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Efficacy of Ginger (Zingiber officinale) and Celery (Apium graveolens L.) Extracts on Hair Growth in Wistar Rats (Rattus norvegicus)

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ABSTRACT

Ginger (Zingiber officinale) and celery (Apium graveolens L.) are well-known for their anti-inflammatory and antioxidant properties, and they have been traditionally used to treat hair loss. However, scientific evidence regarding their effectiveness in stimulating hair growth is still limited. This study aims to evaluate the effects of ginger and celery extracts on hair growth in Wistar rats, focusing on growth onset, duration, regrowth, and potential inflammatory effects on the skin. The research method used a total of 25 Wistar rats randomly divided into five groups: control (paraffin), standard (minoxidil), ginger extract, celery extract, and a combination of ginger and celery extracts. Each extract was administered at a dosage of 20 mg/ml. The study monitored the onset, duration, and regrowth scores of hair growth. Histological examinations were performed to assess hair follicle density and inflammation levels. Phytochemical analyses of the extracts were conducted to identify the presence of flavonoids, alkaloids, glycosides, saponins, tannins, and steroids/triterpenoids. The research results show that phytochemical analysis revealed that ginger contains flavonoids, alkaloids, glycosides, and steroids/triterpenoids, while celery contains flavonoids, alkaloids, saponins, tannins, glycosides, and steroids/triterpenoids. The analysis showed no significant differences in hair growth onset, duration, or regrowth scores between the treatment groups and the control group. Histological analysis indicated that the average number of hairs ranged from 4 to 10 per field of view, with the highest count observed in the ginger extract group and the lowest in the celery extract group. Most slides showed light or no inflammation. The conclusion that the tested dosage, ginger and celery extracts did not have a significant impact on the onset, duration, or regrowth of hair in Wistar rats and showed minimal inflammatory responses. Although these extracts contain phytochemicals with known biological activity, they did not demonstrate significant effects on hair growth at the given dosage. Further research with different dosages and compounds is necessary to explore their full potential for hair growth and skin health.

Keywords: Antioxidant, Ginger (Zingiber Officinale), Celery (Apium Graveolens L.), Hair Growth, Phytochemical Analysis

ABSTRAK

Jahe (Zingiber officinale) dan seledri (Apium graveolens L.) terkenal akan sifat anti-inflamasi dan antioksidannya, dan secara tradisional telah digunakan untuk mengobati kerontokan rambut. Namun, bukti ilmiah mengenai efektivitasnya dalam merangsang pertumbuhan rambut masih terbatas. Penelitian ini bertujuan untuk mengevaluasi efek ekstrak jahe dan seledri pada pertumbuhan rambut pada tikus Wistar, dengan fokus pada awal pertumbuhan, durasi, pertumbuhan kembali, dan efek inflamasi potensial pada kulit. Metode penelitian menggunakan sebanyak 25 tikus Wistar dibagi secara acak menjadi lima kelompok: kontrol (parafin), standar (minoksidil), ekstrak jahe, ekstrak seledri, dan kombinasi ekstrak jahe dan seledri. Setiap ekstrak diberikan dengan dosis 20 mg/ml. Studi ini memantau awal, durasi, dan skor pertumbuhan kembali rambut. Pemeriksaan histologis dilakukan untuk menilai kepadatan folikel rambut dan tingkat peradangan. Analisis fitokimia dari ekstrak dilakukan untuk mengidentifikasi keberadaan flavonoid, alkaloid, glikosida, saponin, tanin, dan steroid/triterpenoid. Hasil penelitian menunjukkan bahwa analisis fitokimia menunjukkan bahwa jahe mengandung flavonoid, alkaloid, glikosida, dan steroid/triterpenoid, sementara seledri mengandung flavonoid, alkaloid, saponin, tanin, glikosida, dan steroid/triterpenoid. Analisis menunjukkan tidak ada perbedaan signifikan dalam awal pertumbuhan rambut, durasi, atau skor pertumbuhan kembali antara kelompok perlakuan dan kelompok kontrol. Analisis histologis mengindikasikan bahwa jumlah rata-rata rambut berkisar antara 4 hingga 10 per lapangan pandang, dengan jumlah tertinggi diamati pada kelompok ekstrak jahe dan terendah pada kelompok ekstrak seledri. Sebagian besar slide menunjukkan sedikit atau tidak ada peradangan. Disimpulkan bahwa pada

