

Article

The Effect of Adding Ruku-Ruku Plant Essential Oil (*Ocimum tenuiflorum* L.) as a Source of Antioxidants in Lip Balm Preparations

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Abstract. This study aimed to evaluate the effect of adding ruku-ruku (*Ocimum tenuiflorum* L.) essential oil as a natural antioxidant source in lip balm formulations and to determine the best formulation based on physicochemical, antioxidant, and organoleptic characteristics. The study used a Completely Randomized Design (CRD) with five treatments and three replications. Essential oil concentrations consisted of 0%, 1%, 2%, 3%, and 4% in the lip balm formulations. The prepared lip balms were analyzed for pH, antioxidant activity, homogeneity, spreadability, irritation, moisture enhancement, and organoleptic properties (color, aroma, and texture). The results showed that increasing the concentration of ruku-ruku essential oil decreased the pH value of lip balm from 5.33 to 4.66, which remained within the acceptable cosmetic pH range. Antioxidant activity increased significantly with higher essential oil concentrations, with the highest activity obtained in the 4% treatment at 85.03%. All formulations showed homogeneous texture, even spreadability, and no irritation reactions. Based on overall organoleptic acceptance, the best formulation was obtained with 1% essential oil addition, showing a pH value of 5.16, antioxidant activity of 53.83%, and moisture enhancement of 21.56%, with favorable panelist scores for color (4.04), aroma (3.60), and texture (4.16). The main bioactive compounds identified in the essential oil were eugenol, limonene, and caryophyllene. These findings indicate that ruku-ruku essential oil has potential as a natural antioxidant ingredient in lip balm formulations.

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1. Introduction

Lips are a part of the body that is more sensitive than other skin because the skin on the lips tends to be thinner and smoother, has weaker barrier function, lower water content, and higher transepidermal water loss than facial skin, so that sun exposure can cause free radical reactions that make the lips dry and chapped, lips darken, and cause premature aging up to skin cancer through UV-induced oxidative stress and photoaging mechanisms [1-5]. The stratum corneum on the lips is thinner than on the face and shows altered intercellular lipid organization, with a higher fraction of fluid-phase lipids and inferior barrier properties, while the facial stratum corneum is thicker and forms a more robust barrier; therefore the layers on the lips are more susceptible to damage from the external environment (UV, dry air, irritants) and from the use of inappropriate care products that disturb stratum corneum lipids, pH, and structure, leading to dry, flaky, and sensitive skin [1],[6-9]

One type of cosmetic used to protect the lips is lip balm, a preparation applied to the lips that functions mainly to moisturize and protect by forming an oil-based, occlusive layer on the lip surface [10-13]. Lip balm is a lip cosmetic generally consisting of main components such as waxes, fats/butters, and oils from natural or synthetic sources to prevent dryness and protect the lips from adverse environmental factors [10-11],[14-15]. The layer formed by lip balm protects the lips from external influences (such as wind, low humidity, and sunlight) and helps prevent damage such as dryness, cracking, and irritation of the thin lip skin [10],[11-12],[14].

Typically, lip balms are formulated with added antioxidants to protect lips from UV-induced free radical damage [12],[14]. In many commercial products, these antioxidants and UV filters are often synthetic compounds which are under increasing scrutiny because of demonstrated toxicity and concerns as emerging indoor and cosmetic contaminants [16].

A plant that has the potential to be a natural antioxidant addition to lip balm is the ruku-ruku plant (*Ocimum tenuiflorum* L.), whose essential oil and extracts show strong antioxidant and broad pharmacological activities, including antimicrobial, anti-inflammatory, antidiabetic, cardioprotective, and wound-healing effects [17-18]. According to recent reviews, *O. tenuiflorum* contains diverse bioactive secondary metabolites (terpenoids, phenols, flavonoids, phenylpropanoids, tannins, essential oils) that underlie these activities [17]. Ruku-ruku leaves and their essential oil are also highlighted as promising medicinal resources that remain underutilized despite traditional use in Indonesia, especially as a culinary herb with a characteristic clove-like aroma due to eugenol-type constituents [18-19].

One of the major ingredients in *O. tenuiflorum* essential oil is eugenol or methyl eugenol, which contributes both the distinctive aroma and key biological activities, including antioxidant and antimicrobial effects [17],[19-20]. The addition of antioxidants from ruku-ruku essential oil in lip balm can therefore provide protective antioxidant activity together with a characteristic aroma, aligning with the growing interest in *Ocimum* essential oils as natural antioxidant and antimicrobial agents for cosmetic applications [17],[19].

In ruku-ruku leaf oil there are antioxidant compounds, and the antioxidant activity of *O. tenuiflorum* essential oil has been categorized as very strong in vitro, with IC₅₀ values in the low µg/mL range using DPPH and other assays [17],[19-20]. One study on holy basil leaves reported an IC₅₀ of about 7.895 µg/mL for essential oil distilled from fresh leaves, supporting its classification as a powerful natural antioxidant suitable as an active ingredient in formulations [19].

In topical cosmetic formulations, particularly lip balm preparations, essential oils are commonly incorporated at low to moderate concentrations to maintain product safety, stability, sensory acceptability, and to minimize the risk of irritation on sensitive lip skin [21]. Herbal lip formulations containing lavender and rose essential oils, as well as cinnamon-based lip balms, have been shown to be homogeneous, stable, microbiologically safe, and well tolerated when essential oils are used at low concentrations while still providing antimicrobial benefits [22-23].

