From Invasive to Creative: Transforming *Salvinia molesta* in Taman Botani Sri Medan into Cosmeceutical Solid Soap

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ABSTRACT
Salvinia molesta is invasive species and is also known as the worst weed that invaded Malaysia's native wide range of aquatic ecosystem. This study was conducted to identify the potential metabolites *Salvinia molesta* invasive plant species from family Salviniaceae in Taman Botani Sri Medan, Batu Pahat, Malaysia. Qualitative and quantitative analysis done with *Salvinia molesta* that yield the result of phytochemical content such as tannin, flavonoid, alkaloid, saponin, and phenolic compounds. The total phenolic content was analyzed using the Folin-Ciocalteu method was recorded at 7.803 ± 0.015. The flavonoid content determined by the aluminum chloride colorimetric method was recorded at 121.41 ± 0.116. Total tannin content was determined and resulted at 46.154 ± 0.31. While for alkaloid content and total saponin content at 1.74 ± 0.933 and 13.12 ± 2.561 respectively. The analysis of solid soap product included pH using pH meter recorded at 10.68 ± 2.311, moisture content at 20.01 ± 3.163 and foam height recorded at 7.26 ± 1.906. The developed soap with *Salvinia molesta* extracts as the final cosmeceutical product was analyzed with a soap analysis to ensure the quality, safety and acceptance of the public.

Keywords*: Cosmeceutical solid soap, Phytochemical content.*

1. INTRODUCTION

Salvinia molesta, often known as Giant Salvinia or Kariba weed, is a freshwater fern in the Salviniaceae family. Salvinia ferns are made up of 10 species, the bulk of which grow in tropical and subtropical freshwater bodies. [1]. It's a free-floating plant that doesn't cling to the ground but floats on the surface of a body of water. Salvinia molesta likes slow-moving waters like those found in lakes and ponds to thrive. [2].

Salvinia molesta is still one of the world's most critical plant management issues, and our country's most pressing scientific issue. Salvinia molesta reduces nutrient and oxygen concentrations in water while increasing carbon dioxide and hydrogen sulphide concentrations, resulting in a reduction in water quality. [3]. *Salvinia molesta* is regarded as the world's worst weed [4].

There is a broad range of compounds especially phenolic compounds, discovered and isolated from plant parts of *Salvinia molesta*, and studies have also shown these chemicals have antibacterial, antimicrobial, antidepressant, antiviral and other activities [5]. The presence of considerable levels of antibacterial activity, total phenol, total flavonoid, tannins, alkaloids, and saponin content in Salvinia molesta leaf extract was discovered in this study. [2]. Phenolic compounds may have potent antibacterial properties. As expected, the effects of phenolic compounds ranged from bacterial growth stimulation to antibacterial action, and were extremely variable depending on the bacterial strains. [6]. Flavonoids also have been reported to possess many useful properties, including antimicrobial, anti-inflammatory, antiallergic, cytotoxic and vascular antitumor activity [7]. Apigenin, galangin, flavone and flavonol glycosides, isoflavones, flavanones, and

chalcones are some of the flavonoids that have been demonstrated to have antibacterial activity. [8].

Next, humans use natural alkaloids extracted from a range of plants as antibacterial, antiviral, antifungal, and anticancer medicines. Various alkaloids display beneficial properties, some of which being effective in skin sunscreens [9]. Alkaloids are also capable of inhibiting the activity of bacteria, fungi, and protozoan. Tannins can be toxic to bacteria, filamentous fungi and yeast. Good antibacterial activity was observed due to the presence of antibacterial components in plants like tannins [10]. For example, hydrolyzable and condensed tannins derived from flavanols showed antibacterial activity by inhibiting particularly the growth of bacteria [11]. Saponins have long been thought to be a phytochemical substance that protects plants from infections due to their widespread distribution throughout plants. As a result, there is no doubt that saponins are a promising therapeutic candidate. [2]. Saponins exhibit a wide range of biological actions, including antibacterial, antifungal, antiviral, anti-inflammatory, anti-ulcer, hemolytic, and hepatoprotective characteristics. [24]. Salvinia molesta, a fast-growing freshwater weed with prospective therapeutic properties, was examined and discovered as an aquatic weed with promising therapeutic capabilities that can be beneficially employed for its medicinal properties to heal and address numerous new disorders. [2].

