Jurnal Biologi Tropis

Original Research Paper

Physical Quality and Organoleptic Testing of Golden Apple Snail *Pomacea canaliculata*) Mucus Gel as a Burn Treatment

Diana Fadhilah[1], Mikail Nadjmir[2], Ardis Trianita Adilla[2], Putra Santoso[1], Rita Maliza[1*]

[1]Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University, Limau Manis, Padang 25163, West Sumatra, Indonesia**;**

[2]Faculty of Medicine, Andalas University, Limau Manis, Padang 25163, West Sumatra, Indonesia;

Article History
Received : October 20th, 2024
Revised : November 10th, 2024
Accepted : November 28th, 2024

*Corresponding Author:
Rita Maliza, Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University, Limau Manis, Padang 25163, West Sumatra, Indonesia;
Email: ritamaliza@sci.unand.ac.id

Abstract: Golden Apple Snail (*Pomacea canaliculata*) secretion has traditionally been used for wound healing due to its high protein content, which promotes cell regeneration and inhibits inflammation. This study aims to utilize this secretion to formulate a topical gel for burn treatment, providing a controlled use for the abundant, invasive species in agricultural areas. Gel formulations with varying secretion concentrations (10%, 15%, and 20%) were evaluated for organoleptic properties, homogeneity, pH, adhesion, spreadability, and viscosity. Results indicated that all formulations were homogeneous and had pH values within the acceptable range (4.5-6.5). The 15% secretion gel showed the highest user acceptance and optimal balance between spreadability and adhesion, but all formulations had higher than standard viscosity and lower spreadability. Adjusting carbopol concentration is recommended to improve the gel's physical properties. The 15% formulation is the most promising for effective topical application.

Keywords: *Pomacea canaliculata*, snail secretion, burn treatment, gel formulation, wound healing.

Introduction

Snails and mollusks have long been utilized in traditional medicine across the world for treating burns, abscesses, and chronic wounds (Ulagesan *et al*., 2017; Song *et al*., 2021). Their mucus is known to contain amino acids and proteins that promote cell regeneration and growth, making it highly valuable for wound healing. The proteins in snail mucus have been shown to have significant biological activity, aiding in the repair of damaged tissues and reducing inflammation (Harti *et al*., 2016).

One type of mollusk commonly found in agricultural areas is the golden apple snail (*Pomacea canaliculata*). This species is known for its invasive nature and its role as a host for human parasites (Boraldi *et al*., 2018). Despite being considered a serious pest of aquatic plants in Southeast Asia, including Indonesia, its high population offers potential for alternative uses. In addition to being used as a food source and animal feed by local communities (Liu *et al*., 2016; Saputra *et al*., 2018; Nadeak *et al*., 2019), its mucus shows promise as a raw material for topical formulations such as gels. These gels are particularly suitable for wound care due to their ease of use, rapid absorption, cooling effect, and moisturizing properties (Patil *et al*., 2019; Bhuyan *et al*., 2021).

To ensure the quality and effectiveness of golden apple snail mucus gel, it is crucial to conduct a series of physical evaluations. These include organoleptic testing, which assesses the gel's appearance, color, and scent, as well as other important parameters such as homogeneity, spreadability, adhesion, pH, and viscosity (Forestryana *et al*., 2022). These tests are essential to confirm that the gel meets established quality standards, ensuring its safety, consistency, and suitability for wound healing applications.

Several studies have been conducted on the physical and organoleptic evaluation of snail mucus gels, most of which have focused on the mucus of *Achatina fulica*. These studies have demonstrated that the concentration of *A. fulica* mucus does not significantly affect the physical quality of the gel formulation (Shoviantari *et al*., 2021; Forestryana *et al*., 2022). However, research on the physical and organoleptic properties of golden apple snail (*P. canaliculata*) mucus gel has not yet been explored.

This study aims to develop a gel formulation using golden apple snail mucus and evaluate its physical properties, with a focus on organoleptic characteristics. The findings of this research are expected to provide valuable insights into the potential of *P. canaliculata* mucus as a functional ingredient in wound care products. Additionally, it offers an innovative solution for addressing the overpopulation of golden apple snails while contributing to the development of affordable and effective wound treatment options.

