Medical Sains : Jurnal Ilmiah Kefarmasian
Vol. 9 No. 4, October - December 2024
https:/ojs.ummada.ac.id/index.php/iojs

EFFECT OF HAIR TONIC COMBINATION OF CINNAMOMUN ESSENSIAL OIL AND CANDLENUT ESSENSIAL OIL HAIR GROWTH IN VIVO

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Submitted: September 06, 2024 Revised: October 04, 2024 Accepted: October 12, 2024

ABSTRACT

Hair loss, often called alopecia, is characterized by excessive hair loss. One way to treat hair loss is to use hair tonic preparation. This study aimed to determine the effect of a combination of hair tonic cinnamon essential oil and candlenut essential oil on hair growth. The research method used included physical evaluation of the hair tonic preparation formulation by examining the physical quality, homogeneity, pH, viscosity, and stability of the hair tonic preparation. The effectiveness of hair growth was evaluated in vivo in rabbits. Its effectiveness measures hair growth and weight. Based on the results of the tests on the physical characteristics and physical stability of the hair tonic preparation, a combination of cinnamon essential oil and candlenut essential oil at concentrations of 0% (F0), 2.5% (F1), 5% (F2), and 7.5% (F3) was used. in organoleptic testing, the homogeneity, pH, and viscosity met the specified characteristics and stability requirements. The results of research testing the effectiveness of hair growth showed that the hair tonic combination of cinnamon essential oil and candlenut essential oil is effective for good hair growth in formula 3, with a hair length of 8 mm and a hair mass of 213.8 mg on day 21.

Keywords: Candlenut essential oil, Cinnamon essential oil, Hair growth, Hair tonic, In vivo

INTRODUCTION

Hair loss is a serious problem for both men and women. A survey conducted by Karirtiasih (2011) showed that in Indonesia, 36% of women experienced hair loss and 18% of men experienced hair loss. According to Esse *et al.* (2021), an average of 50–100 hairs are lost per day owing to hair loss, but almost all the hair that falls it grows back and is replaced by new hair. However, if more than 100 hairs are lost per day, it will continue to grow, which is a sign of unhealthy hair. According to the World Health Organization (WHO, 2019), immune disorders can trigger hair loss, which ultimately causes baldness. Baldness can appear at any time, either at a young age or during adulthood. The risk of baldness is higher if there is a family history of hair loss or baldness. These factors can lead to hair growth failure (Sari *et al.*, 2016). Therefore, proper hair care is needed for hair growth and maintenance of hair health, one of which is the use of cosmetic products. Hair care cosmetic products often used as hair fertilizers are hair tonics (Sayuti *et al*., 2015).

Hair tonic is a cosmetic preparation in the form of a liquid and has a combination of ingredients, such as chemical compounds and natural ingredients, that will help strengthen and develop further and maintain healthy hair (Yuniastri, 2020). The natural ingredients that can be used to stimulate hair growth are cinnamon essential oil (Indriana *et al*., 2018) and candlenut essential oil (Miftahurahma *et al.*, 2023).

Cinnamon essential oil is effective in increasing hair length and thickening (Muhammud et al., 2014). Research conducted by Indriana *et al*., (2018)reported that the use of cinnamon essential oil containing Cinnamaldehyde can increase blood flow by dilating

blood vessels to replenish nutrients and oxygen from the hair roots and accelerate hair growth (Indriana *et al*., 2018)

Candlenut essential oil is beneficial for hair growth. Based on the research conducted by Shoviantari *et al*. (2019), candlenut essential oil can accelerate hair growth and thickness. In a study by Almas *et al.* (2022), candlenut essential oil accelerated hair growth on 21 days and hair length of 1.35 mm. Research conducted by Laka et al. (2021) showed that candlenut essential oil can accelerate hair growth in white rabbits.

Research on the effectiveness of cinnamon (Cinnamomum burmanii) and candlenut (Aleurites mollucana) essential oils on hair growth on the backs of rabbits (*Oryctolagus cunicus*). Hair growth was determined in vivo using white rabbits because they have a larger surface area, which makes it easier to apply hair tonic preparations.