The understanding of the mechanism of beneficial properties of *Salvinia molesta* extract is the first step in the optimal utilization of this plant extract as natural alternative way to tackle issues of invasive species in Malaysia. With this goal, this study seeks (1) to identify the phytochemical contents quantitative and qualitative in *Salvinia molesta*, invasive plant and (2) to develop creative cosmeceutical product, solid soap using *Salvinia molesta* extract.

2. MATERIALS AND METHODS

2.1 Plant Identification and Herbarium

Plant samples of Salvinia molesta were gathered using conventional procedures in Taman Botani Sri Medan, Johor. Other standard data was entered on pre-prepared forms at Taman Botani Sri Medan, including location, vegetation, habitat description, other medicinal plants present, and local plant name. Photographs of morphological features were also taken with a digital camera. Associate Professor Dr. Alona Cuevas Linatoc of Universiti Tun Hussein Onn Malaysia (UTHM) performed the authentication. Triplicates of each Herbarium specimen were pressed, oven-dried for two weeks at 40°C, and mounted on herbarium sheets, which were subsequently deposited in the Herbarium Collection at Universiti Tun Hussein Onn Malaysia (UTHM) for future reference.

2.2 Plant Sample Extract Preparation

The *S. molesta* sample was rinsed to remove the dirt on the surface using tap water. The constant mass of *S. molesta* plant sample was obtained after 89 hours air-dried. Then dried samples were grounded into a fine powder by using a blender and kept in a desiccator -20° C until extracted. The sample was mixed with methanol with a ratio of 1:10 in a conical flask. Before filtering it using Whatman filter paper No. 1, soaked for 30 minutes the mixture at room temperature [12]. Repeated processes for 3 times and combined the methanol extract all together in a beaker. Next, evaporated the extract using a rotatory evaporator and weighted the crude methanol extract and calculated the percentage of yield.

2.3 Qualitative Analysis

By using different solvent reagent on aquatic plant extract were tested for the presence of flavonoid, phenol, tannin, saponin and alkaloid.

2.3.1 Test Phenolic

One ml of *S. molesta* extract was added with one ml of distilled water. Then two drops of ferric chloride solution were added and the formation greenish indicate the presence of phenolic compound [13].

2.3.2 Test Flavonoids

To 0.05 g of S. molesta extract, a few drops of diluted 20 % sodium hydroxide were applied. With the addition of a few drops of dilute acid, the strong yellow colour fades to colourless, indicating the presence of flavonoids [14].

2.3.3 Test Alkaloid

Two ml of S. molesta extract and two ml of concentrated HCI were mixed together. The presence of alkaloid was determined by adding a few drops of Mayer reagent, which resulted in the production of a white creamy precipitate [13].

2.3.4 Test Saponin

Two ml of *S. molesta* extract was added to two ml of distilled water and shaken vigorously for 10 minutes. The formation of 1cm layer foam indicate the presence of saponin [13].

2.3.5 Test Tannin

Two ml of 5 percent ferric chloride were added to one ml of S. molesta extract. The presence of tannins is indicated by the greenish-black coloration [15].

2.4 Quantitative Analysis

2.4.1 Total Phenolic Content

Total phenolic content in the *Salvinia molesta* extracts was determined [16] with slight modification. 1 mL of extract was mixed with 2.5 mL of Folin-Ciocalteu reagent which was diluted 10fold with distilled water. The mixture was then added 2 mL of 7.5 % sodium bicarbonate and incubated for 10 minutes at room temperature. A UV/ Visible spectrophotometer was used to test the absorbance at 765 nm against a blank and standard gallic acid solution. At room temperature, the procedures for varying concentrations of standard solution were repeated. The sample's total phenolic acid concentration was calculated as mg gallic acid equivalent.

