Test The Growth Process Of Hair Follicles By Administering Coconut And Candlenut Oil To The Entire Back Of White Rats (Rattus Norvegicus) Of The Wistar Strain

Mulan[1], Hendrianto[2], Sahna Ferdinand[3*]

[1,2,3] Master Study Program in Biomedical Sciences, Faculty of Medicine, Dentistry and Health Sciences, Prima Indonesia University, Medan, Indonesia
[*] Corresponding Author:
Email: sahnaferdinand@unprimdn.ac.id

Abstract.

Hair serves a variety of purposes, including thermoregulation and protection. Hair regulates temperature in nonhuman animals, including primates, by holding heat or preventing cold. Hair can also be used for disguise and as a sexual attractant. Human hair is thinner and lighter than that of primates. The purpose of this study was to determine and test the efficacy of providing a coconut oil and candlenut oil mixture in the process of hair development in Wistar rats (Rattus norvegicus). The study's findings indicate that a combination containing 80% coconut oil and 20% candlenut oil is the most efficient in stimulating hair development in white rats (Rattus norvegicus) of the Wistar strain. This hair growth acceleration is possible because coconut oil contains a high concentration, precisely 80%. Because coconut has a high amount of lauric acid, it has numerous health benefits, including good hair.

Keywords: *Hair, Candlenut Oil and Coconut Oil.*

I. INTRODUCTION

Animal "feathers"—hair—distinguish mammals. Hair regulates temperature and protects. Primate hair controls temperature by retaining heat or preventing cold. Deception and sexual attraction are possible with hair. Humans have thinner, lighter hair than primates. Hair is sensitive and thermoregulates perspiration. Hair protects the skin, especially from UV rays [1].Hair is an epidermal derivative divided into two parts: the follicle and the hair shaft. Follicles are an essential unit in hair development. Humans have over 5 million hair follicles, with 100,000 of them located on the scalp. During seasonal molting, hair follicles can change type and density [2]. Meanwhile, the hair shaft comprises cortex and cuticle cells, as well as the medulla for some kinds of hair [2].Lanugo, villus, and terminal hair are classified by hair follicle size. Lanugo hair is long, unpigmented, and delicate, with hair follicles creating it. Hair follicles form and produce this hair as the embryo develops. In preparation for delivery, the seed sheds its first wave of development and grows terminal or vellus hair at about eight months.The disorder "congenital hypertrichosis lanuginosa" can coat babies with lanugo hair. Short, fine, unpigmented vellus hair. This hair is usually on the nose and cheeks—finally, terminal, long, arduous, pigmented, and often medulla. Men's genitals, armpits, beard, and chest hair follicles change from vellus to terminal throughout puberty due to hormones [3].Anagen, catagen, and telogen are hair follicle growth phases. Anagen is the proliferation phase when the hair follicle generates a new hair shaft.

Phase length varies. Hair on the scalp can grow for 2–6 years, whereas eyebrows and eyelashes may develop in months. This is the sole phase with the inferior hair follicle segment. Dermal papillae signal bulge multipotent epithelial stem cells to start anagen. After stimulating these stem cells, the inferior hair follicle can develop downward and form a ball around the dermal papilla. Now, the dermal papillae can tell bulb matrix cells to proliferate, differentiate, and rise upward, generating new hairs [4].Catagen is the transition or regression phase. The shortest of the three steps may last weeks. In this phase, matrix cell division stops, and the inferior hair follicle regresses. After the low portion of the strand disappears, the dermal papilla moves upward to connect the bulge again. The tips of club hairs are firm white knotted throughout this procedure.

The final phase is telogen, or resting. The club's dead hair was held. Club hairs on the scalp endure 100 days generally. These hairs fall out, so the anagen phase can start anew with new hair [4].Public awareness of healthy scalp and hair is low. Few people know how to care for their hair and scalp. The appearance of healthy hair depends on a healthy scalp and vice versa. Alopecia—hair loss—can result from unhealthy hair and scalp [5]. Alopecia (hair loss), a dermatological disorder, affects women and men of all ages. Hair has been women's most important symbol for generations. Women's attractiveness, beauty, and strength are enhanced by healthy hair. This is why women experience more psychological issues from hair loss than males [6].The term alopecia means hair loss regardless of cause. It can occur anywhere on the body, not just on the scalp. Everyone has hundreds of thousands of head hairs. Hair growth happens in anagen, rests in catagen, and sheds in telogen.