Materials and Methods

Research Time and Location

This research was conducted from September 2023 to May 2024 at the Animal Structure Development Research Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University.

Materials

Golden apple snail mucus, distilled water, Carbopol 940, triethanolamine (TEA), methylparaben, propylparaben, and glycerin.

Collection of Golden Apple Snail Mucus

Golden apple snails were collected from paddy fields and then identified. All individuals were cleaned and maintained without feeding for three days. Mucus collection was carried out by first removing the snail's body from the shell and placing it in a sterile container. The snail's body was then gently rubbed with a sterile cotton swab. The collected mucus was sterilized using filtration devices with pore sizes of 70 µm, 40 µm, and 0.2 µm. The filtrate was stored at a temperature of 4°C or -80°C (Trapella *et al*., 2018).

Preparation of Golden Apple Snail Mucus Gel Formula

Carbopol 940 is stirred in hot water. In a beaker containing glycerin, methylparaben is added and mixed until homogeneous (mixture 1). Propylparaben and mucus are dissolved in the remaining distilled water (mixture 2). The swollen Carbopol 940 is triturated, then mixtures 1 and 2 are gradually added to the Carbopol 940, and stirred until homogeneous. TEA is added to the mixture to neutralize the formulation, as Carbopol 940 is acidic (Shoviantari *et al*., 2021).

Quality Testing of Golden Apple Snail Mucus Gel

Organoleptic Test of Gel

The organoleptic test of the gel involves visual observation of the gel's appearance, color, and odor (Forestryana *et al*., 2022). A good gel formulation has a jelly-like appearance, is clear, and has a semi-solid consistency (Shoviantari *et al*., 2021). The organoleptic test is evaluated based on shape and acceptance scores, conducted by 15 panelists, including 5 standard and 10 non-standard panelists.

Homogeneity Test of Gel

The homogeneity test is performed by taking 0.5 g of gel and placing it on an object glass. The homogeneity is observed visually, and the presence of coarse particles is used to evaluate the gel's uniformity. The measurement is done three times (Forestryana *et al*., 2022).

pH Test

pH measurement is conducted using a calibrated pH meter (Mettler Toledo) with buffer solutions of pH 4 and pH 7. The pH meter electrode is immersed in the gel formulation and left for a few seconds until the reading stabilizes (Shoviantari *et al*., 2021). The ideal pH range for topical formulations is between 4.5 and 6.53 (Forestryana *et al*., 2022).

Adhesion Test

The adhesion test is performed by placing 0.25 g of gel in the center of an object glass and covering it with a glass plate. A 1 kg weight is placed on the glass plate for 5 minutes. The object glass is then mounted on a testing apparatus with an 80 g weight. Adhesion is measured based on the time required for the

object glass to detach (Shoviantari *et al*., 2021). This measurement is conducted in three trials (Forestryana *et al*., 2022).

Spreadability Test

The spreadability test is conducted by weighing 0.5 g of gel and placing it on a marked glass plate, then covering it with another glass plate with weights added sequentially at 50 g, 100 g, 150 g, 200 g, and 250 g until a stable value is reached. Each weight increment is added in 1-minute intervals (Shoviantari *et al*., 2021).

Viscosity Test of Gel

The viscosity of the gel is measured using a Brookfield DV 2T viscometer with spindle No. 7. The gel formulation is placed on a glass plate, then the spindle is immersed in the gel and stirred at 50 rpm. Measurements are performed three times (Forestryana *et al*., 2022).

Results and Discussion

Morphology of Golden Apple Snail Mucus Gel Formulation

Gel formulations containing golden apple snail mucus at concentrations of 10%, 15%, and 20% were prepared according to the specified formulation. These formulations produced gels with different morphologies, as shown in Figure 1.