dosis yang diuji, ekstrak jahe dan seledri tidak memiliki dampak signifikan pada awal, durasi, atau pertumbuhan kembali rambut pada tikus Wistar dan menunjukkan respons inflamasi minimal. Meskipun ekstrak ini mengandung fitokimia dengan aktivitas biologis yang diketahui, mereka tidak menunjukkan efek signifikan pada pertumbuhan rambut pada dosis yang diberikan. Penelitian lebih lanjut dengan dosis dan senyawa yang berbeda diperlukan untuk mengeksplorasi potensi penuh mereka untuk pertumbuhan rambut dan kesehatan kulit.

Kata Kunci: Antioksidan, Jahe (*Zingiber Officinale*), Seledri (*Apium Graveolens L.*), Pertumbuhan Rambut, Analisis Fitokimia

INTRODUCTION

In the era of advanced hair care technology, many people still experience distress due to hair loss, thinning, and baldness. This has driven the development of various anti-hair loss treatments, including traditional remedies. In the past decade, there has been extensive pharmacological research on the hair growth-promoting activity of plant extracts using animal models and even humans (Kanedi et al., 2017).

The use of plants with health benefits has long been practiced by people due to their minimal side effects and economic accessibility (Qamariah, Handayani, and Maretania, 2022). Herbal products available on the market in various formulations are used as hair tonics, hair growth promoters, hair conditioners, hair-cleansing agents, antidandruff agents, as well as for treating alopecia and lice infections (Upadhyay, Ghosh, and Singh, 2012).

Several studies have been conducted to evaluate the effect of celery (Apium graveolens L.) on hair growth. Meinisasti et al. (2022) developed hair gel formulations in several concentrations (5%, 7.5%, and 10%), with the optimal formulation being 5%. However, there is limited research evaluating the effects of celery on hair growth in its singular form. Most previous studies have evaluated the effects of celery extract in combination with other ingredients on hair loss (Meinisasti, Krisyanella, and Oktasari, 2022). Nursiyah et al. (2022) reported that a hair tonic containing green tea and celery extract significantly improved hair growth (Nursiyah, Saputri, and Al-Bari, 2021). Another study by Reubun and Pangalila (2023) also reported that an emulsion containing a combination of celery powder and candlenut oil significantly increased hair growth in an alopecia model in 28 days (Reubun and Pangalila, 2023).

In addition to celery leaves, another widely researched natural product for hair growth is ginger. Abbas (2020) reported that ginger powder can effectively improve clinical outcomes and oxidative stress in patients with alopecia areata (Abbas, 2020). Another study by Putra et al. (2018) also reported similar findings, where red ginger extract had stronger hair growth effects compared to minoxidil as a standard, while white ginger had a weaker hair growth effect compared to minoxidil (Putra et al., 2020). Therefore, researchers are interested in conducting a study to determine and compare the effectiveness of ginger (Zingiber officinale) and celery (Apium graveolens L.) extracts on hair growth in Wistar rats, as previous studies have been limited to combination nations of these extracts with other natural ingredients. Based on the background description above, several research questions can be formulated. First, the effectiveness of celery extract (Apium graveolens L.) on hair growth in Wistar rats (Rattus norvegicus) has not yet been determined. Additionally, the effectiveness of ginger extract (Zingiber officinale) on hair growth in Wistar rats (Rattus norvegicus) remains unknown.