Ninety percent of hair is growing (anagen), and ten percent is resting and falling out. Hair falls out in the telogen phase, then recycles and rises again in the anagen phase. Scarring and non-scarring alopecia exist [7].Androgenetic or non-scarring alopecia is most common. Most males start losing hair in their 20s, while women in their 40s or 50s. A person loses hair with aging. Pattern distinguishes male and female hair loss. Women lose hair in the middle of the head, whereas men lose it in the front and temporal areas. Men can get completely bald, but women won't. The posterior scalp hair is resistant to androgenic hormones; thus, men keep it [7].Hair growth and density slow with age. This can be caused by medicines, nutrition, hormonal imbalances, altered mitotic activity, growth cycle anomalies, etc. A complete history, physical exam, hair pull test, daily hair count, section width, clip test to evaluate the hair shaft, hair growth window, plucking, and trigrams can diagnose hair disease. Some cases require scalp biopsies, hormone investigations, and potassium hydroxide fungal testing. Correctly diagnosing hair problems is crucial for treating hair loss [4].Alopecia patients must be examined appropriately to establish their kind and etiology. Some patients need a complete blood count, iron panel, thyroid function tests, autoantibodies, total and free testosterone, ovarian hormone, luteinizing hormone, and follicle-stimulating hormone. (Evaluation of hair plucking and loss can tell whether hair strands are breaking off and whether the crown is white or dark (telogen vs. anagen cycle).

The office hair pull test is straightforward. Doctors can employ dermoscopy/trichoscopy. A biopsy reveals the most regarding hair loss [7].Genetics, hormones, nutrition, and environmental exposure (radiation, chemicals) cause hair loss [8]. Maintaining a healthy scalp and hair is one of the most straightforward strategies to avoid hair loss and promote follicle growth. Medication treats hair loss. Minoxidil is often given for hair loss [9]. These medications improve hair follicles and minimize hair loss, although they can cause adverse contact dermatitis, erythema, and itching. Patients who do not see significant hair recovery with conventional therapies or experience side effects often try new treatments from abundant natural product resources to find safe, honest, and effective hair restoration therapies [8].Increase blood circulation to the scalp and massage it with hair oil to nourish the hair and scalp to restore damaged hair. Various oils help hair condition. This oil treats dandruff, hair loss, and dry hair. Regular hair oil prevents breakage and split ends, shines hair, and moisturizes the scalp. Hair oil provides nutrients to hair roots for optimal development. Coconut and candlenuts are inexpensive and helpful raw resources for hair oils, which are usually pricey [10].The most widespread fruit plant on Earth is Cocos nucifera, the "coconut tree." In the past, minerals, plants, and animals were the primary sources of medicine. Cocos nucifera has antihelminthic, anti-inflammatory, antinociceptive, antioxidant, antifungal, antibacterial, and anticancer properties [11]. The general public uses coconuts for cooking, eating, traditional medicine, and hair care. Coconut oil offers several health benefits, including hair health, due to its high lauric acid content [12].Along with coconut, candlenuts are good for hair—an essential multipurpose plant: candlenut (Aleurites moluccana).

Tribes worldwide use Aleurites moluccana in traditional medicine as part of their local wisdom. This medicinal plant knowledge was passed down verbally or in texts. This species has been used as a traditional medicine in Indonesia for generations and is considered a cultural property [13]. Candlenuts are used in cooking seasonings and medicinal. Candlenuts grow nicely in several Indonesian areas. Candlenuts are a local and export item in Indonesia because they are easy to grow. Candlenut seed oil is helpful in paint,

varnish, soap, medicine, cosmetics, and fuel [14], [15].Based on this background, this study tests the hair growth effects of coconut and candlenut oil on Wistar rats (Rattus norvegicus). To compare hair growth rates in rats (Rattus norvegicus) given varying quantities of coconut oil (Cocos nucifera) and candlenut oil (Aleurites moluccana). And to determine which oil mixture stimulates hair development in Wistar rats (Rattus norvegicus) and the properties of coconut and candlenut oils.