Figure 1. Three types of golden apple snail mucus gel preparations with different concentrations; (G1) 10% golden apple snail mucus gel, (G2) 15% golden apple snail mucus gel, (G3) 20% golden apple snail mucus gel.

Based on morphology, gel formulations containing golden apple snail mucus at different concentrations (10%, 15%, 20%) have distinct morphologies. Generally, the gel containing golden apple snail mucus is semi-solid or highly viscous with a slightly cloudy appearance and tends to have a carbopol-like odor. The differences between each gel group are more clearly identified through physical quality and organoleptic testing.

When comparing the golden apple snail mucus gel to snail mucus gel (*A. fulica*), both types have a clear, yellowish to cloudy appearance with a semi-solid consistency. Visually, there is no significant morphological difference in the golden apple snail mucus gel, nor in the snail mucus gel, even with varying mucus concentrations. However, the snail mucus gel has no odor, unlike the golden apple snail mucus gel, which has a fragrance or a carbopol-like odor (Fajriyah *et al*., 2020; Shoviantari *et al*., 2021).

Physical Quality of Golden Apple Snail Mucus Gel Formulation

In this study, the physical quality of the golden apple snail mucus gel was tested based on viscosity, pH, homogeneity, adhesion, and spreadability, with three repetitions. Three types of gel formulations were prepared with varying concentrations of golden apple snail mucus (10%, 15%, and 20%). The results of the physical quality tests for the gel containing golden apple snail mucus are shown in Table 1. Viscosity is a measure of a liquid's thickness. An ideal gel formulation has a viscosity between 2.000 and 50.000 cps (SNI 16-4380-1996) (Rinatha *et al*., 2023). The viscosity test results for the golden apple snail mucus gel formulation ranged from 54.133 to 60.560 cps (Table 1), exceeding the standard viscosity range for gels. Viscosity is inversely related to spreadability; the higher the viscosity of a liquid, the lower its spreadability. The gel containing 15% golden apple snail mucus exhibited the highest viscosity compared to the 10% and 20% concentrations. A significant difference was observed in the gel formulation group with a 20% concentration. Carbopol 940, a gelling agent, plays an important role in regulating the viscosity of the gel formulation (Nurman *et al*., 2019).

Acidity (pH) is a crucial parameter for gel formulations, as gels are topical preparations applied to the skin. Therefore, the gel should have a pH similar to human skin (4.5–6.5) to prevent irritation or erythema (Nurman *et al*., 2019). In this study, the golden apple snail mucus gel had a pH of 4.96–5.16, which is within the range of human skin pH (Table 1). A lower pH gel formulation can reduce infection, accelerate re-epithelialization, and speed up new skin formation (Moen *et al*., 2018). Triethanolamine (TEA) was used in preparing the golden apple snail mucus gel. In gel formulations, TEA regulates the acidity level, ensuring it is safe for users. TEA has a pH of 10.5, which is slightly alkaline, whereas Carbopol 940, the gelling agent, has a more acidic pH (Cui *et al*., 2022; Safitri *et al*., 2021). The combination of TEA and Carbopol 940 in the gel formulation helps enhance gel properties such as pH, viscosity, spreadability, adhesion, organoleptic characteristics, and stability (Safitri *et al*., 2021).

The homogeneity test was conducted to determine the uniformity and stability of the gel formulation. The gel formulation containing golden apple snail mucus appeared homogeneous, with no visible clumps and an even distribution. A homogeneous gel formulation facilitates the uniform distribution of active ingredients and can effectively penetrate wounds, thereby accelerating the healing process (Ali *et al*., 2013). The adhesion properties of a gel are an important characteristic that indicates its ability to adhere to the wound surface and promote healing. The gel formulation containing golden apple snail mucus exhibited adhesion for more than five minutes. This meets the adhesion criteria for gel formulations, which is more than four seconds (Shoviantari *et al*., 2021). Based on this testing, no significant differences were observed among the gel formulation groups.