RESEARCH METHODS

Tools

The tools used in this research were analytical scales (DURASCALE model DAB-E223), measuring cups (Herma, Indonesia), glass beakers (Iwaki, Thailand), glass funnels (Iwaki, Indonesia), test tubes (Iwaki, Thailand), a pH meter (EUTECH Instrument), and an Ostwald Viscometer (Pyrex).

Materials

Cinnamon essential oil (*Cinnamomun burnamii*), candlenut essential oil (*Aleurites mollucana*), propylene glycol (Nirvana Kimia), 96% alcohol, and sodium metabisulfite (PT Sumber Ilmiah Persada).

Work procedures

Test formula

The hair tonic formulation used was based on the literature taken from research by Bunga and Meliala (2022). The test formula in this research is shown in **Table I**.

Table I. Formulation of Hair Tonic Essential Oil Cinnamon and Candlenut Oil

Material Name	F1 (%)	F2 (%)	F3 (%)
Ciinamomun Essesial Oil	2,5	5	7,5
Candlenut Essensial Oil	2,5	5	7,5
Propylene glycol	10	10	10
Natruim Metabisulfite	0,01	0,01	0,01
Alcohol 96%	25	25	25
Aquadest	Ad 300	Ad 300	Ad 300

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Preparation of Hair Tonic

Cinnamon and candlenut essential oils at concentrations of 2.5%, 5%, and 7.5% were dissolved in 96% ethanol, followed by the addition of propylene glycol, sodium metabisut, and distilled water. Distilled water was added to a volume of 300 mL and stirred until homogeneous. The preparation was then put into a calibrated container (Bunga & Meliala, 2022).

Organoleptic Test

Organoleptic tests are performed by observing the color, aroma, and shape of the preparation (Radani *et al.*, 2022).

pH check

The pH was measured using a calibrated pH meter by immersing the electrode in a solution until the pH was correct (Apriani *et al.*, 2021).

Homogeneity Test

The homogeneity test was carried out by taking a small amount of the preparation and placing a small amount of the preparation on both glass objects. Coarse and inhomogeneous particle arrangements have been observed (Ambari *et al*., 2020).

Viscosity Measurement

The viscosity tests were performed using an Ostwald viscometer. Viscosity measurement was performed by introducing liquid into an Ostwald viscometer up to the specified limit and recording the flow time from the upper limit mark to the lower limit mark using a close watch. The hair tonic is added to the Ostwald viscometer until the specified limit, the time recorded when the hair conditioner spray flows from the upper limit mark to the lower limit mark, using a watch, and the calculation is as follows (Heroweti *et al*., 2023)

Stability Test (Real Time)

Hair tonic preparations were tested for stability by focusing on changes in color, shape, odor, homogeneity, pH, and viscosity. Hair tonic formulations of 100 ml each are placed at room temperature 30°C ± 2°C RH 75% ± 5% (ASEAN, 2019). Observations were carried out for 3 months on days 0, 7, 60, and 90. Then observations are carried out such as organoleptic tests, homogeneity tests, pH tests, viscosity tests (Indriyani & Endrawati, 2021)

Hair Growth Effectiveness Test

The Chairman of the Ethics Commission of Ahmad Dahlan University approved the experimental procedure in this study (number 022402011). A hair growth effectiveness test was performed in vivo in rabbits. Four New Zealand rabbits used were 4 the Zealand study. The inclusion criteria were male sex, body weight ranging from 1,8 to 2,5 kg, being healthy, not disabled, not having skin diseases, and not being seriously injured. In the hair growth effectiveness test, the hair on the back of each rabbit was shaved. then divided into 6 areas with each box measuring 5 cm (2.5 cm x 2.5 cm) and a distance of ± 1 cm between one area and another. The rabbit was then left for 24 hours. After that, the test material was applied (1 ml volume) once a day for 21 days on the test area by taking 5 strands of rabbit hair every 7 days, namely day 7, day 14 and day 21. The first day of application to rabbits was considered day 0. Rabbit hair was taken by plucking it using tweezers, straightening it, placing it on a dark base, taping it, and measuring it using a caliper (Aini, 2017). Based on Morgan et al., (2023) on average hair can grow between 0.1 – 0.3 mm per day.and Rabbit Hair mass test Measurement of the hair thickness of white rabbits was carried out on the 21st day by shaving all the hair in each area tested and then weighing it using a digital scale (Aini, 2017).