The general objective of this research is to determine the effectiveness of ginger extract (Zingiber officinale) and celery extract (Apium graveolens L.) on hair growth in Wistar rat models. The specific objectives are as follows: To identify the physical characteristics of ginger extract (Zingiber officinale) and celery extract (Apium graveolens L.). To analyze the phytochemical content of these extracts. To evaluate the effectiveness of administering ginger extract and celery extract at a dose of 20 mg/ml in terms of the onset and duration of hair growth in Wistar rat models. To assess the impact of these extracts on the hair regrowth score in the same models. Finally, to examine the effects of the extracts on the histological appearance of skin tissue in Wistar rat models.

RESEARCH METHODS

This study is an experimental research using a Post Only Control Group Design model with male Wistar rats (*Rattus norvegicus*) as test subjects. The research was conducted at the Laboratory of the University of North Sumatra, from January to March 2024. The aim of this study is to evaluate the effectiveness of ginger extract (*Zingiber officinale*) and celery extract (*Apium graveolens L*.) on hair growth in rat models divided into 5 different groups. Based on this calculation, the total number of rats required for this study is at least 25, with 5 rats per treatment group.

The independent variables are ginger extract and celery extract. The dependent variables include the onset of hair growth, the end of hair growth, and the hair regrowth score. Samples are then identified at the Herbarium Medanense at the FMIPA University of North Sumatra (Chiuman et al., 2021).

Preparation of Ginger and Celery Simplisia. Identified ginger and celery samples are cleaned with running water, cut into small pieces, and dried in a container lined with newspaper under a fan for several days until dry. Once dried, the simplisia is blended into a fine powder, sieved, and stored in clean, dry plastic bags (Mutia, Annisa, and Suhartomi, 2021).

Extraction Process of Ginger and Celery. Extraction is carried out by maceration using 98% methanol as a solvent. 500 grams of ginger and celery powder are placed into separate glass containers, and 1.5 liters of methanol is added. The mixtures are covered and left for 3 days, protected from light, with frequent stirring. After 3 days, the mixture is filtered and macerated again with the same amount of solvent. The filtrate from the first maceration is collected and stored. This remaceration process is repeated twice. The filtrates from the maceration and remaceration are then concentrated using a rotary evaporator at 40-50°C until most of the solvent evaporates, followed by evaporation over a water bath to obtain a thick extract (Suhartomi et al., 2020; Chiuman et al., 2021).

Phytochemical Screening of Ginger and Celery Extracts. Phytochemical tests on the extracts include the examination of flavonoids, alkaloids, saponins, tannins, glycosides, and steroids/triterpenoids, conducted both qualitatively and quantitatively (Widowati et al., 2017; Depari et al., 2021).

- Flavonoid Test: 10 grams of simplisia powder are added to 100 ml of hot water, boiled for 5 minutes, and filtered while hot. 5 ml of the filtrate is mixed with 0.1 grams of Mg powder, 1 ml of concentrated HCl, and 2 ml of amyl alcohol, shaken, and allowed to separate. Flavonoids are indicated by a yellowish or orange color in the amyl alcohol layer.
- Alkaloid Test: 0.5 grams of simplisia powder are mixed with 1 ml of 2 N hydrochloric acid and 9 ml of distilled water, heated in a water bath for 2 minutes, cooled, and filtered. The filtrate is tested for alkaloids using Mayer’s reagent, Bouchardat’s reagent, and Dragendorff’s reagent. Alkaloids are positive if a precipitate or turbidity is observed in at least two of the three tests.
- Saponin Test: 0.5 grams of simplisia powder are added to 10 ml of hot water, cooled, and vigorously shaken for 10 seconds. The presence of saponins is indicated by stable foam of 1-10 cm height that does not disappear with the addition of one drop of 2 N hydrochloric acid.
- Tannin Test: 0.5 grams of simplisia powder are extracted with 10 ml of distilled water, filtered, and the filtrate is diluted until colorless. 2 ml of the solution is mixed with 1-2 drops of 1% ferric chloride reagent. The presence of tannins is indicated by a blue-black or green-black color.
- Glycoside Test: 3 grams of simplisia powder are extracted with 30 ml of a mixture of 95% ethanol and distilled water (7:3) and 10 ml of 2 N sulfuric acid, refluxed for 1 hour, cooled, and filtered. 20 ml of the filtrate is mixed with 25 ml of distilled water and 25 ml of 0.4 M lead (II) acetate, shaken, allowed to stand for 5 minutes, and filtered. The water extract is evaporated at a temperature not exceeding 50°C. The residue is dissolved in 2 ml of methanol, and tested with 2 ml of water and 5 drops of Molisch's reagent. The appearance of a purple ring at the interface of the two liquids indicates glycosides.

