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CHARACTERIZATION AND STANDARDIZATION OF SCOBY (SYMBIOTIC CULTURE OF BACTERIA AND YEAST) FERMENTATION USING MANGO LEAVES (*Mangifera indica* L.) AS A RAW MATERIAL FOR TOPICAL APPLICATIONS

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ABSTRACT

Background: Fermentation using SCOBY (Symbiotic Culture of Bacteria and Yeast) represents an innovative bioprocess with significant potential for producing active ingredients suitable for topical applications. In this study, mango leaves (Mangifera indica L.), recognized for their rich content of secondary metabolites such as polyphenols, were utilized as a substrate to enhance the profile of bioactive compounds through fermentation. The primary objective was to characterize and standardize the chemical composition of SCOBY-fermented mango leaves via organoleptic evaluation and quantification of total phenolic and flavonoid content
Methods:. Characterization and standardization of SCOBY fermentation using mango leaves (*Mangifera indica* L.) were conducted through organoleptic evaluation and quantification of total phenolic and flavonoid content in accordance with Indonesian Herbal Pharmacopeia
Result: The fermented product exhibited a dark brown color, a distinct fermented aroma, a sour and mildly bitter taste, and a pH reduction to 3. Chemical analyses revealed a total phenolic content of 3.79% GAE (gram equivalent of gallic acid) and a total flavonoid content of 1.94% QE (gram equivalent of quercetin), with an IC_{50} antioxidant activity value of 1.89 mg/mL. Given its enriched polyphenol content, the SCOBY-fermented mango leaf extract demonstrates substantial potential as an active ingredient in topical formulations, specifically due to its antioxidant properties, wound healing capabilities, and UV protective (Sun Protection Factor, SPF) effects. This study highlights the potential value of fermented mango leaves as a key component in natural skincare and therapeutic formulations, offering sustainable, bioactive-rich alternatives for product development in the cosmetic industry.

Keywords: SCOBY fermentation; Mango leaves (Mangifera indica L.); Topical formulations; Phenolic content; Flavonoid content; antioxidant

INTRODUCTION

Growing public awareness of healthy lifestyles has fueled interest in foods and beverages that offer both refreshment and health benefits. Among these functional fermented products, kombucha has become increasingly popular for its potential to support microbiota balance and provide a rich source of antioxidants (Ecklu-Mensah et al., 2024; Huang, 2024). Kombucha is typically produced by fermenting tea and sugar, facilitated by a Symbiotic Culture of Bacteria and Yeast (SCOBY) (Huang, 2024). During fermentation, the SCOBY converts sugars and phenolic compounds in tea into various bioactive compounds, including organic acids, polyphenols, and antioxidants (Shi et al., 2023; Su et al., 2023).

To diversify fermentation substrates, researchers have explored other natural ingredients, such as fruits, herbs, and agricultural by-products, as alternatives to tea (Barakat et al., 2023). In this study, mango

leaves (Mangifera indica L.), recognized for their high content of bioactive compounds like mangiferin and quercetin with potent antioxidant activity (Shah et al., 2024), were selected as the SCOBY fermentation substrate. Unlike traditional kombucha, primarily consumed orally, this research aims to characterize and standardize SCOBY fermentation using mango leaves for the production of topical skincare products, introducing a novel approach in skincare applications.

This study will evaluate the bioactive components, particularly antioxidants, in the fermented product for their potential to protect skin from free radical damage. The goal is to develop a standardized mango leaf-based product that is both safe and effective for skincare use. Thus, this research seeks to develop and standardize SCOBY fermentation with mango leaves (Mangifera indica L.) as an innovative, antioxidant-rich raw material for topical applications, offering potential benefits for skin protection and health.

METHODS

Instruments

The equipment used in this study includes an a nalytical balance, water bath, oven, and UV-Vis spectrophotometer.

Materials

The samples used in this study are mango leaves (Mangifera indica L.). Additional materials include distilled water, kombucha starter, gallic acid, sugar, methanol (analytical grade), Folin-Ciocalteu reagent, Aluminum chloride, DPPH (1,1-diphenyl-2-picrylhydrazyl), sodium hydroxide, and sodium acetate.