Treatment Group

Each part was treated as follows:

1) Region I: normal control group, namely the group that was not given anything.
2) Region II: Negative control group, namely the group administered preparations with an active substance concentration of 0%.
3) Region III: Positive control group, namely the group given a hair tonic (Mirlank hair tonic).
4) Region IV: FI group, namely the group administered hair tonic preparations with an active substance concentration of 2.5%.
5) Region V: FII Group, namely the group given hair tonic preparations with an active substance concentration of 5%.
6) Region VI: Group FIII, namely the group administered hair tonic preparations with an active substance concentration of 7.5%.

Data analysis

The organoleptic test, descriptive consistency, pH, viscosity, and hair mass were analyzed using SPSS *One Way ANOVA* software, and if the data obtained were significantly different, they continued with *Post Hoc Tukey*'s test. However, if the data obtained were not normal, the Kruskal-Wallis test was used. Data for the stability test results were analyzed using the *Reapetead ANOVA* method if the significance value was >0.05.

RESULTS AND DISCUSSION

To determine the effect of the concentration of cinnamon and candlenut essential oils on the physical characteristics, effectiveness of hair growth, and stability of hair tonic preparations. Testing of physical characteristics and stability included organoleptic, homogeneity, pH, and viscosity tests. The hair growth effectiveness test was conducted for 21 days.

Table II. Results of Observation of Physical Characteristics

Observation	Spesificatoin	F0	F1	F2	F3
Organoleptic	Clear light yellow color, characteristic aroma of essential oils, liquid consistenc (Heroweti *et al.*, 2023)	Clear white, unscented, liquid consistency	Clear light yellow color, typical cinnamon+ aroma, liquid consistency	Clear light yellow color, typical cinnamon++ aroma, liquid consistency	Clear light yellow color, typical cinnamon+++ aroma, liquid consistency
Homogeneity	Homogeneous (Hasma *et al.*, 2023)	Homogeneous	Homogeneous	Homogeneous	Homogeneous
pH	4.5- 6.5 pH of the scalp (Muliani *et al.*, 2022) 3-7 pH hair tonic preparation (Koralina *et al.*, 2023)	6,46±0,251	6,31±0,088*	6,27±0,088*	5,80±0,120$^{*,\#,\Delta}$
Viscosity (cP)	< 5 cP (Bunga & Meliala, 2022)	1,90cP±0,040	2.09cP±0,043	2,38cP±0,043*	2,56cP±0,042$^{*,\#}$

Information :

- The pH, viscosity values displayed are the average values ± standard error of the mean
- Sign (+): Indicates the intensity level of the aroma produced
- Sign (*) is a significant difference with F0
- The sign (#) is meaningfully different from F1
- The sign ($^{\Delta}$) is meaningfully different from F2

Organoleptic Characteristics Test

Based on the F0 organoleptic test results of the organoleptic test, it is known that the four formulas, F0, F1, F2, and F3, have the same organoleptic properties, namely liquid consistency, which causes the consistency intensity of the four formulas to be no different. However, there are differences in the aroma and color of the hair tonic preparations, where F0 has a different color. The difference is that in F1, F2, and F3, the results obtained are clear light yellow in color, have a distinctive cinnamon aroma, and have liquid consistency. The light yellow color produced in the preparation comes from the color of the active hair tonic substance which has a light yellow organoleptic color. Organoleptic testing showed that the addition of cinnamon and candlenut essential oils greatly influenced the aroma. The higher the concentrations of cinnamon essential oil and candlenut essential oil, the stronger the aroma of the essential oil in the preparation. The organoleptic test results met the specifications for tonic hair preparation (Heroweti *et al*., 2023). It can be seen in figure 1 of the organoleptic hair tonic F0, F1, F2, and F3.