2.4.2 Total Flavanoid Content

The total flavonoid content of *Salvinia molesta* was determined by aluminum chloride colorimetric method [16] with minor modification. 1 ml of *Salvinia molesta* extract was added to 3 ml with methanol. Then, 0.2 ml of 10% AlCl3, 0.2 ml of potassium acetate and 5.6 ml distilled water were added to the extract. The test solution was vigorously shaken. Absorbance was recorded at 415 nm after incubated for 30 minutes. A UV/ Visible spectrophotometer was used to create a standard calibration plot at 415 nm using varying amounts of rutin. The flavonoid concentrations in the test samples were estimated using the calibration plot and represented in mg rutin equivalent (QE).

2.4.3 Total Alkaloid

Total alkaloid content was determined according to the methodology [13] with slight modification. 100 ml of 10% acetic acid in ethanol was added to the *S. molesta* sample and allowed to stand for 2 hours. Next, the extract was reduced and concentrated to 25 ml from the original volume. 15 drops of concentrated ammonium hydroxide were applied after filtration until the precipitation was complete. The supernatant was discarded after 3 hours of sedimentation, and the precipitates were rinsed with 20 mL ammonium hydroxide and filtered using Whatman paper No. 1. The residue of the extract was dried in an oven at temperature 50°C until reached constant mass for 96 hours and the percentage of alkaloid was expressed and calculated mathematically as by the following Equation (1):

$$\% \text{ Alkaloid} = \frac{\text{Weight of alkaloid}}{\text{Weight of sample}} \text{x } 100 \quad (1)$$

2.4.4 Total Saponin Content

The total saponin content was determined according to the methodology [16] with minor modification. 100 ml of 20% aqueous ethanol was added to *Salvinia molesta* sample and was heated over a hot water bath at a temperature of 55°C for 2 hours. After filtration, the residue of the mixture was re-extracted with another 100 ml of 20% aqueous ethanol and heated for 2 hours at 55°C at a continuous temperature. Over a water bath at 90°C, the mixed extract was evaporated to 20 mL. After that, 10 mL diethyl ether was added to the concentrate and vigorously shaken. The aqueous layer was saved, while the ether layer was thrown away. This purification procedure was carried out twice more. 30 mL n-butanol was added, and 5 mL of 5% sodium chloride was extracted twice. The sodium chloride layer was then removed, and the residual solution was heated in a water bath for 30 minutes before being dried in an oven for 72 hours to achieve a constant weight. The saponin content was calculated as a percentage following the Equation (2):

$$\% \text{ Saponin} = \frac{\text{Weight of saponin}}{\text{Weight of sample}} \text{x } 100 \quad (2)$$

2.4.5 Total Tannin Content

The tannins were determined using the Folin-Ciocalteu method with minor modifications [16]. 0.1 ml of the sample extract was added to a volumetric flask containing 7.5 ml of distilled water, 0.5 ml of Folin-Ciocalteu phenol reagent, and 1 ml of 35 % sodium carbonate solution, and then diluted to 10 ml with distilled water. The liquid was thoroughly mixed before being stored at room temperature for 30 minutes. A set of tannic acid reference standard solutions (20, 40, 60, 80, 100 g/ml) was developed. A UV/ Visible spectrophotometer was used to measure the absorbance of test and standard solutions against a blank at 700 nm. The tannin content of the dried sample was measured in mg of tannic acid equivalents.

