


Research Article

Stability of Hand Body Gel Formulated with Avocado (*Persea americana*), Stingless Bee Honey, and Bee Pollen

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Abstract

The development of hand body care products in gel form, incorporating natural ingredients, remains an underexplored area, particularly concerning the combination of avocado (*Persea americana*) extract, Stingless bee (*Trigona* sp.) honey, and pollen in cosmetic formulations. Gel formulations are favored for their superior skin moisturizing properties and enhanced dermal absorption compared to lotions. This study aimed to evaluate the stability and moisturizing efficacy of novel hand body gel formulations containing varying ratios of *P. americana* extract combined with *Trigona* bee pollen and honey. Employing an experimental quantitative design, three distinct gel formulations were prepared with different concentrations of *P. americana* extract with *Trigona* bee pollen and honey. The stability of these formulations as skin moisturizers was assessed through a comprehensive evaluation encompassing organoleptic properties, homogeneity, potential for irritation, pH, spreadability, viscosity, and moisture content analysis using skin analysis instrumentation. The results indicated that the gel formulation designated F1, containing 2.5% *P. americana* extract and 7.5% honey combined with bee pollen, exhibited the highest skin moisture content, suggesting its potential as an effective moisturizing hand body gel.

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INTRODUCTION

As the body's outermost organ, the skin is continuously exposed to various environmental stressors, including radiation, air pollution, dust, sunlight, and cigarette smoke. Such persistent exposure can lead to visible signs of damage, manifesting as dryness, pallor, wrinkles, hyperpigmentation, and loss of skin definition. Given the significant impact of skin health on overall well-being and aesthetic appeal, its proper care and maintenance are paramount. A primary contributor to skin damage is the presence of free radicals, which are atoms possessing one or more unpaired electrons in their outer orbital. These inherently unstable molecules seek stability by acquiring electrons from other molecules, often leading to oxidative stress and cellular damage. While the body produces antioxidants to neutralize free radicals, excessive free radical generation can deplete these endogenous reserves, necessitating the external supplementation of antioxidants to mitigate oxidative damage and maintain cellular integrity^{1,2}.

Natural products have garnered significant interest in recent years for their diverse therapeutic properties. *Trigona* sp., commonly known as kelulut or stingless bee, native to East Kalimantan, produces a range of products with documented antioxidant, anti-inflammatory, antibacterial, and antiviral activities³⁻⁸. Similarly, avocado (*Persea americana*) has demonstrated considerable antioxidant potential⁹ and is a rich source of fats, carbohydrates, folic acid, and protein¹⁰. Research by Iskandar *et al.* highlights the promising dermatological applications of *P. americana* fruit, including its ability to

maintain skin moisture, reduce wrinkles and dryness, and enhance skin smoothness and softness, particularly when combined with humectants or used as a delivery vehicle for beneficial substances like sunscreens¹¹. The synergistic potential of combining *P. americana* extract with *Trigona* bee products as a cosmetic preparation warrants further exploration. Despite the established benefits, the development of hand body gels incorporating a combination of *P. americana* extract, *Trigona* bee honey, and pollen remains limited. In East Kalimantan, using *Trigona* bees by-products, such as pollen, is minimal, with honey predominantly consumed. This presents an opportunity for innovation in derivatizing propolis, honey, and pollen from *Trigona* bee species, offering alternative income streams for local cultivators¹². Furthermore, the abundant availability of *P. americana* in Kalimantan makes them a practical and sustainable source for developing novel cosmetic and pharmaceutical products^{13,14}. Therefore, this research aims to formulate a hand body gel combining *P. americana* extract, *Trigona* bee honey and pollen, and to evaluate its effectiveness as a skin moisturizer.