Collection, Identification, and Preparation of Samples

Mango leaves weighing 5 kg were collected from East Tanjab Regency, Jambi Province. The samples were identified at the Plant Taxonomy Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran. The mango leaves were dried using an oven at 50 °C for approximately three days, resulting in mango leaf simplicia.

Preparation of Mango Leaf Infusion and Fermentation

A total of 125 grams of mango leaf powder was added to 500 mL of distilled water at 100 ºC. The infusion was then filtered, and the volume was adjusted to 500 mL by passing hot water over the sample residue. The infusion was placed in a glass container and cooled to approximately 27 ºC, after which 3 grams of SCOBY (Symbiotic Culture of Bacteria and Yeast) was added. The glass container was covered with a clean white cloth, secured with a rubber band, allowing air to enter while protecting the infusion. Fermentation was carried out for 14 days at room temperature (27 ºC) and stored in a safe place, away from direct sunlight.

Organoleptic Evaluation

The mango leaf infusion and SCOBY fermentation products were analyzed organoleptically by evaluating taste, aroma, and color. Additionally, pH parameters were measured before and after fermentation.

Total Phenol and Flavonoid Assay

The total phenol and flavonoid content of the fermented mango leaf SCOBY products was analyzed according to standard procedures outlined in the Indonesian Herbal Pharmacopoeia (Kementerian Kesehatan RI, 2017).

Antioxidant Assay

The antioxidant activity of the fermented mango leaf SCOBY products was tested using the DPPH method, in accordance with procedures developed by (Zou et al., 2021).

RESULTS AND DISCUSSION

This study utilized mango leaves (*Mangifera indica* L.) sourced from Bunga Tanjung, East Tanjung Jabung Regency, Jambi Province. Taxonomic identification was conducted to verify the authenticity and accuracy of the plant material, encompassing its scientific name, synonyms, local names, and family characteristics. The identification process took place at the Plant Taxonomy Laboratory, Department of Biology, FMIPA, Universitas Padjadjaran (No. 53/HB/01/2024), confirming the sample as Mangifera indica L. This step was critical for ensuring the validity of the study and consistency of data.

The preparation process began with drying mango leaves at 50 °C in an oven, which aimed to reduce moisture content, prevent microbial growth, and ensure the stability of the material during storage. The dried leaves were then processed into a uniform powder of mango leaf simplicia through cutting and grinding, thereby increasing the surface area for better solvent interaction during extraction, enhancing the yield of active compounds (Alshammaa, 2016).

The selection of the hot infusion method using distilled water as the solvent for extracting active compounds from mango leaves is based on its effective ability to dissolve bioactive substances such as xanthone glycosides and mangiferin. However, this method does have limitations compared to more advanced techniques, such as ultrasonic extraction or the use of organic solvents (Castro-Muñoz et al., 2024; Loan et al., 2021), which generally offer higher efficiency in extracting bioactive compounds. Despite this, distilled water remains an economical, safe, and environmentally friendly choice, though further optimization of the extraction process may be necessary to achieve maximal compound yield. The infusion process facilitated the growth of microorganisms within the SCOBY culture, a key element in the fermentation process. Fermentation results indicated notable changes in organoleptic characteristics, including a distinctive fermented aroma, a sour taste with a hint of bitterness, and a pH reduction from 4 to 3. This pH decrease suggested the production of organic acids during fermentation, contributing to the product's functional properties.

The table summarizes the changes in mango leaf infusion characteristics before and after SCOBY fermentation (Table 1). Quantitative analysis of total phenolic and flavonoid content was conducted to standardize the fermented mango leaf product. The phenolic content, expressed as gram equivalents of gallic acid (GAE) per 100 grams of sample, was found to be 3.79%, while the flavonoid content, expressed as gram equivalents of quercetin (QE) per 100 grams of sample, was measured at 1.94%.

Table 1. Characteristics of fermented SCOBY mango leaves.