Similarly, essential oils incorporated at 1–2% in topical cream or emulsion formulations can act as effective natural preservatives and antioxidants while maintaining formulation stability and acceptable physicochemical properties [24]. In contrast, higher concentrations (around 8–9%) in topical sprays and other dermal systems have been associated with increased risk of irritation or sensitization in safety assessments and patch-testing studies, indicating that excessive essential oil levels may increase the risk of skin reactions in repeated-use products [21]. Therefore, the concentration range of 1–4% ruku-ruku essential oil used in this study is consistent with previous findings on the safe and effective use of essential oils as active and preservative components in lip balm and topical cosmetic formulations [21-24].

One method for extracting essential oils from the ruku-ruku plant is water and steam distillation, a conventional technique widely used for essential oil production from aromatic plants [25-26]. This method has a principle similar to steaming: plant material is exposed to boiling water or steam so that volatile components evaporate with the steam and are then condensed and separated as essential oil [25]. In water–steam (water and steam) distillation, the material is typically placed on racks or perforated grids/sieves above the boiling water; steam generated from the water passes through the plant material, entrains the essential oil vapors, and the condensate is then separated into an oil layer and an aqueous phase [25-26].

Lip balms are cosmetic products applied directly to the lips and are frequently and repeatedly used, with some portion potentially ingested incidentally, so it is important to pay close attention to the safety and type of ingredients used in lip balm formulations [15]. Safety assessments highlight that ingredients such as UV filters (e.g., nano-titanium dioxide) and other additives in lip balms must be evaluated for systemic exposure via oral and dermal routes, even though current data suggest that incidental oral exposure from lip balms is generally low-risk when concentrations are within regulatory limits [15],[27].

Although many have researched cosmetics made from natural ingredients, currently no one has made lip balm from ruku-ruku leaf oil. This research was conducted because there are no lip balm preparations made from ruku-ruku plant essential oils and to determine the effectiveness of ruku-ruku plant antioxidants in lip balm preparations.

2. Method

2.1 Materials and Tools

The main ingredient used in this study was ruku-ruku leaves (*Ocimum Tenuiflorum* L.) obtained from Nagari Alahan Panjang, Lembah Gumanti District, Solok Regency, West Sumatra. The lip balm ingredients used were beeswax, shea butter, cacao butter, and VCO. The materials used in the analysis were distilled water, DPPH, ethanol, methanol, commercial lip balm, pH paper, and lip balm containers.

The tools used in this lip balm preparation research consist of a hot plate, spatula, beaker, analytical balance, water steam distillation, separator flask, glass bottle, thermometer, burette, Erlenmeyer flask, dropper pipette, glass funnel, magnetic stirrer, and monyl cloth. The tools used for analysis are GCMS, UV-Vis spectrophotometer, burette, spatula, stirring rod, and skin analyzer.

2.2 Research Design

This study used a Completely Randomized Design (CRD) with 5 treatment levels and 3 replications. The observation data obtained were then statistically tested using the F test and continued with the DNMRT (Duncan's New Multiple Range Test) at a 5% significance level if the data obtained were significantly different.

The lip balm preparation was prepared by varying the concentration of ruku-ruku essential oil, obtained from the total amount of ingredients used, which was 30 grams for each treatment. The treatment for adding ruku-ruku essential oil was as follows:

- A = Without adding ruku-ruku plant oil
 B = Addition of 1% ruku-ruku plant oil
 C = Addition of 2% ruku-ruku plant oil
 D = Addition of 3% ruku-ruku plant oil
 E = Addition of 4% ruku-ruku plant oil

2.3 Research Implementation

2.3.1 Extraction of Ruku-ruku Plant Essential Oil

The distillation of ruku-ruku essential oil refers to a modified study by [28] and follows common hydrodistillation practice for plant essential oils [19],[25],[29]. The ruku-ruku plant was air-dried at room temperature for 24 hours to obtain wilted material, a pretreatment known to influence essential oil yield and quality in aromatic plants [19]. Then 2 kg of wilted ruku-ruku plant was placed into the water and steam distillation apparatus, similar to procedures used for holy basil and other herbs [19],[29].

The separator was filled with distilled water first and the condenser was ensured to be running smoothly before turning on the distillation apparatus, in line with standard Clevenger-type hydrodistillation systems [25]. The extraction process was carried out for 5 hours starting from the first drop at a temperature of about 100–110 °C, comparable to holy basil hydrodistillation where leaves are distilled at ~100 °C for 3–6 hours and 5 hours gives the highest yield [19],[26]. The oil and water were then separated, and the essential oil phase collected and weighed to calculate yield, as commonly done in hydrodistillation studies on *Ocimum tenuiflorum* and other essential oil plants [25],[29].

2.3.2 Determination of Lip Balm Preparation Formula

The lip balm formulation refers to a modified study by [30]. The lip balm formulation used corresponds to the treatment described in Table 1.