II. METHODS

This study employs an experimental quantitative research design, namely a true experiment or laboratory experimental design. True experimentation is a severe experimental study that controls all external variables that can influence experimental activity [16]. This study used a pre-test - post-test control group design to identify and analyze the effectiveness of the hair follicle growth process in Wistar strain rats (Rattus norvegicus) when administered with a mixture of coconut and candlenut oil. Wistar rats (Rattus norvegicus) weighing 160-200 grams and 2-3 months old were used in this investigation. Variables are features or attributes that may be measured or seen that differ among the persons or organizations evaluated. The variables in this study are the objectives of research observation [17], in this case, the administration of coconut and candlenut oil extracts, and the hair growth process in Wistar strain rats (Rattus norvegicus).

First, research is done quickly to adapt to the changing environment, climate, circumstances, or atmosphere, and all Wistar strains for seven days at the Animal House, Faculty of Mathematics and Natural Sciences, Medan State University, then shaved their backs with a 4x4 cm hair shaver. Make coconut and candlenut oils, then assess their quality. Place a drop of oil in each mouse's eyes and observe for 24 hours to test for eye irritation. Oils are individually evaluated for animal skin irritation. One oil at a time was administered to the mice's skin and monitored for 24 hours for redness or irritation.Acclimatized test animals had their backs shaved four times using a 4x4 cm2 hair clipper until smooth. Hair length was measured on days 7, 14, and 21. The research data was analyzed using SPSS 25.0 for Windows. The Kolmogorov-Smirnov test ($p > 0.05$) assessed data normality. The significance between groups was tested using a one-way analysis of variance (One-way ANOVA) with a 95% confidence level ($p < 0.05$). The Post Hoc Test with LSD was used for further research.

III. RESULTS AND DISCUSSION

Result

Table 1. Observation Scale for Eye Irritation Testing

Symptom	Score
Cornea	
The cornea is clear, not cloudy	0
The cloudy areas are scattered, iris details are still visible	1
The cloudy area is more expansive; the iris details are less clear	2
Large cloudy areas, iris details not visible	3
Cornea cloudy, iris faint	4
Iris	
Normal, the iris lines are visible	0
There is swelling of the iris, reactive to light	1
Bleeding occurs in the iris	2
Conjunctiva	
Normal	0
Redder	1
Blood vessels appear red	2
The blood vessels appear red	3
Chemosis (swelling of the eyelids)	
Normal	0
Swelling is slightly above normal	1
Swelling is noticeable, and part of the eyelid seems to be turning over	2
Swollen eyelids cause about half of the eye to close	3
Swollen eyelids cause more than half of the eye to close	4

In Table 1, The ocular irritation test involved placing oil drops in each mouse's eyes and monitoring them for 24 hours. Redness and swelling in the eyes are tested for oil irritation. The OEDa (2021) parameters measure ocular inflammation.

Table 2. Eye Irritation Testing Classification (OEDa, 2021)

Category	Criteria
Category 1, Irreversible Effects	Non-healing cornea, iris, or conjunctiva occur during the 14-day observation period.
Category 2, 2A/Irritant Labor	The observation time resolves cornea, iris, and conjunctival effects.
2B/ Irritant	Adverse cornea, iris, or conjunctival effects resolve during observation.

Table 3. Observation Scale for Skin Irritation Testing (OECD, 2015)

Skin Reactions	Score
A. Erythema and Eschar Formation	
Erythema does not form	0
Very mild erythema	1
The erythema is mild and obvious	2
Moderate to severe erythema	3
Severe erythema	4
B. Edema Formation	
No edema formed	0
Very mild edema	1
Mild edema (clearly raised edge)	2
Moderate edema (1 mm rise in edge height)	3
Severe edema (edema edge height > 1 mm and extends externally)	4

Animal skin irritation tests are performed on each oil in Table 3. One oil at a time was administered to the mice's skin and monitored for 24 hours for redness or irritation.