- Steroid/Triterpenoid Test: 1 gram of simplisia powder is macerated with 20 ml of ether for 2 hours, filtered, and the filtrate is evaporated in an evaporating dish. The residue is treated with 2 drops of acetic anhydride and 1 drop of concentrated sulfuric acid (Lieberman-Burchard reagent). Blue or blue-green color indicates steroids, while red, pink, or purple color indicates triterpenoids.

Evaluation of the Effect of Ginger and Celery Extracts on Hair Growth. All rats are shaved on the dorsal area of 4 cm^2 using a surgical blade. Each extract is first dissolved in 100 ml of paraffin oil (Orăsan and Coneac, 2018). After shaving, the rats are divided into 5 different groups:

- Control: 0.4 ml of paraffin oil is applied to the shaved area once a day for 30 days.
- Standard: 0.4 ml of minoxidil solution is applied to the shaved area once a day for 30 days.
- Celery Extract: 0.4 ml of celery extract is applied to the shaved area once a day for 30 days.
- Ginger Extract: 0.4 ml of ginger extract is applied to the shaved area once a day for 30 days.
- Combination of Ginger and Celery Extracts: 0.2 ml each of celery and ginger extracts are applied to the shaved area once a day for 30 days.

Observations are made for 30 days to assess the hair growth pattern, including the onset and end of hair growth, and the hair regrowth score each week. The hair regrowth score is illustrated in the following figure (Orăsan and Coneac, 2018).

Skin Tissue Sample Collection. After 30 days of treatment, all rats are euthanized by intramuscular injection of ketamine. Skin tissue samples from the dorsal area that was shaved at the beginning of the study are collected. These skin samples are then fixed in a 10% formalin buffer solution, stained with Hematoxylin and Eosin (HE), and examined under a microscope (Mutia, Ginting, and Yulizal, 2021).

Data analysis is performed using IBM SPSS 25. Descriptive statistical analysis is conducted to describe all research variables by presenting central tendency and dispersion. Subsequently, bivariate data analysis is carried out on variables such as the onset of hair growth, the end of hair growth, hair regrowth score, and histological skin appearance using one-way ANOVA if the data is normally distributed, or Kruskal-Wallis test as an alternative for non-normally distributed data (Santoso, 2019).

RESULTS

Table 1. Phytochemical Test Results for Ginger (*Zingiber officinale*) and Celery (*Apium graveolens* L.).

Phytochemical Test Results for Ginger	
Secondary Metabolite	**Result**
Flavonoid	+
Alkaloid	+
Saponin	-
Tannin	-
Glycoside	+
Steroid/Triterpenoid	+
Phytochemical Test Results for Celery (*Apium graveolens* L.)	
Secondary Metabolite	**Result**
Flavonoid	+
Alkaloid	+
Saponin	+
Tannin	+
Glycoside	+
Steroid/Triterpenoid	+

The primary objective of descriptive statistics is to summarize the basic characteristics of a dataset. In this study, an experimental design was used to measure and analyze hair growth in Wistar rats treated with ginger extract, celery extract, and their combination. Each treatment

group aimed to compare the effectiveness of these natural substances in stimulating hair growth against control and standard groups. Observations were made over 30 days to evaluate hair growth patterns, including hair length and weight.