MATERIALS AND METHODS

Materials

The following materials were utilized in this study: *P. americana*, *Trigona* bee honey and pollen, hydroxypropyl methylcellulose (HPMC), methyl paraben, sodium metabisulfite, propylene glycol, disodium EDTA, and distilled water. The *P. americana* fruits were sourced from various local markets within Samarinda, East Kalimantan, Indonesia. Botanical identification of the *P. americana* fruits was officially confirmed at the Ecology and Tropical Forest Biodiversity Conservation Laboratory, Faculty of Forestry, Universitas Mulawarman, under registration number 273/UNI.7.4.08/LL/2023. *Trigona* bee honey and pollen were obtained from the Sahabat Kelulut Samarinda Bee Farm in 2023. For comparative analysis, Citra® Aloe Vera Fresh Glow Hand Body Gel was selected as a reference.

Methods

Extraction

Approximately 3.5 kg of fresh *P. americana* fruit was thoroughly peeled, and the skin and seeds were carefully removed. The edible flesh was then cut into thin, uniform pieces to facilitate drying. These pieces were subsequently dried in a convection oven at 50°C until a constant weight was achieved, indicating complete dehydration. The dried *P. americana* material was then finely blended into a smooth powder using a high-speed blender. From this process, a total of 228 g of *P. americana* extract powder was obtained for subsequent experimental use.

Hand body gel preparations

All ingredients were accurately weighed prior to preparation. The HPMC was first dispersed in hot distilled water (80–90°C) and stirred at 300 rpm for 15 minutes to ensure complete hydration and development of the gel base. Subsequently, methylparaben was dissolved in hot water and thoroughly mixed with propylene glycol¹⁵. In parallel, sodium metabisulfite and disodium EDTA were dissolved in distilled water. The prepared *P. americana* extract mixture was then meticulously ground¹⁶ with *Trigona* bee honey and pollen until a homogeneous gel base was achieved. The specific quantities and proportions for each component were meticulously followed as outlined in Table I.

Table I. Hand body gel formulation.

Formula	Negative control	F1	F2	F3	Positive control
<i>Persea americana</i> extract (g)	0	2.5	5	7.5	Citra® Aloe Vera Fresh Glow Hand Body Gel
<i>Trigona</i> bee honey (g)	0	3.75	2.5	1.25	
<i>Trigona</i> bee pollen (g)	0	3.75	2.5	1.25	
HPMC (g)	10	10	10	10	
Methylparaben (g)	0.03	0.03	0.03	0.03	
Propylene glycol (mL)	15	15	15	15	
Disodium EDTA (g)	0.05	0.05	0.05	0.05	
Sodium metabisulfite (g)	0.1	0.1	0.1	0.1	
Distilled water ad (mL)	100	100	100	100	

Hand body gel stability test

All nanoemulgel formulations underwent an initial 30-day evaluation period prior to human irritation testing. During this period, organoleptic properties, including odor and color, were assessed daily to monitor stability¹⁷. Homogeneity was confirmed visually, ensuring no particulate matter was present. pH measurements were taken regularly, with formulations targeting a range of 4.5-7.0, and spreadability was determined, aiming for a consistent diameter of 5-7 cm¹⁸. Following the successful completion of these stability assessments, further evaluation for skin irritation and moisture content was conducted using a skin analyzer. This human subject testing component received ethical clearance approval from the Health Research Ethics Commission of the Poltekkes Kemenkes Kaltim (Certificate Number: DP.04.03/7.1/07811/2023).

Data analysis

Homogeneity test

Homogeneity of the hand body gel preparations was qualitatively assessed by visual inspection. A small amount of each gel formulation was applied onto a Petri dish and carefully spread. The presence or absence of coarse grains or undissolved particles within the preparation was then meticulously observed to determine its homogeneity.

Viscosity test

The viscosity of the prepared formulations was quantitatively assessed based on the instrumental test results. Viscosity, a critical rheological parameter, directly reflects a fluid's resistance to flow. For quality assurance and regulatory compliance, the observed viscosity values were compared against the established national standard, SNI 16-4399-1996, which specifies an acceptable range of 3,000 to 50,000 cP for such preparations¹⁹.