Table 4. Classification of Skin Irritation Tests (OECD, 2015)

Classification	Criteria
Non-irritating	0
Mild irritation	< 2
Moderate irritation	2 – 5
Severe or main irritation	>5 or by eschar formation

Days 7, 14, and 21 measured hair length. Six of the longest rat hair strands were plucked, straightened, and attached to a solution to measure distance. Use a caliper to measure hair length. On day 21, hair weight was measured by cutting and weighing test region hair and statistically calculating the results.

Table 5. Characteristics of Test Animals

Component	Control	P1	P2	P3	P4	P5
Types of Rats	*White Rattus norvegicus Wistar strain*					
General Condition	White feathers, healthy and active					
Average Initial Body Weight	196 gr	192 gr	198 gr	190 gr	195 gr	194 gr
Average Final Body Weight	195 gr	192 gr	197 gr	190 gr	193 gr	193 gr

This study was carried out to assess the growth process of hair follicles by applying coconut oil and candlenut oil to the backs of white rats (Rattus norvegicus).

Table 6. Average Eye Irritation Test Results

	Observation time																	
	1 hour						24 hours						21Days					
	K	1	2	3	4	5	K	1	2	3	4	5	K	1	2	3	4	5
Cornea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conjunctiva	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemosis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note : K: Control, 1,2,3,4,5 Treatment

Table 6 shows that coconut and candlenut oils did not cause eye irritation until the 21st day, as demonstrated by cornea, iris, conjunctiva, and chemosis symptoms. Precise therapy is used on the cornea—normal iris with noticeable lines. Then, there is no conjunctival membrane redness, eyelid edema, or chemosis. They don't tear much or react to light. Based on the symptoms caused, the coconut oil did not affect the test animals' eyes. Thus, the value from the first hour to the 21st day was 0, like the control eyes.

Table 7. Average Skin Irritation Test Results

Parameter	Observation time																	
	1 hour						24 hours						21 days					
	K	1	2	3	4	5	K	1	2	3	4	5	K	1	2	3	4	5
Erythema	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Edema	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note : K: Control, 1,2,3,4,5 Treatment

Table 7 shows that mice did not display any irritation reaction from application until the 21st day, as demonstrated by test rabbit skin symptoms. The application region did not develop erythema or edema for one hour, 24 hours, or the whole 21-day period. Skin conditions matched the control group.

Table 8. Rat Hair Length

		Mouse hair length (cm)		
Group	Repetition	Day 7	Day 14	Day 21
Control	1	0	0.47	0.62
	2	0	0.42	0.83
	3	0	0.29	1.07
	4	0	0.43	1.08
	5	0	0.44	1.01
Treatment 1	1	0.79	0.82	1.04
	2	0	0.57	1.20
	3	0.57	0.72	1.20
	4	0.65	1.09	1.32
	5	0.91	1.42	1.49
Treatment 2	1	0.66	0.94	1.15
	2	0.73	1.37	1.47
	3	0.87	1.09	1.14
	4	0.53	1.15	1.20
	5	0.56	1.22	1.35
Treatment 3	1	0.69	0.82	1.40
	2	0.52	0.87	1.44
	3	0.83	1.01	1.18
	4	0.26	0.79	1.05
	5	1.04	1.41	1.57
Treatment 4	1	0.72	1.14	1.14
	2	0.88	0.84	1.25
	3	0.85	0.87	1.67
	4	0.85	1.15	1.82
	5	0.57	1.24	1.39
Treatment 5	1	1.05	1.14	1.19
	2	0.72	0.84	1.08
	3	0.71	0.87	1.34
	4	0.71	1.15	1.23
	5	0.71	1.24	1.41

Table 8 shows hair growth in all groups. The researchers assessed the average hair growth and standard deviation for each treatment group to determine which had the fastest hair growth.

Table 9. Average Hair Length of Rats

	Average mouse hair length (cm)		
Group	Day7	Day14	Day21
Control	0	0.410	0.922
Treatment 1	0.584	0.924	1.250
Treatment 2	0.670	1.154	1.262
Treatment 3	0.668	0.920	1.248

Treatment 4	0.774	1.294	1.412
Treatment 5	0.780	1.048	1.266

Table 9, the average mouse hair length, shows that each group grew hair over 21 days. On the last day, the control group hair length was 0.92cm, treatment group 1 1.25 cm, group 2 1,262 cm, group 3 1,248cm, group 4 1,412cm, and group 5 1,266 cm. This average difference showed that group 4 had the most hair growth, 1,412 cm. Group 4 was slathered with 80% coconut and 20% candlenut oil. The control group had the slightest hair growth at 0.922cm on day 21. The control group received only distilled water.