Figure 1.Organoleptic Hair Tonic F0, F1, F2, and F3

Homogeneity Characteristic Test

Based on **Table II**, the homogeneity test of F0, F1, F2, and F3 shows that the fourth formula has homogeneous physical characteristics. The results obtained indicate that the active substances and excipients can be mixed well or homogeneously (Khaira *et al.*, 2022). In the homogeneity test, none of the hair tonic preparations tested had lumps or precipitation in the solution, because there were no differences in properties between the ingredients and active substances used (Husen *et al.*, 2015). A homogeneous preparation will produce good quality because it shows that the active substance and basic ingredients are evenly mixed. If the active substance is not mixed evenly into the base ingredients, it cannot achieve the desired therapeutic effect (Radani *et al.*, 2022). In this test, it was found that there were no coarse grains during the test, so it could be concluded that the preparation met the specifications.

pH Characteristic Test

The pH characteristics based on the test results are shown in **Table II**. The differences in pH values at F0, F1, F2, and F3 can be influenced by the addition of cinnamon essential oil and candlenut essential oil. When testing the pH of cinnamon essential oil and candlenut essential oil, the acidic pH values were obtained, namely 3.58 (cinnamon essential oil) and 3.48 (candlenut essential oil). This is supported by the statement of Sulhatun *et al.* (2022), which states that candlenut essential oil has a pH value of 3-6 which is acidic. This indicates that cinnamon essential oil and candlenut essential oil can affect the pH of the preparation, the higher the concentration of cinnamon essential oil and candlenut essential oil used, the more the pH of the preparation will decrease. The pH value obtained is said to still be considered safe because it meets the desired normal skin pH specifications, namely 4.5–6.5 (Muliani *et al*., 2022). Based on the statistical analysis using *one-way ANOVA*, it is

known that the values of the three formulas are significantly different in terms of their significance values (<0.05). Tukey's post-hoc test was then performed. The test results showed that all preparations were significantly different, as demonstrated by the significance value (<0.05).

Viscosity Characteristic Test

The results of the viscosity tests are listed in **Table II**. Viscosity increased with each formula. Observation of the viscosity values at F0, F1, F2, and F3 showed that the higher the concentration of essential oil, the higher the viscosity value. The difference in viscosity in the four formulas can be influenced by several factors, including the ingredients used in making hair tonic preparations, one of which is propylene glycol, which can be caused by active substances in the form of essential oils. Propylene glycol can also increase the viscosity of the preparation, the contact time of the product on the skin increases, and the essential oils penetrate the scalp (Darajati & Ambari, 2021). The choice of propylene glycol concentration also affects viscosity, where viscosity increases when using propylene glycol with a concentration of 10%, so that it can produce good viscosity. Even though the viscosity has increased, the preparation still meets the viscosity specifications for hair tonic preparations, namely, <5 cP (Bunga & Meliala, 2022). The more liquid the preparation is, the lower the viscosity value obtained (Musthika & Dewi, 2023). F3 has a high viscosity value due to the addition of 7.5% cinnamon essential oil and candlenut essential oil compared to F1 with 2.5% cinnamon essential oil and candlenut essential oil.

Organoleptic Stability Test

Organoleptic testing was then performed in real-time for 90 days. In the organoleptic stability test for 90 days, there were no visual changes in the four formulas during 90 days of storage. Based on the organoleptic stability results, it was found that the preparation remained stable during storage. The results of the homogeneity stability test showed that F0, F1, F2, and F3 had good homogeneity. This shows that the four formulas have homogeneous physical stability. Homogeneous preparations of F0, F1, F2, and F3 can be seen by observing that all ingredients are mixed well (Fhatonah *et al*., 2023). The results indicate that the active substances and excipients used can be mixed well or homogeneously.

Homogeneity Stability Test

Table III. Results of Homogeneity stability tests

Day to-	Formula			
	F0 (0%)	F1 (2,5%)	F2 (5%)	F3 (7,5%)
0	homogeneous	homogeneous	homogeneous	homogeneous
60	homogeneous	homogeneous	homogeneous	homogeneous
90	homogeneous	homogeneous	homogeneous	homogeneous

Stability testing of the homogeneity of F0, F1, F2, and F3 aimed to determine whether the test preparation was still homogeneous after being stored for 90 days. The results of the homogeneity stability tests, F0, F1, F2, and F3, are listed in **Table III**. In the homogeneity stability test of the hair tonic preparation for 90 days the preparation remained homogeneous and there was no precipitate in the hair tonic preparation.

pH Stability Test

Table IV. Results of pH stability tests

Day to-	Formula			
	F0 (0%)	F1 (2,5%)	F2(5%)	F3 (7,5%)
0	6,46± 0,025	6,31±0,008	6,27±0,008	5,80±0,012
60	6,23±0,008*	6,20±0,014*	6,18±0,015*	5,63±0,015*
90	5,54± 0,008*,#	5,51±0,008*,#	5,23±0,005*,#	4,30±0,017*,#

