgin coconut Oil (VCO) and olive oil as oil phase with variation Concentration of tween 80 Surfactant. *Research J. Pharm. and Tech.* 2020; 13(7): 3232-3236. doi: 10.5958/0974-360X.2020.00572.7