Table 10. Normality Test Results

Treatment	df	**Sig**
K-Control	5	.200
K-P1	5	.200
K-P2	5	.200
K-P3	5	.200
K-P4	5	.200
K-P5	5	.200

According to Table 10, the Kolmogorov-Smirnov Test determined normalcy. The results were significant > 0.05 in each group. A p-value > 0.05 indicates normally distributed data. This implies that the data is normally distributed.Table 11 shows the probability value in the significant column of 0.008 for the Levene homogeneity test in Table 5. As the significance probability value is more critical than 0.05 (p > 0.05), the control group, treatment 1, treatment 2, treatment 3, treatment group 4, and treatment group 5 come from populations with the same variance, or the group is homogeneous.

Table 11. Homogeneity Test Results

Levene static	**df1**	**df2**	**Sig**
4.635	5	24	.008

The One-Way Anova test in Table 12 yields a significance value of 0.000 or < 0.05. These statistics show significant treatment group differences.

Table 12. One-Way Anova Test Results

	Amount	**Df**	**Mean square**	**F**	**Sig**
Between groups	7.246	5	1.449	19.547	.000
In Group	1.779	24	.002		
Total	9.026	29			

Table 13 shows if groups differ significantly using the LSD Post Hoc Test. Our Post Hoc LSD test analysis showed that only treatment group 4 had a significance value of 0.000 or less than 0.05, indicating a significant difference from the other groups.

Table 13. LSD Post Hoc Test Results

Group		**Mean difference**	**Sig**
Control	Treatment 1	-.47533*	.011
	Treatment 2	-.58467*	.002
	Treatment 3	-.50133*	.008
	Treatment 4	-1.63400*	.000
	Treatment 4	-.58733*	.002
P1	Control	.47533*	.011
	Treatment 2	-.10933	.532
	Treatment 3	-.02600	.881
	Treatment 4	-1.15867*	.000
	Treatment 5	-.11200	.522
P2	Control	.58467*	.002
	Treatment 1	.10933	.532
	Treatment 3	.08333	.633
	Treatment 4	-1.04933*	.000
	Treatment 5	-.00267	.988
P3	Control	.50133*	.008
	Treatment 1	.02600	.881
	Treatment 2	-.08333	.633
	Treatment 4	-1.13267*	.000
	Treatment 5	-.08600	.622

Group		Mean difference	Sig
P4	Control	1.63400*	.000
	Treatment 1	1.15867*	.000
	Treatment 2	1.04933*	.000
	Treatment 3	1.13267*	.000
	Treatment 5	1.04667*	.000
P5	Kontrol	.58733*	.002
	Treatment 1	.11200	.522
	Treatment 2	.00267	.988
	Treatment 3	.08600	.622
	Treatment 4	-1.04667*	.000

The LSD Post Hoc Test is designed to detect whether groups differ significantly from one another.

Discussion

This study examined whether Wistar strain white rats (Rattus norvegicus) grew hair after being injected with coconut and candlenut oil. Ferderer formula calculations yielded 30 Wistar strain white rats (Rattus norvegicus). The test animals were randomly assigned to six treatment groups. The control group received distilled water, while treatment group 1 received 50% coconut oil and 50% candlenut oil. The second and third treatment groups were 70% coconut oil and 30% candlenut oil, 30% and 70%, 80% and 20%, and 20% and 80%.Awareness of scalp and hair health is crucial. The appearance of healthy hair depends on a healthy scalp and vice versa [5]. Alopecia—hair loss—can result from unhealthy hair and scalp. Alopecia, a dermatological illness, affects women and males of all ages [6]. Genetics, hormones, nutrition, and environmental exposure (radiation, chemicals) cause hair loss [8]. Maintaining a healthy scalp and hair is one of the most straightforward strategies to avoid hair loss and promote follicle growth.Increasing blood circulation to the scalp and rubbing it with hair oil helps nourish the hair and scalp and restore damaged hair. Various oils help hair condition. This oil treats hair issues. Hair oil provides nutrients to hair roots for optimal development. Coconut and candlenuts are inexpensive and helpful raw resources for hair oils, which are usually pricey [10].Coconut oil offers several health benefits, including hair health, due to its high lauric acid content [12]. Cocos nucifera has antihelminthic, anti-inflammatory, antinociceptive, antioxidant, antifungal, antibacterial, and anticancer properties [11].