2.5 Solid Soap Preparation

Solid soap was developed [17]. 4g of coconut oil and 6g of olive oil were mixed in the beaker. The mixture was heated and maintained at 115 °C. Then, 30g of glycerin was added to the mixture and maintained at the temperature of 115 °C. Next, 0.1g of *S. molesta* extract was added until it dissolved completely before added 4 drops of lavender essential oils and 6 ml of natural coloring using a transfer pipet. Heated and stirred the mixture for 30 minutes before poured the soap into the soap molds and waited for 48 hours for the soap to harden and solidified.

2.6 Soap Analysis

2.6.1 Foam Height Stability and Hardness of Soap

Soap with 10% solution was prepared by dissolving 1 g of solid soap with *S. molesta* in 10 ml distilled water

formed the lather in a test tube and the height of foam was measured. The standard commercial soap (LUX) was prepared and steps were repeated by lather and foam height was observed and measured [18].

2.6.2 Moisture Content and pH of Soap

The sample solid soap with S. molesta was analyzed and data moisture content was recorded by using moisture analyzer mx-50. For pH measurement, 1 g of solid soap with *S. molesta* dissolved in 10 ml distilled water. The pH of the solid soap solution was measured using a pH meter. The standard commercial soap (LUX) was prepared and steps were repeated by moisture content and pH was observed and measured [18].

2.7 Sensory Evaluation of Solid Soap

The solid soap with *S. molesta* extract was distributed among 50 respondents that consist of students and lecturers in Universiti Tun Hussein Onn, Pagoh. The respondents answered the survey generated in Google Form (Appendix B). The survey includes attributes of solid soap such as hardness, texture, fragrance, lathery, size, and shape of soap [19].

3. RESULTS AND DISCUSSION

3.1 Qualitative Analysis

Table 3.1. Qualitative analysis on *Salvinia molesta* extract

Test	*Salvinia molesta* in methanol extract
Phenol	+
Flavonoid	+
Tannin	+
Alkaloid	+
Saponin	+

*Plus (+) indicates the presence and minus (-) signifies absence.

The phytochemical constituents such as phenols, flavonoids, tannin, alkaloids and saponin in *Salvinia molesta* may responsible for potent antibacterial activity. The phytochemical screening of *Salvinia molesta* qualitatively shown the presence of alkaloids, flavonoids, tannins, saponins along with phenols in methanol extracts investigated (Table 3.1). Greenish blue color indicates the presence of phenolic compound using Ferric Chloride test, colorless color formed to show the presence flavonoid in Alkaline Reagent test while for tannin compound was showed by formation greenish-black color using Ferric Chloride test. Alkaloid compound detected by using Mayer test and presence indicated by the formation white precipitate and saponin presence using foam test and successfully 1 cm layer foam formed.

3.2 Quantitative Analysis

Table 3.2. Quantitative analysis on *Salvinia molesta* extract

Phytochemical	Total Content
Phenol	7.803 ± 0.015
Flavonoid	121.41 ± 0.116
Tannin	46.154 ± 0.312
Saponin	13.12 ± 2.561
Alkaloid	1.74 ± 0.933

The total phenolic component concentration of Salvinia molesta extracts, as evaluated by the Folin-Ciocalteu reagent. y = 0.0001x + 0.0543 with R2=0.9758 were used to create linear calibration curves. Salvinia molesta has a total phenolic concentration of 0.7803 mg GAE/g in methanol extraction. The total phenolic compound was found to be 7.803 ± 0.015. (Table 3.2). The amount of phenols in Salvinia molesta extracts was determined by the polarity of the solvent employed for extraction. The strong dissolubility of phenols in polar solvents resulted in a high concentration of phenol components in extracts prepared with polar solvents like methanol. Antioxidant and antibacterial properties of phenolic compounds have already been investigated. Antimicrobial characteristics are known to exist in several plant phenolics. Bactericidal and fungicidal properties have also been discovered in phenolic compounds. Increased phenolic compound buildup in plants can help plants defend themselves against diseases. [20].