Table 1. Lip balm preparation formula

Material	Treatment				
	A (0%)	B (1%)	C (2%)	D (3%)	E (4%)
Ruku-ruku plant oil (g)	0	0.3	0.6	0.9	1.2
Beeswax (g)	8	8	8	8	8
Shea butter (g)	4	4	4	4	4
Cacao butter (g)	5.5	5.5	5.5	5.5	5.5
VCO (g)	12	12	12	12	12
Oil patchouli (g)	0.5	0.5	0.5	0.5	0.5

Note: The ruku-ruku plant oil added to each treatment was obtained based on the amount of mixed ingredients used, namely 0.3; 0.6; 0.9; 1.2

2.3.3 Making Lip Balm Preparations

The preparation of lip balm refers to a modified study by [31]. Weigh all ingredients according to the calculation, then melt the cacao butter, shea butter, beeswax, and VCO at 65°C on a hot plate and then homogenize. Once homogenized, cool until the temperature drops and add patchouli oil and ruku-ruku essential oil according to the treatment to minimize damage to the active ingredients in the oil. The mixture is homogenized and transferred into a lip balm container before it hardens and is cooled at room temperature until it becomes solid.

2.3.4 Panelists

A total of 10 healthy volunteers were recruited for the irritation and moisturizing tests. The inclusion criteria were healthy skin condition, no history of dermatological diseases, no known allergy to cosmetic ingredients, and willingness to participate in the study. The volunteers consisted primarily of university students. Organoleptic evaluation was conducted using 25 randomly selected untrained panelists consisting of male and female participants. Most of the panelists were university students and had no prior training in sensory evaluation. The panelists assessed the color, aroma, and texture of the lip balm based on their personal preferences using a 5-point hedonic scale (1 = dislike very much, 5 = like very much).

2.4 Observations

Observations made in this study included observations of ruku-ruku leaf oil and lip balm preparations. On ruku-ruku leaf oil, physical state analysis, acid value, analysis of ruku-ruku essential oil content using GC-MS, and antioxidant activity were carried out. Observations on lip balm preparations with the addition of ruku-ruku leaf oil were carried out through homogeneity tests, smear tests, antioxidant activity tests on lip balm preparations, moisturizing effect tests, sensory tests, and pH value tests.

The irritation and moisturizing effect tests were conducted using 10 healthy volunteer panelists consisting of male and female participants, most of whom were university students, with no history of skin diseases, cosmetic allergies, or visible skin disorders. The irritation test was performed by applying the lip balm to the inner forearm and observing any signs of redness, itching, swelling, or other adverse reactions. The moisturizing effect was evaluated using a skin analyzer by measuring skin moisture before and one hour after lip balm application.

Sensory evaluation was carried out by 25 randomly selected untrained panelists consisting of male and female participants. Most of the panelists were university students and had no prior training in sensory evaluation. The panelists assessed the color, aroma, and texture of the lip balm using a 5-point hedonic scale (1 = dislike very much, 5 = like very much).

3. Results and Discussion

3.1 Raw Material Analysis

The raw material used in this study was ruku-ruku essential oil. The analyses performed on the ruku-ruku essential oil included yield analysis, acid value analysis, antioxidant activity analysis, and GC-MS analysis. The results of the raw material analysis can be seen in Table 2.

Table 2. Results of raw material analysis

Analysis Component	Ruku-Ruku Plant Oil (Mean±SD)
Yield (%)	0.93±2.47
Acid Number (mg NAOH/g oil)	7.82±0.22
Antioxidants (%)	58.68±0.80

Description: SD = Standard Deviation

Based on Table 2, it can be seen that the yield of ruku-ruku (*Ocimum tenuiflorum*) essential oil was 0.93%. This value is within the range of holy basil oil yields reported in other studies, which vary roughly from 0.62% to about 1.05% depending on cultivation and processing conditions [19-20],[32]. The results obtained in this study are higher than those of research that reported a yield of 0.26% using water distillation and 0.66% using steam distillation for holy basil leaves [19],[32].

The antioxidant activity of ruku-ruku oil was analyzed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical absorption method, measured at a wavelength of 517 nm, a common protocol for essential oil antioxidant testing [19-20]. The analysis results showed that the antioxidant activity of ruku-ruku plant oil was 58.68% at a concentration of 10 ppm, which places it in the strong

antioxidant category when compared with IC50-based classifications where very strong activity is defined at IC50 < 50 µg/mL and strong at 50–100 µg/mL [19],[33]. This is supported by Mulyati's (2023) research, which classified holy basil essential oil as a very strong natural antioxidant with IC50 values of 11.1851 µg/mL (fresh leaves), 8.603 µg/mL (wilted leaves), and 7.895 µg/mL (dry leaves) [19]. The major antioxidant source in ruku-ruku essential oil is the phenylpropanoid eugenol/methyl eugenol, identified as a dominant component and strongly linked to radical scavenging activity [19-20].

The acid value analysis of ruku-ruku essential oil was 7.82%. Acid value reflects the level of free fatty acids or other acidic components present in an oil and is widely used as an indicator of hydrolysis and oxidative degradation, thus of oil deterioration and quality loss, not superiority [19],[34]. In edible and many essential oils, higher acid value is generally associated with rancidity and reduced quality, whereas lower acid value indicates better preservation and suitability [34]. Factors affecting acid value include operating/extraction temperature, water content, extraction or processing time, exposure to air/oxygen, and raw material freshness [19],[34].

In the analysis of essential compounds using GC–MS, numerous volatile components of *O. tenuiflorum* essential oil are typically identified, including methyl eugenol, eugenol, β-elemene, germacrene D, and other terpenoids, with studies reporting between about 13 and more than 20 detected compounds depending on origin and conditions [19-20]. The results of the GC–MS analysis of ruku-ruku essential oil, with 27 compounds detected, are consistent with reports that holy basil essential oil is chemically complex and rich in eugenol-type constituents and sesquiterpenes [19],[20],[33]. The results of the GCMS analysis of ruku-ruku essential oil can be seen in Table 3.