Along with coconut, candlenuts promote hair development. Many benefits of candlenut oil include hair growth [14], [15]. Researchers want to know if coconut and candlenut oil can speed up hair growth in white Wistar rats.The average mice weight before coconut and candlenut oil treatment was 194.16 grams. To conclude the investigation, the mice were weighed again and marginally lighter. All groups of test animals showed no significant body weight change. The research animals were healthy and active till the end. The 14-day observation approach yielded data that needed to be processed and tested, requiring various data analyses. First, data is processed and normality tested. The Kolmogorov-Smirnov test in SPSS determined normality. All test groups had normally distributed data with a significance value of 0.200 > 0.05. Thus, the data is regularly distributed or represents the population. The Levene test determines if normally distributed data comes from a population with the same variance. Results indicate 0.369 significance. A significance probability greater than 0.008 suggests all groups are from the same people. This normally distributed and homogeneous data was assessed for efficacy and effectiveness using One-Way ANOVA. One-way ANOVA test results show 0.000, less than 0.05. These findings show substantial differences between the control and treatment groups, requiring a post-hoc LSD test. A post-hoc LSD test was used to compare the group's average body weights. Only treatment group 4 showed a significance value of 0.000 or less than 0.05 in this study's Post Hoc LSD test analysis, indicating that it was substantially different from the control group and other treatment groups.

The hair growth of white Wistar rats (Rattus norvegicus) treated with coconut and hazelnut oil at varied concentrations was compared to the group smeared with distilled water. The average mouse hair length shows that each group grew hair over 21 days. The control group had 0.92 cm hair length on the last day, treatment group 1 1.25 cm, treatment group 2 1,262 cm, treatment group 3 1,248 cm, treatment group 4 1,412 cm, and treatment group 5 1,266 cm.Following this average difference, the researchers found that group 4 had the most hair growth, 1,412 cm. Group 4 was slathered with 80% coconut and 20% candlenut

oil. The control group had the slightest hair growth at 0.922 cm on day 21. The control group received only distilled water. In Wistar white rats (Rattus norvegicus), 80% coconut oil and 20% candlenut oil accelerate hair development best. Coconut oil's 80% content accelerates hair development. Coconut's high lauric acid content provides various health benefits, including hair health [12].

IV. CONCLUSION

This study found that coconut and candlenut oil accelerates hair development in Wistar white rats (Rattus norvegicus). The longer average hair growth in the coconut-candlenut oil group compared to the distilled water group. The five groups received coconut-candlenut oil. Treatment group 4, with 80% coconut and 20% candlenut oil, had the most hair growth, averaging 1,412 cm.One-way ANOVA test results suggest 0.000 or less than 0.05 significance. These statistics show a significant difference between the control and treatment groups. Only treatment group 4 had a 0.000 Post HoC LSD test considerable value. According to these data, the control group and treatment group 4, which received 80% coconut oil and 20% candlenut oil, differed significantly.Suggestions for future research on the hair-growth-boosting effects of coconut and candlenut oil. Complete testing of coconut and candlenut oil substance composition is also needed. Histopathological observations of hair growth are required to strengthen research.

V. ACKNOWLEDGMENTS

The author would like to thank the Faculty of Medicine, Dentistry and Health Sciences, Prima Indonesia University, for supporting this project, the head of the Animal House Center, the Faculty of Mathematics and Natural Sciences, Medan State University, and the supervisor. We also thank the research partners for their valuable advice.

REFERENCES

[1] M. B. Murphrey, S. Agarwal, and P. M. Zito, *Anatomy, Hair*. Treasure Island (FL), 2023.

[2] M. S. Orăsan and A. Coneac, “Evaluation of Animal Models Suitable for Hair Research and Regeneration,” in *Experimental Animal Models of Human Diseases - An Effective Therapeutic Strategy*, I. Bartholomew, Ed., London: IntechOpen, 2018, pp. 235–255. doi: 10.5772/intechopen.69698.