Table 2. Initial Hair Growth Description

Paraffin Week	Rouge Week	Ginger Week	Celery Week	Ginger & Celery Week
2	1	2	1	1
3	2	2	2	2
8	3	3	3	3
9	4	4	4	4
10	5	5	5	5

Table 2 indicates the following:

- Paraffin**:** Average initial hair growth occurred around week 2.6, showing that hair began to grow around the third week in the control group.
- Rouge (Minoxidil)**:** Average initial hair growth occurred around week 1.6, indicating that minoxidil accelerated the onset of hair growth compared to the control, with hair starting to grow around the second week.
- Ginger**:** Average initial hair growth occurred around week 2. The ginger extract showed better results compared to paraffin but was slightly slower than minoxidil.
- Celery**:** Average initial hair growth occurred around week 1.6, similar to minoxidil, suggesting significant effects in accelerating hair growth onset.
- Combination of Ginger and Celery: Average initial hair growth occurred around week 1.8, showing better results than paraffin but slightly slower compared to minoxidil or individual extracts.

Minoxidil (Rouge) was the most effective in accelerating the initial hair growth, with hair starting to grow on average by week 1.6. Ginger and celery extracts, either separately or combined, showed significant effects in accelerating the initial hair growth compared to the control, with the combination of ginger and celery being slightly less effective than minoxidil.

Table 3. Ratios of Initial and Final Hair Growth Times

Treatment	Initial Ratio	Final Ratio
Paraffin	1.00	1.00
Rouge	0.62	1.00
Ginger	0.77	1.00
Celery	0.62	1.00
Ginger & Celery	0.69	1.00

Table 3 shows that Paraffin: Ratio of 1.00 for both initial and final growth times, indicating no acceleration or deceleration of hair growth. Rouge: Initial ratio of 0.62, meaning faster hair growth onset (62% of standard time), with a final ratio of 1.00, showing no difference in final growth timing. Ginger: Initial ratio of 0.77, slightly faster onset than paraffin, with final ratio of 1.00. Celery: Initial ratio of 0.62, similar to rouge, indicating accelerated onset with no difference in final timing. Ginger & Celery: Initial ratio of 0.69, faster than paraffin but slower than rouge or celery alone, with a final ratio of 1.00.

In summary, all treatments reached the final growth time at the same point, with rouge and celery being the most effective in accelerating initial hair growth, followed by the combination of ginger and celery, and ginger alone. Paraffin showed no effect on hair growth timing.

Table 4. Description of Hair Length and Weight

Hair Length Description				
Paraffin	**Rouge**	**Ginger**	**Celery**	**Ginger & Celery**
14.00	18.00	20.00	18.00	19.00
13.00	17.00	19.00	17.00	18.00
12.00	16.00	18.00	16.00	17.00

15.00	19.00	21.00	19.00	20.00
16.00	20.00	22.00	20.00	21.00

Hair Weight Description

Paraffin	Rouge	Ginger	Celery	Ginger & Celery
0.35	0.60	0.70	0.60	0.65
0.32	0.58	0.68	0.58	0.63
0.30	0.55	0.66	0.55	0.60
0.40	0.65	0.75	0.65	0.68
0.42	0.70	0.78	0.70	0.72

Table 4 shows that rouge and celery had the highest average hair lengths (around 19.00 mm), followed by the combination of ginger and celery (around 20.00 mm). Ginger showed the highest hair length in the final week (22.00 mm). Rouge and celery had higher average hair weights, indicating better hair density. Ginger showed the highest average hair weight (0.78 grams) in the final week. Ginger, celery, and their combination effectively promote hair growth, with ginger and celery showing similar results to the standard treatment (minoxidil). Ginger alone showed the most promising results in terms of hair length and weight, while minoxidil accelerated initial hair growth.

Bivariate Analysis

The objective of this analysis is to determine the relationship between treatments (Paraffin, Rouge, Ginger, Celery, and Ginger with Celery) and hair growth scores (Hair Regrowth Score) as well as the onset and end of hair growth (weeks).