Table 3. GCMS analysis results

Retention time (min)	Compound	Area (%)
13.057	Linalool	2.04
15.388	Endo-borneol	2.36
19.946	α-pinene	1.03
20.733	Eugenol	19.27
21.484	Copaene	8.71
21.715	B-boubonene	2.33
21.845	Limonene	16.86
22.712	Caryophyllene	14.18
25.045	Sabinene	2.31

Based on Table 3, it can be seen that the main components of the essential oil of the ruku-ruku plant are eugenol (19.27%), limonene (16.86%), caryophyllene (14.18%), copaene (8.71%), and other sesquiterpenes, a pattern consistent with many essential oils where eugenol, limonene, caryophyllene, and copaene occur as major constituents [35-36]. Different profile in ruku-ruku essential oil dominated by methyl eugenol, germacrene D, p-elemene, zerumbone, and several fatty acid esters, illustrating chemotypic variation in this species [37-38].

The differences in the chemical composition of ruku-ruku essential oil observed in this study compared with those reported by [37] may be attributed to several factors, including geographical origin, environmental and climatic conditions, altitude, soil properties, plant age, harvest time, post-harvest handling, drying, and extraction methods, which are widely recognized drivers of essential oil chemovariability [38-39]. The ruku-ruku leaves used in this study were collected from Alahan Panjang, Solok Regency, West Sumatra, and were air-dried before distillation; differences in location and drying conditions are known to alter monoterpene and sesquiterpene proportions and shift dominant constituents [38-39].

Although GC–MS analysis detected 27 compounds, Table 3 presents only the major and representative constituents with relatively higher peak areas, which is a common approach since many minor components occur at very low percentages and contribute less to the overall profile [36].

The chromatogram results show that the compound with the largest area percentage is eugenol. Eugenol is a phenolic compound abundant in clove oil and other aromatic oils, responsible for a characteristic spicy aroma and known antiseptic, analgesic, and antioxidant activities [35-36]. The presence of eugenol as a major constituent is therefore consistent with the strong antioxidant activity previously observed for ruku-ruku essential oil [35].

Other key compounds found in ruku-ruku essential oil are limonene and caryophyllene. Limonene is a monoterpene reported to exhibit anti-inflammatory and antidepressant-like or anxiolytic effects in animal models. Caryophyllene (β -caryophyllene) is a sesquiterpene frequently identified as a major component of many essential oils and has documented antimicrobial and other bioactivities, supporting its use in natural antiseptic and preservative applications [35-36].

3.2 Chemical Analysis

3.2.1 pH analysis

A pH analysis was conducted to determine the acidity or alkalinity of a product. An analysis of variance (ANOVA) showed that the addition of ruku-ruku essential oil to lip balm production had no significant effect on the pH of the resulting lip balm at 5% levels. The results of the pH analysis are shown in Table 4.

Table 4. Average Values of Lip Balm pH Test

Treatment	pH value (Average pH \pm SD)
A (Addition of Ruku-ruku Oil 0%)	5.33 \pm 0.28
B (Addition of Oil Ruku-ruku 1%)	5.16 \pm 0.28
C (Addition of 2% Ruku-ruku Oil)	5.00 \pm 0.50
D (Addition of Oil Ruku-ruku 3%)	4.83 \pm 0.28
E (Addition of Oil Ruku-ruku 4%)	4.66 \pm 0.28
Family Card: 15.28%	

Description: SD = Standard Deviation, KK = Coefficient of Diversity

In Table 4, it can be seen that the average pH value in this study ranged from 4.66 to 5.33. The highest average value was found in treatment A (addition of 0% ruku-ruku oil) with a pH value of 5.33, and the lowest average value was found in treatment E (addition of 4% ruku-ruku oil) with a pH value of 4.66. This shows that the higher the addition of ruku-ruku essential oil to the lip balm preparation, the lower the pH of the resulting lip balm, similar to other herbal lip products where increasing acidic plant extract concentration makes the formulation more acidic [40].

Based on the pH results obtained, the pH of the resulting lip balm preparation still meets cosmetic pH requirements for lip products (about 4.5–6.5), which correspond to the physiological pH range considered safe for lip and skin application in several lip balm and lip cream studies [40-41]. Products with pH clearly outside the skin's physiological range (around 4–7) have been associated with increased risk of irritation or barrier disturbance, especially when very acidic (\approx 3) or strongly alkaline (\approx 10) [42-43]. Alkaline soaps and cleansers (pH 8–10) are reported to weaken the skin's protective barrier, disturb the water–lipid balance, and promote dryness and irritation [42]. Very acidic cosmetic formulations can also increase irritation potential and therefore must be controlled in concentration and pH [43].

For lip balm specifically, several herbal and Aloe vera lip balm formulations with pH in the range ~4.4–6.6 were reported as non-irritating and skin-friendly, supporting that lip preparations within this pH window are well tolerated by the lips and do not cause burning or discomfort in users [40,41].

3.2.2 Antioxidant Activity Analysis

Antioxidants are compounds that inhibit free radicals and thereby prevent oxidative damage to lipids, proteins, and DNA [44-46]. Lip balm formulations benefit from antioxidants and UV-protective ingredients to help shield the lips from free radical-mediated damage and UV-induced pigmentation [46].