Table 1. Physical quality of golden apple snail mucus gel preparations with different concentrations; (G1) 10% golden apple snail mucus gel, (G2) 15% golden apple snail mucus gel, (G3) 20% golden apple snail mucus gel

Numb.	Parameters	Standard	G1	G2	G3
1.	Viscosity (cps)	2.000 – 50.000	59.893,33 ± 1834[a]	60.560,00± 0,00 [a]	54.133,33 ± 1073 [b]
2.	pH	4,5 – 6,5	5,16 ± 0,01 [b]	4,96 ± 0,00 [a]	4,99 ± 0,00 [a]
3.	Homogeneity	Homogeneous	Homogeneous	Homogeneous	Homogeneous
4.	Adhesion (minute)	> 4 seconds	>5	>5	>5
5.	Spreadability (cm)				
	50 g		3,03 ± 0,20 [a]	2,90 ± 0,11 [a]	2,93 ± 0,06 [a]
	100 g		3,23 ± 0,14 [a]	3,03 ± 0,08 [a]	3,13 ± 0,03 [a]
	150 g	5 – 7	3,53 ± 0,05 [a]	3,30 ± 0,1 [a]	3,37 ± 0,11 [a]
	200 g		3,77 ± 0,03 [a]	3,60 ± 0,05 [a]	3,60 ± 0,05 [a]
	250 g		4,00 ± 0,00 [a]	3,90 ± 0,10 [a]	3,93 ± 0,03 [a]

The values represent Mean ± Standard Error. Different lowercase letters in the same row indicate significant differences ($p<0.05$) based on Duncan's test.

The spreadability of a formulation is defined as the ability of the gel to be spread on the skin surface. The larger the spreading diameter, the greater the surface area that can be covered by the gel. Good spreadability supports the uniform application of a gel when applied to the skin. An ideal spreadability range for gel formulations is between 5 and 7 cm (Nurman *et al*., 2019). The spreadability test results for the gel containing golden apple snail mucus showed values ranging from 2.90 to 4 cm, indicating that the gel has poor spreadability. The ingredient affecting the spreadability of this formulation is Carbopol 940; as the concentration of Carbopol 940 increases, the spreadability of the gel formulation decreases (Nurman *et al*., 2019). Overall, the golden apple snail mucus gel formulation meets the standards for pH, homogeneity, and adhesion, but it has a viscosity that is too high and suboptimal spreadability. Therefore, adjustments to the formulation, particularly regarding the concentration of Carbopol 940, are needed to achieve viscosity and spreadability that align better with ideal standards.

Although this gel formulation has high viscosity, it can still be used topically; however, special considerations are required for

application on the skin due to its thick consistency, such as the technique used during application. When the gel formulation is applied to the skin, a gentle rubbing or massaging motion is recommended to ensure proper distribution and penetration into the skin (Brown *et al*., 2011). One of the treatments used to heal burn wounds on the skin is hydrogel. Common commercial hydrogel types include IntraSite™ and Nu-Gel™ (Cook *et al*., 2022). These hydrogels have high viscosities, with IntraSite™ ranging from 240 to 250 Pa.s (240.000 to 250.000 cps) and Nu-Gel™ ranging from 580 to 590 Pa.s (580.000 to 590.000 cps) (Jones & Vaughan, 2005).

IntraSite™ has been used on various types of burn wounds. There was a case of second-degree burns occurring in six children caused by fireworks. IntraSite™ was applied to the wounds and covered with a dressing. Five out of the six children with burns healed within 20 days, with the remaining wound healing by day 37 (Jones & Vaughan, 2005). Therefore, gel formulations with very high viscosities can still be used in the topical treatment of burn wounds. However, special techniques are needed for application on the skin, such as gently massaging the area. This is done to ensure the gel formulation is well-distributed and that the patient remains comfortable without feeling pain at the wound site.