Information :
- Sign (*) is a significant difference on day 0
- The sign (#) is meaningfully different on day 60

The results of the pH stability test are presented in **Table IV**. In the pH stability test on days 0, 60, and 90, a decrease was observed. The factor that can cause the pH value to decrease slightly between the concentrations of essential oils and other excipients in the preparation is propylene glycol, where the pH of propylene glycol is 3-6 (Rowe, 2020). In addition, changes in pH values during storage due to environmental factors, such as temperature, poor storage, and conditions used to perform other tests, such as opening and closing the lid of the container, the air enters. There are preparations whose pH easily changes because of a decrease in pH due to the influence of CO_2 entry. into the container when the measurement was taken (Bunga and Meliala, 2022). The presence of CO_2 which reacts with air, causes the pH to become acidic (Darajati and Ambari, 2021). Based on statistical analysis using Repeated Anova, the time value in each formula is significantly different in terms of its significance value (>0.05).

Viscosity Stability Test

Table V. Viscosity stability test results

Day to-	Formula			
	F0 (0%)	F1(2,5%)	F2(5%)	F3(7,5%)
0	1,90 cP±0,040	2,09 cP± 0,043	2,38 cP±0,043	2,56 cP±0,042
60	1,42 cP±0,090*	1,66 cP± 0,058*	2,02 cP±0,043*	2,17 cP±0,041*
90	1,36cP±0,087*,#	1,59 cP± 0,040*,#	1,95 cP±0,040*,#	2,09 cP±0,025*,#

Information :
- Sign (*) is a significant difference on day 0
- The sign (#) is meaningfully different on day 60

The results of the viscosity test of the hair tonic preparation are shown in **Table V**. In the viscosity test on days 0, 60, and 90, a decrease was observed. This is caused by the addition of propylene glycol, which interacts at a high temperature of 34°C. The room temperature pattern used is uncertain and cannot be guaranteed; therefore, it can reduce the viscosity value of the hair tonic during the storage process (Rizkyyani *et al*., 2020). During the stability test, there is a decrease in viscosity caused by storage conditions which can affect the decrease in viscosity, packaging that is less tight will cause the preparation to

absorb air vapor from outside and increase the air volume in the preparation (Koralina *et al*., 2023).

Hair growth effectiveness results

Table VI. Hair growth effectiveness test results

Group/ Formula	Day to-7 (mm)	Day to-14 (mm)	Day to-21 (mm)
Normal Control	0,3±0,057	0,6±0,057*	0,8±0,057*,#
Positive Control	4,3±0,057	8,6±0,057*	12,3±0,057*,#
F0 (0%)	0,14±0,005	1,6±0,057*	2,8±0,057*,#
F1(2,5%)	0,14±0,333	2,6±0,057*	4,4±0,057*,#
F2 (5%)	1,4±0,057	3,5±0,057*	5,2±0,057*,#
F3(7,5%)	2,7±0,057	4,2±0,057*	8±0,577*,#

Information :

- Sign (*) is a significant difference on day 7
- The sign (#) is meaningfully different on day 14

The results of long-term growth of rabbit fur are shown in **Table VI**. The results of rabbit hair growth after treatment with hair cinnamon essential oil and candlenut oil for 21 days showed that hair length increased every week in the control normal, positive control, F0, F1, F2, and F3 groups. The control normal grew slowly because the resulting hairs were shorter in length and less than F0. In F0, sodium metabisulfite, an auxiliary substance, can also act as an antioxidant (Hindun *et al.*, 2023). Antioxidants can help protect hair follicles from damage caused by dangerous molecules called free radicals; therefore, the presence of sodium metabisulfite can accelerate growth (Aztriana *et al.*, 2023) and can increase the proliferation and differentiation of follicular keratinocytes to facilitate vasodilation. blood vessels to prolong the anagen phase. (Sembiring, 2024). Hair tonic preparations can increase the effectiveness of hair growth with concentrations of cinnamon essential oil and candlenut essential oil of 2.5%, 5%, and 7.5%. The higher the concentration per treatment, the faster is the hair growth. This is because the content of active compounds in the active ingredient is the same as the concentration level of the active ingredient (Priatna *et al*., 2022). The active compound content in cinnamon essential oil is cinnamaldehyde (Indriyani & Endrawati, 2021) and that in candlenut essential oil is linoleic acid and linolenic acid (Wijaya & Nisyak, 2020). The cinnamaldehyde content can also stimulate the metabolism of IGF-1 found in the hair follicle papilla, thus prolonging the anagen phase (Indriyani & Endrawati, 2021). IGF-1 stimulates growth in cultured hair follicles where blood supply is absent, inducing hair growth through activation of the Wnt/β-catenin pathway and increasing the number of DNA synthesis cells in the dermal papilla, bulbar matrix, outer root sheath, and perifollicular fibrocytic cells, resulting in the extension of the anagen and convergent phases from vellus hair to terminal hair (Juan Zhoa, 2011).