Skin irritation test

Skin irritation was evaluated through a panelist test involving 10 participants. A hand body gel preparation was applied to the retroauricular area of each participant and left for 24 hours. The assessed parameters included skin roughness, itching, and redness. All observations yielded negative results, indicating the preparation's dermal safety and suitability for use. This methodology aligns with established protocols for assessing topical product irritation²⁰.

Moisture test

Skin humidity measurements were quantitatively assessed using a skin analyzer, with results expressed as a percentage. The measured humidity percentages were categorized into three distinct levels for interpretative analysis: dehydration (0-29%), normal hydration (30-50%), and optimal hydration (51-100%)²¹.

RESULTS AND DISCUSSION

The stability of the hand body gel preparation, incorporating a combination of *P. americana* extract, *Trigona* bee honey, and pollen, is detailed in **Table II**. Visual characterization of the various formulations, particularly regarding color, is presented in **Figure 1**. This study specifically investigated hand body gel formulations where these three natural ingredients served as active components. Their synergistic combination was explored, given that *P. americana* extract, *Trigona* bee honey, and pollen are well-known for their rich antioxidant compounds effective in neutralizing free radicals and possessing notable moisturizing properties. The aim was to assess whether this blend could enhance skin moisturization and elevate the overall value of the product. This research addresses a gap in the current market, as the beneficial active substances derived from natural ingredients remain largely underutilized, especially in the development of skin and body cosmetic products²².

Table II. The stability test of hand body gel formula.

Parameter	Test condition/ acceptance criteria	F1	F2	F3
Odor	Sweet aroma	Sweet aroma	Sweet aroma	Sweet aroma
Color	Yellow	Yellow	Yellow	Yellow
Homogeneity	Homogenous	Homogenous	Homogenous	Homogenous
pH	4.5 - 7.0	5 ± 0.000	5 ± 0.000	5 ± 0.000
Spreadability (cm)	5 - 7	6.5 ± 0.058	6 ± 0.283	6 ± 0.058
Viscosity (cP)	3,000 - 50,000	5,768	3,025	4,277
Skin irritation	No irritation	0 ± 0.000	0 ± 0.000	0 ± 0.000
Skin moisture (%)	% Moisture	57.2 ± 5.424	51.0 ± 6.689	54.3 ± 5.871



Figure 1. Hand body gel formula. (a) negative control, (b) F1, (c) F2, and (d) F3.

The organoleptic properties, specifically the color and scent, of the hand body gel preparations were directly influenced by the incorporation of *P. americana* extract, *Trigona* bee honey, and pollen. Sensory evaluation, conducted through observation of color, odor, and dosage form using human perception²³, revealed a concentration-dependent relationship: higher concentrations of the combined active ingredients resulted in more intense color and aroma. Interestingly, the organoleptic profile of the developed hand body gel formula, containing the *P. americana* extract, *Trigona* bee honey, and pollen combination, was nearly identical to that of the positive control (Citra® Aloe Vera Fresh Glow Hand Body Gel). This suggests successful formulation development in terms of sensory appeal, a crucial factor for consumer acceptance in cosmetic products.

The homogeneity of the hand body gel formulations, incorporating *P. americana* extract, *Trigona* bee honey, and pollen, was assessed. All prepared formulations exhibited no discernible coarse grains upon visual inspection when spread uniformly on a petri dish. This observation indicates that the active ingredients and excipients were thoroughly and evenly dispersed throughout the gel matrix, confirming the homogeneity of the preparations, consistent with established quality control standards for semi-solid formulations²⁴.

The spreadability of the three nanoemulgel formulations ranged from 5 to 7 cm, indicating a good dispersion capacity²⁵. This is crucial for topical applications, as a higher spreadability facilitates better distribution and interaction of active ingredients with the skin, ultimately enhancing therapeutic efficacy²⁶. Analysis of the spreadability test results revealed a direct correlation between the concentration of the extract within the formula and its spreadability; formulas with higher extract concentrations exhibited greater spread²⁷. Furthermore, the nanoemulgel combining *P. americana* extract, *Trigona* bee honey, and pollen demonstrated spreadability parameters comparable to those of the positive control, suggesting its potential for effective topical delivery.