The results of the analysis conducted on the antioxidant activity of lip balm with the addition of ruku-ruku oil showed a significant effect at the 5% level, with the highest antioxidant activity in treatment E (4% ruku-ruku oil) of 85.03% at 1000 ppm. This pattern—higher antioxidant capacity with increasing content of antioxidant-rich plant material—is consistent with studies where phenolic- and polyphenol-rich ingredients increase DPPH/FRAP values in a concentration-dependent manner [45-47]. The results of the analysis of the antioxidant activity of lip balm with the addition of ruku-ruku essential oil can be seen in Table 5.

Table 5. Analysis of Lip Balm Antioxidant Activity

Treatment	Antioxidant Activity (Mean (%) \pm SD)
A (Addition of Ruku-ruku Oil 0%)	44.27 \pm 0.58 a
B (Addition of Oil Ruku-ruku 1%)	53.83 \pm 1.32 b
C (Addition of 2% Ruku-ruku Oil)	67.04 \pm 1.21 c
D (Addition of Oil Ruku-ruku 3%)	73.33 \pm 0.95 d
E (Addition of Oil Ruku-ruku 4%)	85.03 \pm 1.15 e
Family Card: 13.39%	

Description: SD = Standard Deviation, KK = Coefficient of Diversity

Table 5 shows that increasing ruku-ruku essential oil concentration in lip balm increases antioxidant activity, consistent with dose-dependent behavior observed in essential oil cosmetic formulations [48-49]. Antioxidant activity ranged from 44.27–85.03% at 1000 ppm (treatment A: 44.27%; treatment E: 85.03%), similar to essential-oil-based cosmetics with strong radical-scavenging activity [48-49]. The raw ruku-ruku oil showed 58.68% antioxidant activity, consistent with antioxidant essential oils [48].

Key antioxidant compounds in ruku-ruku oil include methyl isoeugenol, eugenol, β -elemen, germacrene, linalool, beta-caryophyllene, and camphor [50], with eugenol as the dominant compound. Eugenol is well-documented for antioxidant activity, ROS scavenging, and protection from oxidative damage [51-52]. Similar phenylpropanoids and terpenes (especially eugenol) dominate clove and betel leaf antioxidant oils [53-54]. Eugenol's phenolic structure and hydrogen-donating capacity stabilize radicals and stop oxidation propagation [51-53].

Antioxidant activity is also influenced by raw materials. Virgin coconut oil (VCO) and plant fats provide natural antioxidants (tocopherols, polyphenols, flavonoids) that counteract lipid peroxidation [48]. Cacao butter and plant-derived lipids contain phenolic compounds with radical-scavenging capacity [48]. Shea butter formulations with vitamin E show antioxidant activity and protect keratinocytes from H₂O₂-induced oxidative stress [52]. These lipid excipients contribute baseline antioxidant activity, explaining why lip balm without ruku-ruku oil already shows 44.27% antioxidant activity [48-49],[52].

3.3 Physical Analysis

3.3.1 Spreadability

A lip balm preparation has good spreadability if it is colorless (transparent) and spreads evenly when applied. The results of the spreadability test for the ruku-ruku oil lip balm preparations indicate that all preparations have good spreadability. The results of the spreadability test for the lip balm preparations can be seen in Table 6.

Table 6. Lip balm spreadability

Treatment	Spreadability
A (Addition of Ruku-ruku Oil 0%)	No colored, even
B (Addition of Oil Ruku-ruku 1%)	No colored, even
C (Addition of 2% Ruku-ruku Oil)	No colored, evenly
D (Addition of Oil Ruku-ruku 3%)	No colored, evenly
E (Addition of Oil Ruku-ruku 4%)	No colored, even

Based on Table 6, it can be seen that each lip balm treatment with the addition of ruku-ruku oil has good rubbing power, as indicated by lip balm that spreads evenly and is colorless (transparent). This is in line with previous lip balm formulations that showed good smearing/spreadability characteristics in semisolid lip preparations [55-56]. According to Supartiningsih et al. (2021), lip balm is considered to have good spreadability if it spreads evenly on the back of the hand, which is consistent with spreadability criteria and test ranges used in lip balm evaluations [55-57].

3.3.2 Homogeneity

The homogeneity test of the preparation showed a homogeneous preparation, indicated by the absence of coarse grains when the lip balm preparation was smeared on transparent glass. The results of the homogeneity test of the lip balm preparation can be seen in Table 7.

Table 7. Lip balm homogeneity

Treatment	Homogeneity
A (Addition of Ruku-ruku Oil 0%)	Homogeneous, no coarse grains
B (Addition of Oil Ruku-ruku 1%)	Homogeneous, none coarse grains
C (Addition of 2% Ruku-ruku Oil)	Homogeneous, none coarse grains
D (Addition of Oil Ruku-ruku 3%)	Homogeneous, none coarse grains
E (Addition of Oil Ruku-ruku 4%)	Homogeneous, none coarse grains

Based on Table 7, it can be seen that each lip balm treatment with the addition of ruku-ruku oil had good homogeneity, meaning that when applied, it was homogeneous and free of coarse grains [58-60]. The lip balm formulation contains beeswax, a raw material that has good emollient and thickening properties [11],[61]. Beeswax contains approximately 70% ester, which is useful as an oil binder, providing shine, consistency, and maintaining color stability [58]. If the lip balm preparation is homogeneous, the active ingredient content can be assumed to be consistent with each application [11],[59]

3.3.3 Irritation Test

Based on Table 8, the addition of ruku-ruku essential oil (0%, 1%, 2%, 3%, 4%) did not cause irritation on panelists' inner arms, indicating good skin tolerability similar to other herbal lip balm formulations with no irritation [12],[59]. Irritation testing on human volunteers is standard to confirm cosmetic skin compatibility and low irritation potential [62]. All panelists showed no allergic reactions, consistent

with natural lip balm products that passed safety-in-use tests [59],[63]. This proves ruku-ruku oil lip balm is safe for skin, as natural plant extract lip balms are safe, stable, and non-irritating [12],[59],[63].