Characteristic	mango leaf Infusion	Fermented of mango Leaf
color	Blackish brown	Yellowish Brown
Aroma	Distinctive aroma	Distinctive aroma
Taste	Bitter	Sour with a little bitter
pH	4	3

These high levels of phenols and flavonoids highlight the significant potential of the fermentation product as a raw material for topical applications. Phenolic and flavonoid compounds possess a wide spectrum of biological activities, notably strong antioxidant properties, demonstrated by an IC_{50} value of SCOBY fermented mango leaves was 1.89 mg/mL, which helps protect skin from free radicals, and anti-inflammatory effects that promote wound healing. Together, these properties make the SCOBY-fermented mango leaf extract a promising candidate for use in

antioxidant creams, wound-healing gels, and other skin-protective formulations.

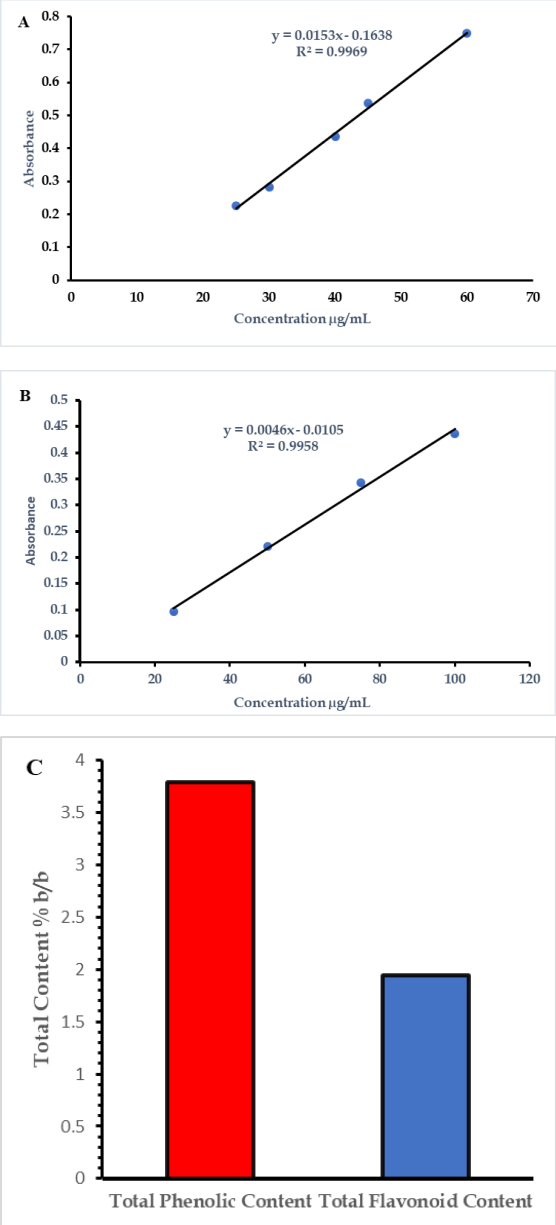

Figure 1. Determination of the total flavonoid and phenolic content in fermented SCOBY mango leaves. (A) Standard curve of Total Phenolic Content (TPC) using gallic acid as standard; (B) Standard curve of Total Flavonoid Content (TFC) using quercetin as standard; (C) TPC and TFC of fermented SCOBY mango leaves.

Thus, the application of SCOBY fermentation to mango leaves not only adds value to this natural material but also offers an innovative solution for the development of safe, nature-based cosmetic and topical formulations. The potential demonstrated here highlights that microbial fermentation can be a sustainable and effective approach to enhancing the therapeutic benefits of bioactive compounds derived from local plants.

CONCLUSION

The fermentation of mango leaves (*Mangifera indica* L.) using SCOBY cultures resulted in significant changes, such as color alterations, the distinctive aroma of fermentation, a sour taste, and a decrease in pH. The high phenol (3.79%) and flavonoid (1.94%) content observed in the fermented product indicates potential antioxidant and anti-inflammatory activity. Consequently, the fermented mango leaf has considerable potential as a raw material for topical formulations, such as antioxidant creams and other skincare products, based on natural, value-added ingredients.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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