[3] B. Erdoğan, “Anatomy and Physiology of Hair,” in *Hair and Scalp Disorders*, Z. Kutlubay and S. Serdaroglu, Eds., London: IntechOpen, 2017, pp. 13–27. doi: 10.1016/B0-44-306557-8/50208-2.

[4] J. L. Martel, J. H. Miao, and T. Badri, *Anatomy, Hair Follicle*. Treasure Island (FL): StatPearls Publishing, 2023.

[5] K. Ullah, A. Azam, A. Khan, S. U. Gul, and A. I. Qazi, “Effect of topical applications of oils extracted from medicinal plants and coconut oil mixed with egg yolk and vitamin e on the growth of rabbit hair of District Karak, Khyber Pakhtunkhwa, Pakistan,” ***Int. J. Biol. Sci.***, vol. 2, no. 2, pp. 57–61, 2020, doi: 10.33545/26649926.2020.v2.i2a.57.

[6] Z. Kutlubay and S. Serdaroglu, *Hair and Scalp Disorders*. BoD–Books on Demand, 2017.

[7] A. M. Al Aboud and P. M. Zito, *Alopecia*. Treasure Island (FL): StatPearls Publishing, 2023. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK538178/

[8] D. Mirecki-Garrido, S.-F. M., G.-H. R., F. N., Jimenez-Acosta, and D. L. Lorenzo-Villegas, “Ginseng in Hair Growth and Viability,” in *Ginseng: Modern Aspects of the Famed Traditional Medicine*, C. Hano and J.-T. Chen, Eds., BoD–Books on Demand, 2022, p. 69.

[9] P. Suchonwanit, S. Thammarucha, and K. Leerunyakul, “Minoxidil and its use in hair disorders: A review,” *Drug Des. Devel. Ther.*, vol. 13, pp. 2777–2786, 2019, doi: 10.2147/DDDT.S214907.

[10] D. Zawedde, “Extraction, characterization and evaluation of candlenut as an alternative source of hair oil,” Makerere University, 2022. [Online]. Available: http://hdl.handle.net/20.500.12281/11797

[11] J. Ma *et al.*, “Insight of the Functional and Biological Activities of Coconut (Cocos nucifera L.) Protein by Proteomics Analysis and Protein-Based Bioinformatics,” *Molecules*, vol. 27, no. 9, 2022, doi: 10.3390/molecules27092987.

[12] Y. J. Ng, P. E. Tham, K. S. Khoo, C. K. Cheng, K. W. Chew, and P. L. Show, “A comprehensive review on the techniques for coconut oil extraction and its application,” *Bioprocess Biosyst. Eng.*, vol. 44, no. 9, pp. 1807–1818, 2021, doi: 10.1007/s00449-021-02577-9.

[13] A. Hakim, J. Jamaluddin, S. W. Al Idrus, A. W. Jufri, and B. N. S. Ningsih, "Ethnopharmacology, phytochemistry, and biological activity review of Aleurites moluccana," ***J. Appl. Pharm. Sci.***, vol. 12, no. 4, pp. 170–178, 2022, doi: 10.7324/JAPS.2022.120419.

[14] M. A. Shaah *et al.*, "Candlenut oil: review on oil properties and future liquid biofuel prospects," ***Int. J. Energy Res.,*** vol. 45, no. 12, pp. 17057–17079, 2021, doi: 10.1002/er.6446.

[15] G. Anusha, R. Sunayana, M. Ponnam, and B. A. Kumar, "Asian Journal of Pharmaceutical Research and Development," ***Asian J. Pharm. Res. Dev.,*** vol. 8, no. 6, pp. 77–80, 2020.

[16] S. Notoatmodjo, *Metodologi Penelitian Kesehatan*, 3rd ed. Jakarta: Rineka Cipta, 2018.

[17] B. Suwarno and A. Nugroho, *Kumpulan Variabel-Variabel Penelitian Manajemen Pemasaran (Definisi & Artikel Publikasi)*, 1st ed. Bogor: Halaman Moeka Publishing, 2023.