Table 8. Lip balm irritation test

Panelists	A(0%)	B(1%)	C(2%)	D(3%)	E(4%)
P1	(-)	(-)	(-)	(-)	(-)
P2	(-)	(-)	(-)	(-)	(-)
P3	(-)	(-)	(-)	(-)	(-)
P4	(-)	(-)	(-)	(-)	(-)
P5	(-)	(-)	(-)	(-)	(-)
P6	(-)	(-)	(-)	(-)	(-)
P7	(-)	(-)	(-)	(-)	(-)
P8	(-)	(-)	(-)	(-)	(-)
P9	(-)	(-)	(-)	(-)	(-)
P10	(-)	(-)	(-)	(-)	(-)

Description: (-) = negative/no irritation reaction occurs, (+) = positive/irritation reaction occurs

Non-irritating lip balm provides safe feeling and is preferred for routine lip care [12],[59],[63]. Natural ingredients minimize irritation, as herbal/essential-oil cosmetics reduce side effects compared to synthetic ingredients when concentrations are safe and properly tested [64]. Therefore, ruku-ruku oil lip balm passing irritation testing is safe for lips [12],[59],[63].

3.3.4 Humidity

The moisture test is useful for determining the effectiveness of lip balm in moisturizing the lips. The moisture test was conducted using Lip Balm B (1% ruku-ruku oil) because this formulation was identified as the best overall treatment based on organoleptic acceptance by panelists. Although Lip Balm E (4% ruku-ruku oil) showed the highest antioxidant activity, Lip Balm B exhibited the most favorable balance between antioxidant properties and consumer acceptability, particularly in terms of color, aroma, and texture. Therefore, Lip Balm B was selected for comparison with a commercial lip balm (Lip Ice brand) in the moisturizing effectiveness test.

All panelists first measured their skin moisture condition using a skin analyzer, then applied lip balm to the skin, waited for 1 hour, and then measured the skin moisture condition again after applying lip balm. The skin moisture parameter categories according to the skin analyzer were dry (<33%), slightly dry (34-37%), normal (38-42%), slightly moist (43-46%), and moist (>47%). The results of the lip balm moisture test can be seen in Table 9.

Table 9. Humidity Values

Treatment	Percent Increase in Humidity (Mean±SD)
Ruku-ruku Lip Balm (1%)	21.56±1.67
Commercial Lip Balm	20.56±1.81
Family Card: 0.94%	

Description: SD = Standard Deviation, KK = Coefficient of Diversity

Based on Table 9, lip balm with ruku-ruku oil showed higher moisture increase (21.56%) vs commercial lip balm (20.56%), with final moisture 54.67% vs 53.89% from initial 33.33%. A skin analyzer moisture >47% is stated as moist [65-66]. Moisture comes from moisturizing ingredients: VCO, cacao butter, shea butter, and patchouli oil [67-69].

VCO acts as natural moisturizer, rich in medium-chain fatty acids, functioning as emollient and occlusive agent that increases skin hydration and elasticity [67-69]. Shea butter restores skin barrier, fills lipid gaps, prevents transepidermal water loss, improving hydration [52]. Cacao butter, rich in triglycerides and fatty acids, shows moisturizing/occlusive effects enhancing skin hydration [68]. Therefore, ruku-ruku oil lip balm effectively moisturizes, supported by emollient ingredients [65-68].

3.4 Organoleptic Analysis

The testing included a preference test for color, aroma, and texture produced by 5 lip balm formulations. The panelists who conducted this organoleptic test were 25 panelists who were randomly selected, including untrained panelists, with a rating scale ranging from 1 to 5. The lip balm product with the addition of ruku-ruku plant essential oil can be seen in Figure 1.