Organoleptic Testing of the Gel Formulation

The gel formulation that has been created underwent organoleptic testing, which involved filling out questionnaires from 15 panelists consisting of 10 non-standard panelists and 5 standard panelists. The organoleptic testing of the gel formulation includes scoring tests and acceptance tests, as shown in Figures 2 and 3. Based on the scoring test of the gel preparation (Figure 2), the gel preparations containing golden apple snail secretion in groups G1, G2, and G3 tend to have a very thick consistency and a pleasant aroma with a slight scent of carbopol. The gel preparations exhibit different colors depending on the concentration of golden apple snail secretion used. Gel preparations with a low concentration of snail secretion (10%) tend to be more transparent, whereas those with a high concentration (20%) appear whitish.

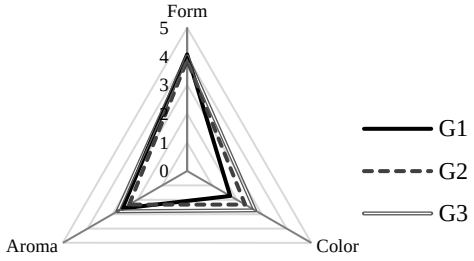

Figure 2. Scores of the gel preparations 1, 2, and 3 based on the percentage of panelists (%). **Note:** For **form**, (1) is very liquid, (2) is liquid, (3) is viscous, (4) is very viscous, and (5) is solid. For **color**, (1) is clear, (2) is slightly cloudy, (3) is whitish, (4) is white, and (5) is slightly yellowish. For **aroma**, (1) is odorless, (2) is fragrant, (3) has a slight smell of Carbopol, (4) smells of Carbopol, and (5) has a strong smell of Carbopol. The gel preparations are categorized as follows: G1 (gel with 10% Golden Apple Snail mucus), G2 (gel with 15% Golden Apple Snail mucus), and G3 (gel with 20% Golden Apple Snail mucus).

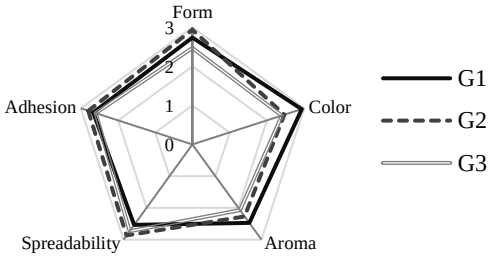

Figure 3. Acceptance scores of gel preparations 1, 2, and 3 based on form, color, aroma, spreadability, and adhesion. **Note:** (1) dislike, (2) somewhat dislike, (3) like. The gel preparations are categorized as follows: G1 (gel with 10% Golden Apple Snail mucus), G2 (gel with 15% Golden Apple Snail mucus), and G3 (gel with 20% Golden Apple Snail mucus).

Based on the acceptance scores for the gel formulation containing golden apple snail mucus (Figure 3), there are differences in the acceptance of the gel formulation according to the categories of form, color, spreadability, and adhesion. The most favored gel in the form category is G2, in the color category is G1, in the aroma category is G1, in the spreadability category is G2, and in the stickiness category is G2. Overall, the gel formulation containing 15% golden apple snail mucus has the highest acceptance based on form, spreadability, and adhesion compared to the other gel formulations.

The organoleptic testing of the gel

formulation was conducted to evaluate its effectiveness, safety, and how well it can be accepted by users. The testing on the gel formulation is not limited to its effectiveness in healing burns but also considers the comfort during use by the users. If users feel comfortable using this gel formulation, it can enhance their compliance with the treatment, maximizing the benefits of the medication and speeding up the healing of burn wounds (Haris *et al*., 2022). In general, the gel formulation containing 15% golden apple snail mucus demonstrates the best balance between effectiveness, safety, and user comfort. This formulation has high acceptance regarding shape, spreadability, and stickiness, making it an optimal formulation compared to other gel formulations.

Conclusion

The gel of golden apple snail mucus (*P. canaliculata*) possesses gel qualities that meet standards based on pH, homogeneity, and adhesive properties, as well as a high acceptance rate, particularly for the 15% golden apple snail mucus gel formulation. For future research, adjustments to the gel base are necessary to ensure that the gel produced is not overly thick.

Acknowledgments

The authors would like to thank all the panelists who contributed to the organoleptic testing of the formulated gel.

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