The concentration of flavonoids in methanol extracts of *Salvinia molesta* was determined by using the aluminum chloride colorimetric method using $AlCl_3$. Linear calibration curves were produced, y= 0.0003x + 0.121 with R^2= 0.9801 (Table 3.2). The total flavonoid content of *Salvinia molesta* in methanol extraction is 12.141 mg RU/g. Total flavonoid compound recorded at 121.41 ± 0.116 (Table 3.2). Most flavonoid compounds have shown multiple biological activities such as anti-oxidation, antiinflammation, anticancer, and cardiovascular protection. The antibacterial properties of the *Salvinia molesta* may be attributed to the high content of flavonoids which have been proven and reported which flavonoids are synthesized by the plant as secondary metabolites in response to microbial infection and diseases. Plant extracts with antibacterial properties are becoming more common, and more flavonoids, particularly those with hydrophobic substituents like the

phenyl group, have been identified to be antibacterial agents. [21].

While for tannin compound, linear calibration curve produced, y = 0.001x + 0.0796 with R^2= 0.9578 Total tannin content of *Salvinia molesta* in methanol extraction is 4.6154 mg RU/g. Total tannin in *Salvinia molesta* was recorded at 46.154 ± 0.312 (Table 3.2). Tannins have a wide range of biological effects, including cardioprotection, anti-inflammatory, anti-carcinogenic, antiviral, and antibacterial capabilities, which are attributed to their antioxidant and antiradical activity. [22]. Tannins, in particular, hinder bacterial growth and protease activity by inducing fast structural breakdown in the cell wall and cytoplasm. [7].

Alkaloids consist of chemical compounds that contain mostly basic nitrogen atoms which occur naturally, mainly, in plants. In this study, the total alkaloid content was obtained in *Salvinia molesta* is 1.74 ± 0.933 (Table 3.2). Although the value is low it present and show the potential and ability to act as antibacterial. The low yield of alkaloid compound in *Salvinia molesta* maybe because of environmental factors such as the low-stress condition and pathogens attack in Taman Botani Sri Medan. Alkaloids exhibit a wide range of pharmacological effects, according to the literature, including antimalarial, anticancer, antibacterial, and antihyperglycemic properties. Alkaloids have been shown to have antibacterial properties, inhibiting transcription, toxin generation, and other processes.[7]. Alkaloids have been shown to exhibit antibacterial action, and numerous studies have shown that these chemicals could play a key role in the treatment of a variety of infectious disorders.[23].

The amount content of saponin in *Salvinia molesta* methanol extract was 13.12 ± 2.561 (Table 3.2) which moderate value composition phytochemical in plants. Although the extraction yield was low, saponin has pharmacological properties such as anti-inflammatory, antibacterial, anthelmintic, antidermatophytic, antitussives, and cytotoxic activities, which have been proven in previous investigations. The physiochemical and biological properties feature the structural diversity of saponin, which has led to a number of traditional and industrial applications. There is a substantial correlation between saponin structure and antibacterial action. The antibacterial actions are influenced by the structure of the sapogenin moiety, chain length, and sugar content. Saponins, which have detergent-like qualities, may act on the bacterial cell wall and display antibacterial activity by increasing the permeability of the bacterial cell membrane, according to recent research. [24].

3.3 Solid Soap Analysis

The chemical analysis of solid soap with *Salvinia molesta* in terms of moisture content, pH and foam height was compared to standard commercial soap (Table 3.3). The pH value of *Salvinia molesta* soap (10.68 ± 2.311) was slightly higher than standard commercial soap (10.53 ± 2.294) but both in a safe and optimum range of pH. Due to incomplete alkaline hydrolysis, the high pH suggested a significant percentage of unidentified and unsaponifiable materials. Moisture refers to the presence of a liquid, most commonly water, in a trace amount.

Table 3.3. Chemical analysis on quality criteria of soaps with *Salvinia molesta* extract and soap commercial.