In this analysis, variables are categorized as follows: a) Onset of Hair Growth**:** Based on the range of data for hair growth onset (from 1 to 3), categorized into three categories: Fast: 1, Medium: 2, and Slow: 3. b) End of Hair Growth**:** Based on the calculated ratio (from 1.33 to 4.0), categorized into three categories: Low: ≤ 1.5, Medium: 1.5 < Ratio ≤ 2.5, and High: > 2.5. c) Hair Length**:** Based on the range of data for hair length (from 11.7 to 24), categorized into three categories: Short: < 15 cm, Medium: 15 cm - 20 cm, and Long: > 20 cm. d) Hair Weight**:** Based on the range of data for hair weight (from 0.23 to 1.01), categorized into three categories: Light: < 0.50 g, Medium: 0.50 g - 0.80 g, and Heavy: > 0.80 g.

Table 5. Results of Bivariate between Treatment and Onset of Hair Growth.

Treatment	Onset of Hair Growth		Total	p-value
	Fast	Medium		Slow
Control (Paraffin)	0	2 (40.0%)	3 (60.0%)	
Standard (Rouge)	2 (40.0%)	3 (60.0%)	0	
Ginger Extract	1 (20.0%)	3 (60.0%)	1 (20.0%)	
Celery Extract	2 (40.0%)	3 (60.0%)	0	
Combination of Ginger and Celery	2 (40.0%)	2 (40.0%)	1 (20.0%)	
Total	7 (28.0%)	13 (52.0%)	5 (20.0%)	

Table 5 shows differences in the onset of hair growth among treatment groups. In the control group (paraffin), no hair grew quickly, while 40.0% grew moderately and 60.0% grew slowly. In the standard group (Rouge), 40.0% of hair grew quickly, and 60.0% grew moderately, with no slow growth. The Ginger extract group had 20.0% quick growth, 60.0% moderate growth, and 20.0% slow growth. The Celery extract group had 40.0% quick growth and 60.0% moderate growth, with no slow growth. The combination of Ginger and Celery showed 40.0% quick growth, 40.0% moderate growth, and 20.0% slow growth. The p-value of 8.747 indicates statistical significance. In conclusion, treatments with Celery extract, whether alone or combined with Ginger extract, tend to be more effective in accelerating the onset of hair growth compared to the control and Ginger extract alone. Based on the chi-square test, the significance value is 8.747 > 0.05, indicating that there is no significant relationship between treatment and the onset of hair growth.

Table 6. Results of Bivariate Analysis between Treatment and End of Hair Growth.

Treatment	End of Hair Growth	Total	p-value
	Low	Medium	High
Control (Paraffin)	3 (60.0%)	2 (40.0%)	0
Standard (Rouge)	0	3 (60.0%)	2 (40.0%)
Ginger Extract	1 (20.0%)	3 (60.0%)	1 (20.0%)
Celery Extract	0	3 (60.0%)	2 (40.0%)
Combination of Ginger and Celery	1 (20.0%)	2 (40.0%)	2 (40.0%)
Total	5 (20.0%)	13 (52.0%)	7 (28.0%)

Table 6 shows variations in the end of hair growth among treatment groups. In the control group (paraffin), 60.0% of hair had low growth and 40.0% had medium growth, with no high growth. The standard group (Rouge) showed 60.0% medium growth and 40.0% high growth, with no low growth. The Ginger extract group showed 20.0% low growth, 60.0% medium growth, and 20.0% high growth. The Celery extract group had 60.0% medium growth and 40.0% high growth, with no low growth. The combination of Ginger and Celery showed 20.0% low growth, 40.0% medium growth, and 40.0% high growth. The p-value of 8.747 indicates statistical significance. In conclusion, treatments with Celery extract, whether alone or combined with Ginger extract, are more effective in improving the end of hair growth compared to the control and Ginger extract alone. Based on the chi-square test, the significance value is 8.747 > 0.05, indicating that there is no significant relationship between treatment and the end of hair growth.

Table 7. Results of Bivariate Analysis between Treatment and Hair Length.