The efficacy of a skin moisturizing gel is significantly influenced by its viscosity, as an overly viscous gel can prolong skin penetration and thus delay moisturizing effects²⁸. Our viscosity measurements for the gel preparation, incorporating *P. americana* extract, *Trigona* bee honey, and pollen, demonstrated that all formulations met the required viscosity range of 3,025 to 6,029 cP. Furthermore, the spreadability of our developed formula was found to be notably comparable to that of the positive control, suggesting an optimal consistency for topical application.

The hand body gel formulated with *P. americana* extract, *Trigona* bee honey, and pollen underwent a rigorous skin irritation test involving ten panelists, yielding consistently negative results for all participants. This indicates the formulation's safety for topical application, as evidenced by the complete absence of observed adverse reactions such as skin roughness, itching, or redness²⁹. The favorable outcome of this dermal irritation assessment is likely attributed to the careful selection of its components, which are known for their beneficial properties and low irritancy profiles³⁰. Furthermore, the overall safety of

the hand body gel is reinforced by the presumption of its microbiological purity and the inherent safety of its constituent natural ingredients.

Skin moisture levels were assessed using a skin analyzer, demonstrating a notable increase in panelists' skin hydration after three weeks of applying a novel gel formulation combining *P. americana* extract, *Trigona* bee honey, and pollen. Initially dry skin conditions significantly improved to a moisturized state. Specifically, the negative control group showed an increase in skin moisture from 14.6% to 61.8%, while the positive control group improved from 16.9% to 61.3%. The experimental gel combinations also exhibited substantial improvements: the 2.5 g *P. americana* : 7.5 g *Trigona* bee honey and pollen combination increased moisture from 21.2% to 67.4%; the 5 g *P. americana* : 5 g *Trigona* bee honey and pollen combination from 13.2% to 65.8%; and the 7.5 g *P. americana* : 2.5 g *Trigona* bee honey and pollen combination from 14.3% to 63.9%. These findings suggest a dose-dependent moisturizing effect, likely attributable to the rich vitamin, enzyme, and mineral content of the active ingredients, which are known to nourish and hydrate the skin³¹.

Our findings indicate a superior moisturizing efficacy compared to previously reported formulations. For instance, research on a hand body lotion containing 5% pineapple extract demonstrated a maximum moisturizing increase of 12.02%³², which is considerably lower than the over 50% increase in skin moisture observed with our *P. americana*, *Trigona* bee honey, and pollen combination hand body gel formula. While previous studies have explored *P. americana* in hand body lotions, often in combination with ingredients like *Aloe vera*³³ or celery extract³⁴, our study utilizes a gel formulation. Gel preparations offer distinct advantages over lotions, including enhanced spreadability and a desirable cooling sensation upon application³⁵. The promising skin-moisturizing potential of this novel hand body gel, incorporating *P. americana* with *Trigona* bee honey and pollen, offers a valuable reference for the utilization of natural resources from East Kalimantan. The identified best-performing formula holds significant promise for further development into a natural cosmetic product, potentially becoming a flagship regional product that benefits local communities.

CONCLUSION

This study effectively established the viability of creating a moisturizing hand body gel using a synergistic blend of *P. americana* extract, *Trigona* bee honey, and pollen. The formulated hand body gels satisfied the specified quality standards and demonstrated excellent physical stability over the assessment period. The F1 formulation, comprising 2.5 g of *P. americana* extract, 7.5 g of *Trigona* bee honey and pollen, had the maximum water content, signifying its enhanced moisturizing capability.

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AUTHORS' CONTRIBUTION

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Formal analysis: Nur Fauziyah

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Visualization: Nur Fauziyah

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Writing - review & editing: Paula Mariana Kustiawan

DATA AVAILABILITY

None.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this study.

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