Attribute	Soap with *Salvinia molesta* extract	Standard commercial soap (Lux)
pH	10.68 ± 2.311	10.53 ± 2.294
Moisture content	20.01 ± 3.163	9.05 ± 2.127

The moisture contents of *Salvinia molesta* soap were observed at 20.01 ± 3.163 while the percentage of moisture content in the standard commercial soap was 9.05 ± 2.127. The foam height of the *Salvinia molesta* soap was 7.26 ± 1.906 higher than standard commercial soap at 5.43 ± 1.65 were analyzed and show a better ability of lathering. Foam features have related to do with the cleansing ability [18], it is the importance to the consumer and is therefore considered as a parameter in evaluating soaps. The values of *Salvinia molesta* soap extract attributes determined were within the limits set by standards quality of soap.

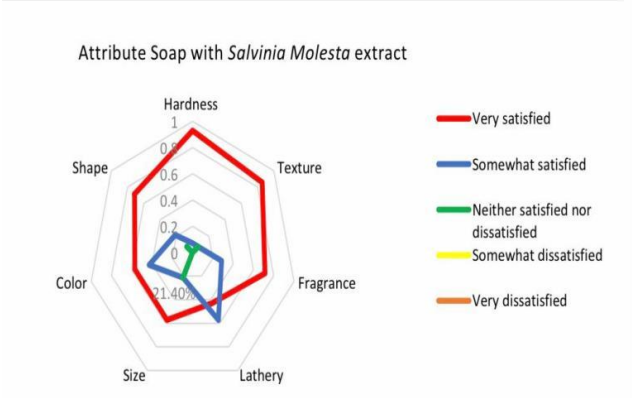

Figure 3.1. Sensory analysis *Salvinia molesta* soap.

Results of the sensory evaluation on a survey of *Salvinia molesta* extract solid soap by 50 respondents from Universiti Tun Hussein Onn Malaysia, Pagoh as shown in Figure 3.1. From the data analysis, more respondents evaluated *Salvinia molesta* extract soap in terms of hardness by 46 respondents (92%) very satisfied while the rest 4 respondent (4%) were somewhat

satisfied. The highest scale which is very satisfied evaluated by the respondent for texture (86%), fragrance (72 %), lathery (42 %), size (58 %), color (58 %), and shape (72%) while somewhat satisfied for texture (7%), fragrance (28 %), lathery (58 %), size (21 %), color (42 %), and shape (20%) and lastly for scale neither satisfied nor dissatisfied for only three attributes which are texture (7%), size (21 %), and shape (7%).

From the survey on sensory evaluation, these attributes are important in determining solid soap quality which that can influence consumer preference and acceptance. Therefore, respondents considered the key attributes of *Salvinia molesta* extract soap to be at the ideal level and acceptable to most of the respondents. With the presence of *Salvinia molesta* extracts in the solid soap, it has excellent ability to clean and disinfect skin from harmful bacteria and dirt which act as antibacterial soaps as one of the most useful and fundamental hygiene tools.

There are phytochemicals content such as tannin, alkaloid, saponin, flavonoid, and phenolic compounds produce in *Salvinia molesta* invasive aquatic plant species that collected at Taman Botani Sri Medan, Johor. *Salvinia molesta* also shown a significant amount of quantitative analysis especially total phenolic content and total tannin content. Lastly, the solid soap cosmeceutical product with *Salvinia molesta* was successfully developed and acceptable among the respondents and safe to be used on the skin and one of the effective alternatives made to tackle issues on invasive species and directly contribute to the survival and conservation of our native species.

ACKNOWLEDGMENT

In this study, I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. A special gratitude I give to my supervisor and my thesis advisor, Dr Furzani Binti Pa'ee of the Faculty of Applied Science and Technology whose contribution in stimulating suggestions and encouragement, helped me to coordinate my project especially in writing this report.

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