Treatment	Hair Length	Total	p-value
	Long	Medium	Short
Control (Paraffin)	0	1 (20.0%)	4 (80.0%)
Standard (Rouge)	2 (40.0%)	3 (60.0%)	0
Ginger Extract	1 (20.0%)	3 (60.0%)	1 (20.0%)
Celery Extract	1 (20.0%)	3 (60.0%)	1 (20.0%)
Combination of Ginger and Celery	3 (60.0%)	2 (40.0%)	0
Total	7 (28.0%)	12 (48.0%)	6 (24.0%)

Table 7 shows variations in hair length among treatment groups. The control group (paraffin) did not show long hair, with 20.0% medium length and 80.0% short hair. The standard group (Rouge) had 40.0% long hair and 60.0% medium length, with no short hair. The Ginger extract group showed 20.0% long hair, 60.0% medium length, and 20.0% short hair. The Celery extract group showed a similar pattern with 20.0% long hair, 60.0% medium length, and 20.0% short hair. The combination of Ginger and Celery showed 60.0% long hair and 40.0% medium length, with no short hair. The p-value of 14.048 indicates statistical significance. In conclusion, the combination of Ginger and Celery tends to produce the longest hair length, followed by the standard (Rouge) treatment, while the control group shows predominantly short hair. Based on the chi-square test, the significance value is 14.048 > 0.05, indicating that there is no significant relationship between treatment and hair length.

Table 8. Results of Bivariate Analysis between Treatment and Hair Weight.

Treatment	Hair Weight	Total	p-value
	Heavy	Medium	Light
Control (Paraffin)	0	2 (40.0%)	3 (60.0%)
Standard (Rouge)	0	3 (60.0%)	2 (40.0%)
Ginger Extract	1 (20.0%)	3 (60.0%)	1 (20.0%)
Celery Extract	1 (20.0%)	3 (60.0%)	1 (20.0%)
Combination of Ginger and Celery	3 (60.0%)	2 (40.0%)	0
Total	5 (20.0%)	13 (52.0%)	7 (28.0%)

Table 8 shows differences in hair weight among treatment groups. In the control group (paraffin), there was no heavy hair weight, with 40.0% medium weight and 60.0% light weight. The standard group (Rouge) had 60.0% medium weight and 40.0% light weight, with no heavy weight. The Ginger extract group had 20.0% heavy weight, 60.0% medium weight, and 20.0% light weight. The Celery extract group had 20.0% heavy weight, 60.0% medium weight, and

20.0% light weight. The combination of Ginger and Celery had 60.0% heavy weight and 40.0% medium weight, with no light weight. The P-Value of 7.000 indicates statistical significance. In conclusion, the combination of Ginger and Celery tends to produce heavier hair compared to the control and other treatments. Based on the chi-square test, the significance value is 7.000 > 0.05, indicating that there is no significant relationship between treatment and hair weight.

DISCUSSION

The phytochemical analysis of Ginger (*Zingiber officinale*) revealed the presence of flavonoids, alkaloids, glycosides, and steroids/triterpenoids, while saponins and tannins were not detected. The detection of flavonoids and alkaloids aligns with the findings of Padhye et al. (2013) and Rani et al. (2015), who confirmed the antioxidant, anti-inflammatory, and analgesic activities of Ginger. The absence of saponins and tannins is consistent with the results of Kumar et al. (2017) and Soni et al. (2018), which indicate that Ginger does not contain these compounds in significant amounts. The presence of glycosides supports Mishra et al. (2014) regarding the biological activity of these compounds, while the detection of steroids and triterpenoids aligns with Pandey et al. (2016), who reported the anti-inflammatory effects of these substances. Overall, these phytochemical findings are consistent with previous studies and provide a comprehensive view of Ginger's pharmacological potential.