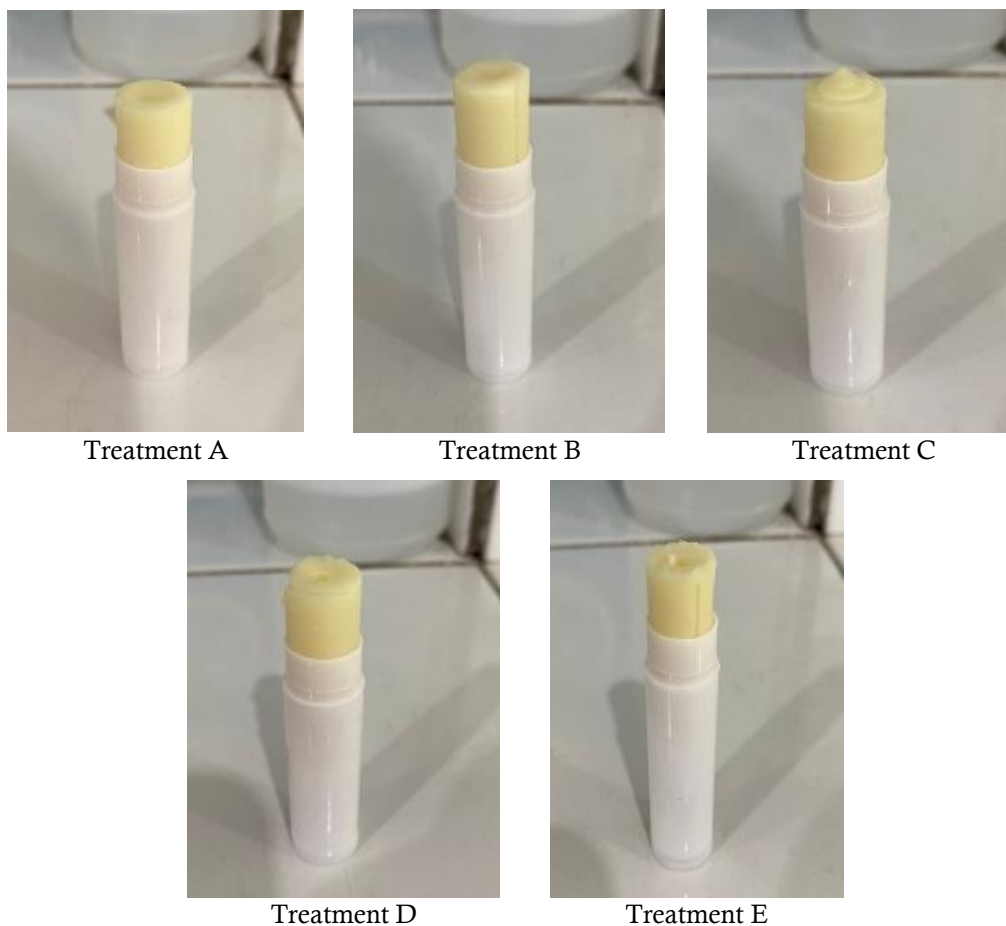


Figure 1. Lip Balm with Added Ruku-ruku Plant Essential Oil

3.4.1 Color

Color is one of the key parameters in cosmetic products. Color can create the first visual impression on consumers. Colors that are less favored by consumers can reduce the attractiveness of the product. Analysis of variance showed that the addition of ruku-ruku essential oil at the 5% level did not significantly affect the color of the resulting lip balm. The results of the organoleptic color test can be seen in Table 10.

Table 10. Organoleptic Color of Lip Balm

Treatment	Color (Mean±SD)
A (Addition of Ruku-ruku Oil 0%)	3.68±0.74
B (Addition of Oil Ruku-ruku 1%)	4.04±1.73
C (Addition of 2% Ruku-ruku Oil)	3.84±0.62
D (Addition of Oil Ruku-ruku 3%)	3.76±0.59
E (Addition of Oil Ruku-ruku 4%)	3.84±0.68
Family Card: 17.77%	

Description: SD = Standard Deviation, KK = Coefficient of Diversity, 1 = really dislike, 2 = dislike, 3 = normal, 4 = like, 5 = really like.

Based on table 10, it can be seen that the average level of panelist preference for the color of the ruku-ruku oil lip balm ranges from 3.68 to 4.04. The highest level of panelist preference was found in treatment B (addition of 1% ruku-ruku oil) the resulting color was not much different with a value of 4.04 (like), and the lowest level of panelist preference was in treatment A (addition of 0% ruku-ruku oil) with a value of 3.68 (like).

The lip balm is yellowish white from ruku-ruku oil's pale yellow color, with eugenol as the main constituent and characteristic component of *Ocimum* essential oils [70]. Eugenol-rich essential oils are transparent/pale-yellow liquids with characteristic odor [71]. Eugenol has clear to pale yellow appearance, poorly water-soluble but soluble in organic solvents [72]. Adding ruku-ruku oil does not markedly change lip balm color, similar to formulations where pale-colored oils caused minimal color shift vs colored plant extracts [73-75].

3.4.2 Aroma

Aroma is an important parameter for consumers in selecting cosmetic products. The panelists' average preference for lip balm aromas can be seen in Table 11.

Table 11. Organoleptic Aroma of Lip Balm

Treatment	Aroma (Mean±SD)
A (Addition of Ruku-ruku Oil 0%)	3.40±1.00
B (Addition of Oil Ruku-ruku 1%)	3.60±0.86
C (Addition of 2% Ruku-ruku Oil)	3.52±0.77
D (Addition of Oil Ruku-ruku 3%)	3.48±0.87
E (Addition of Oil Ruku-ruku 4%)	3.32±1.21
Family Card: 27.18%	

Description: SD = Standard Deviation, KK = Coefficient of Diversity, 1 = really dislike, 2 = dislike, 3 = normal, 4 = like, 5 = really like.

Based on Table 11, panelists aroma preference for lip balm ranged 3.32–3.60 ("normal–like"), comparable to other cosmetic aroma evaluations [76-78]. Highest preference was treatment B (1% oil) at 3.60, lowest was treatment E (4% oil) at 3.32, where higher essential oil levels do not always increase liking [76-78].

Treatment A (without oil) had mild chocolate aroma from cacao butter's volatile profile [79]. Lip balm with ruku-ruku oil had distinctive leaf aroma; more oil meant more intense aroma, consistent with increasing essential oil concentration increasing aroma intensity [76],[80]. GC-MS showed ruku-ruku aroma from eugenol, limonene, linalool, and other terpenes/phenylpropanoids, major constituents in *Ocimum* essential oils [81]. Adding ruku-ruku oil changed aroma but not significantly preference ratings, similar to varying essential oil levels changing aroma character but not overall liking [76-78].