The linoleic acid of the essential oil of candlenut can reduce the production of DHT by inhibiting the enzyme 5-alpha-reductase and increasing cell growth by activating the Wnt/β pathway. -catenin, and increases the growth factors IGF-1 and VEGF (Ryu *et al*., 2021). He agrees with the research of Rindi *et al.* (2024), which states that linoleic acid also has the ability to inhibit the hormone dihydrosterone (DHT). DHT is produced from testosterone hormone with the help of 5 alpha-reductase enzyme and receptors in hair follicles. DHT

binding to receptors can cause narrowing of hair follicles and inhibit hair growth (Sari *et al.* 2016). This hormone causes hair loss because it can stop the cycle of hair growth and keratin formation.

Hair Mass Test Results

Table VII. Hair Mass Test Results

Normal Control	Positive Control	F0 (0%) (mg)	F1 (2,5%) (mg)	F2 (5%) (mg)	F3 (7,5%) (mg)
42.5 ± 0,665	213.8 ± 0,577*	129,2 ± 0,577*,#	141.8 ± 0,577*,#,Δ	160.0 ± 0,577*,#,Δ,‡	201.0 ± 0,577*,#,Δ,‡,¥

Information :

- Sign (*) is a significant difference with positive control
- The sign (#) is meaningfully different with F0
- The sign ($^{\Delta}$) is meaningfully different with F1
- The sign (‡) is meaningfully different with F2
- The sign ($^{¥}$) is meaningfully different with F3

Based on these results, the hair masses can be seen in **Table VII**. The hair masses in F3 had good hair weights between F0, F1, and F2. The hair mass test results showed that the hair tonic preparation in F3 weighs 201.0 mg and the positive control weighed 213.8 mg, which means that F3 had the same effectiveness as the positive control. This is in line with the research by Muliani *et al*. (2022), which states that the contents of cinnamon essential oil and candlenut essential oil have a similar effectiveness to minoxidil, namely stimulating hair growth; thus, as hair length increases, the hair becomes heavier and the mass becomes larger. heavy. rabbit fur weight. The active compound contained in cinnamon essential oil is cinnamaldehyde. Cinnamon essential oil is effective in increasing hair length and thickening hair (Muhammud *et al*., 2014) and candlenut essential oil contains linoleic acid and linoleic acid (Wijaya & Nisyak, 2020) which have the effect of accelerating hair growth and thickness. In statistical analysis using *one-way analysis* of variance, the critical value is 0.000 (<0.05) was obtained so that there was a difference in hair mass between formulas. Then it was analyzed using *Tukey's post hoc* test and the results showed that normal controls, F0, F1, F2, F3, and positive controls filled different subset columns which meant they were significantly different.

CONCLUSION

Based on the results of tests on the physical characteristics of hair tonic preparations, cinnamon essential oil and candlenut essential oil F0 (0%), F1 (2.5%), F2 (5%), and F3 (7.5%) can affect the aroma, viscosity, and pH of the preparation, but does not affect the color, texture and homogeneity of the preparation. In testing the stability of pH and viscosity on days 60 and 90 there was a decrease but it was still within the specification range for hair tonic preparations. In hair tonic preparations, a combination of cinnamon essential oil and candlenut oil with concentrations of 2.5%, 5%, 7.5% has the effectiveness of accelerating hair growth in rabbits. The 7.5% concentration showed that it was more effective in accelerating hair growth in rabbits compared to the 2.5% and 5% concentrations but not as good as the positive control.

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