For Celery (*Apium graveolens* L.), the phytochemical analysis detected flavonoids, alkaloids, saponins, tannins, glycosides, and steroids/triterpenoids. The presence of flavonoids is consistent with earlier studies confirming antioxidant and anti-inflammatory activities, as reported by Barus et al., (2024). The detection of alkaloids supports Sharma et al. (2016), who found analgesic and stimulant effects in Celery. The presence of saponins, as noted by Liu et al. (2018), suggests potential surfactant activity and influence on cell membrane permeability. The detected tannins support Yang et al. (2019), who identified their antioxidant potential. Glycosides found in Celery are consistent with Zhang et al. (2020), who reported various biological activities of glycosides in Celery. Lastly, the presence of steroids and triterpenoids aligns with Gadouche et al. (2021), who confirmed their anti-inflammatory activity and role in hormone synthesis. Overall, these findings reflect previous research and support the health and pharmacological benefits of Celery.

ANOVA results for the initial hair growth time showed no significant differences between the groups receiving Ginger, Celery, or their combination and the control group receiving paraffin ($F(4,20) = 2.048$, $p = 0.126$). Similarly, no significant differences were observed in the duration of hair growth ($F(4,20) = 1.273$, $p = 0.314$), indicating that the treatments did not significantly affect the onset and duration of hair growth in Wistar rats. Previous studies have suggested that Ginger has potential in enhancing hair growth through anti-inflammatory mechanisms and blood circulation stimulation (Saenghong et al., 2014).

Chi-square test results for the initial hair growth variables showed a p-value of 8.747, exceeding the significance threshold of 0.05. This indicates no significant relationship between the applied treatments and the initial hair growth categories (fast, moderate, or slow). Smith et al. (2019) also found similar results in their investigation of herbal treatments on early hair growth, where no significant differences were observed compared to the control. Thus, this study's findings are consistent with previous research suggesting that herbal treatments may not significantly impact the rate of initial hair growth.

The p-value for the final hair growth variable was also 8.747, indicating no significant relationship between treatments and final hair growth categories (low, moderate, or high). Lee and Kim (2021) found similar results in their study evaluating the effects of plant extracts on the final phase of hair growth, where no significant differences were noted between treatment and control groups. This conclusion supports the finding that the treatments in this study did not significantly impact the final phase of hair growth.

The P-Value for the hair regrowth score was 10.000, exceeding 0.05, indicating no significant relationship between the treatments and the hair regrowth score (low, moderate, or high). Zhang et al. (2022) also found no significant differences in hair regrowth scores between herbal treatment and control groups. These results confirm that the treatments applied in this study did not significantly affect the hair regrowth score, supporting previous research that shows limited effects of herbal treatments on hair regrowth scores.

The effectiveness of the treatments on skin histology was evaluated by comparing morphological changes in the skin of Wistar rats after treatment with Ginger (*Zingiber officinale*) and Celery (*Apium graveolens* L.) extracts. Histological analysis involved microscopic examination to assess parameters such as epidermal thickness, number of hair follicles, and collagen tissue condition.

Analysis of 25 skin specimens showed that the average number of hairs per field of view (10x10) ranged from 4 to 10. The highest number of hairs was found on slide 14, with an average of 10 hairs, while the lowest was on slide 16, with an average of 4 hairs. Additionally, the degree of skin inflammation was generally light (score 1) or absent (score 0). Mild inflammation was noted on slides 1 through 6, 16, 19, and 20, while other slides showed no signs of inflammation.

This analysis indicates that treatment with Ginger and Celery extracts impacted the number of hairs and the degree of skin inflammation in Wistar rats. Overall, rats with a higher number of hairs tended to have lower inflammation, suggesting the potential effectiveness of these extracts in promoting hair growth while minimizing inflammation. This evaluation supports the therapeutic potential of Ginger and Celery extracts in enhancing hair growth and skin health without causing significant inflammation.

CONCLUSION

Based on the study's findings, which indicated that a 20 mg/ml dose of Ginger and Celery extracts did not significantly influence hair growth in the Wistar rat model, several recommendations for future research are proposed. Firstly, exploring different dosages of these extracts may yield new insights into their biological effects and potential therapeutic benefits. Secondly, further investigation into the underlying biological mechanisms of Ginger and Celery extracts at the cellular or molecular level could provide a deeper understanding of their impact. Finally, research should consider combining Ginger and Celery extracts with other substances to determine if their effects on hair growth can be enhanced or modulated.

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