3.4.3 Texture

Texture in a product is an important parameter. It is useful for product development, quality control, and ensuring that the lip balm has a texture that meets consumer preferences. Analysis of variance showed that the addition of ruku-ruku oil at the 5% level significantly affected the texture of the resulting lip balm. The resulting lip balm texture was smooth. The results of the organoleptic texture test can be seen in Table 12.

Table 12. Organoleptic Texture of Lip Balm

Treatment	Texture (Mean±SD)
A (Addition of Ruku-ruku Oil 0%)	3.76±0.66a
B (Addition of Oil Ruku-ruku 1%)	4.16±0.68a
C (Addition of 2% Ruku-ruku Oil)	4.16±0.62b
D (Addition of Oil Ruku-ruku 3%)	4.08±0.64b
E (Addition of Oil Ruku-ruku 4%)	4.40±0.57b
Family Card: 15.55%	

Description: SD = Standard Deviation, KK = Coefficient of Variance, 1 = dislike very much, 2 = dislike, 3 = normal, 4 = like, 5 = like very much. Numbers in the same column followed by different lowercase letters are significantly different according to DNMRT at the 5% level.

Based on Table 12, panelists' texture preference for lip balm ranged 3.76–4.40 ("like") on hedonic scales used in cosmetic sensory evaluation [82-83]. Highest preference was treatment E (4% ruku-ruku oil) at 4.40 (soft), lowest was treatment A (0% oil) at 3.76 (soft). Using semi-trained/consumer panelists for texture liking aligns with standard sensory practice [82-83]. Texture differences resulted from ruku-ruku oil addition—more oil produced softer texture because the liquid oil increases the liquid phase compared to control. This aligns with findings that formulation composition (structuring agents:liquid phase ratio) affects firmness, consistency, and spreadability of topical semisolids [84]. The liquid nature of *Ocimum* essential oil affecting texture is documented in *Ocimum* species reviews [18].

3.4.4 Organoleptic Value Recapitulation

The organoleptic values were summarized using a radar chart. This radar chart aims to visualize and facilitate the determination of differences in each panelist's response to the lip balm with the addition of ruku-ruku essential oil. The organoleptic results of all parameters for the lip balm with the addition of ruku-ruku oil are shown in Figure 2.

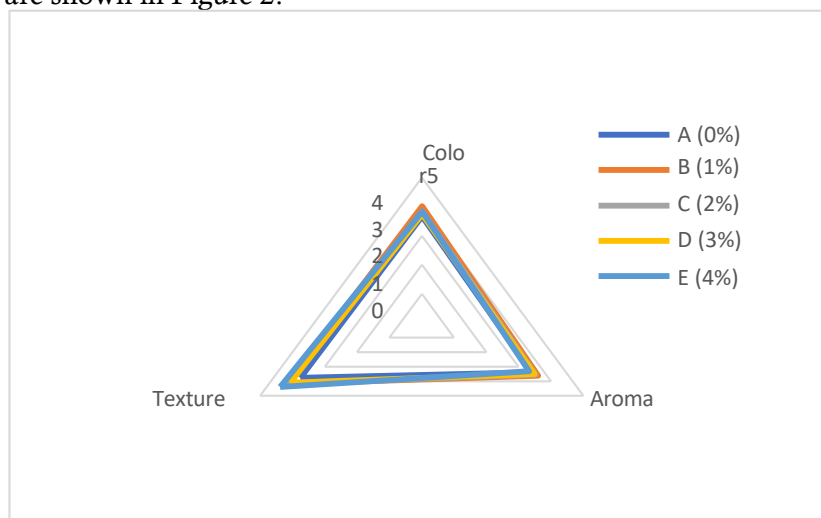


Figure 2. Lip Balm Organoleptic Radar Graph

Based on the ANOVA test, non-negative data were obtained. significant or no significant effect at the 5% level other than the texture parameter, then to determine the best treatment, the highest overall average that the panelists preferred was taken. The best treatment was obtained in treatment B, namely the addition of 1% ruku-ruku essential oil with an average value of 4.04 (like) for color, 3.60 (like) for aroma, and 4.16 (texture).

4. Conclusion

The addition of ruku-ruku (*Ocimum tenuiflorum* L.) essential oil significantly increased the antioxidant activity of lip balm formulations, with antioxidant activity rising from 44.27% in the control formulation to 85.03% at 4% essential oil concentration. Increasing essential oil concentration also reduced the pH value from 5.33 to 4.66, although all formulations remained within the acceptable pH range for lip cosmetic products. All lip balm formulations showed good homogeneity, even spreadability, and no irritation reactions. The major bioactive compounds identified in the essential oil were eugenol (19.27%), limonene (16.86%), and caryophyllene (14.18%), which contributed to the antioxidant properties of the product. Based on overall consumer acceptance, the formulation containing 1% ruku-ruku essential oil was selected as the best treatment, exhibiting a pH value of 5.16, antioxidant activity of 53.83%, moisture enhancement of 21.56%, and favorable sensory scores for color (4.04), aroma (3.60), and texture (4.16). These findings demonstrate that ruku-ruku essential oil has strong potential as a natural antioxidant ingredient for the development of safe, effective, and consumer-acceptable lip balm products.

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