Plant Archives Vol. 26, Supplement 1, 2026 pp. 579-583 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.079

BIO-ENZYME BASED HERBAL HAND WASH FOR EFFECTIVE PATHOGEN DEFENSE FROM NATURE TO CLEAN HANDS

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(Date of Receiving : 02-09-2025; Date of Acceptance : 06-11-2025)

ABSTRACT

This study evaluates the germicidal effectiveness and environmental impact of herbal hand wash enriched with bio-enzymes, positioning it as a sustainable alternative to conventional hand wash products. Composed of natural, plant-derived ingredients, the herbal formulation was tested for its ability to combat common pathogens. Results showed that, when used properly, it matched the performance of standard hand wash products in eliminating harmful microbes. Unlike conventional variants that often rely on synthetic chemicals, this herbal solution is free from harsh additives, making it safer for regular use. A key advantage of the herbal hand wash lies in its eco-friendliness. Being biodegradable, it breaks down without leaving toxic residues, thereby minimizing its contribution to soil and water pollution. In contrast, many traditional hand washes introduce pollutants into the environment due to non-degradable chemical ingredients. This positions herbal hand wash as a responsible choice for individuals seeking both hygiene and environmental care. The findings highlight the dual benefits of such formulations ensuring effective hand hygiene while reducing ecological harm. Promoting herbal hand wash with bio-enzymes can thus play a pivotal role in advancing health-conscious and sustainable living practices. Overall, it emerges as a viable, green alternative for maintaining cleanliness without compromising environmental integrity.

Keywords: Antimicrobial efficacy; bio enzymes; biodegradable formulation; eco-friendly hygiene; herbal hand wash; pathogen control.

Introduction

Hand hygiene is essential for preventing the spread of infections, particularly during global health crises such as the COVID-19 pandemic (Joshi *et al.,* 2008). Conventional hand wash products often contain harsh chemicals that may pose risks to personal health and the environment (Chopra *et al.*, 2022). In contrast, herbal hand washes enriched with bio enzymes offer an effective and eco-friendly alternative (Arora *et al.,* 2007). These formulations use plant-based ingredients and enzymes that break down organic matter and eliminate harmful pathogens (Bureau of Indian Standards, 2002). As a result, herbal hand washing is gaining popularity as a safer, more sustainable approach to hygiene (Patil *et al.,* 2017). Natural ingredients such as aloe vera and citrus extracts not only cleanse but also protect and nourish the skin (El-Saye *et al.,* 2021). Research has shown that these herbal products can outperform chemical ones in cleaning action and dirt dispersion (Anand *et al.,* 2024). Their effectiveness is validated through evaluations such as foam retention, foam height, and skin irritation testing (Eley *et al.*, 2003). Bio enzymes sourced from natural materials enhance cleansing without being harsh on skin (Jayasekara and Ratnayake, 2019). Microbial cellulases, often used in such formulations, improve cleaning and promote skin compatibility (Narayan and Sreeja, 2017). These hand washes help maintain the skin's moisture barrier, minimizing irritation compared to synthetic

formulations (Dastider, 2020). Furthermore, the antimicrobial nature of citrus and plant extracts strengthens their germ-fighting ability (Alamgir, 2017). For instance, citrus-based compounds have shown excellent antioxidant and antibacterial properties (Mishra and Tiwari, 2011). As users grow more conscious of safety and sustainability, herbal hand washes are becoming preferred alternatives to conventional options (Singh and Ali, 2016).

Materials and Methods

The herbal hand wash was prepared using ingredients listed in Table 1, including citrus peel, soapnut, aloe vera, gondkatira, and coco glucoside (Bilal and Iqbal, 2020). Each component provides unique functional and skin-friendly benefits (International Organization for Standardization, 2001). Citrus peel is rich in limonene and citric acid, known for antibacterial and astringent properties (Kirtikar and Basu, 2005). Soapnuts provide natural surfactants saponins that create foam and effectively clean (Kiarashi *et al*., 2024). Aloe vera acts as a skin moisturizer and anti-inflammatory agent due to its polysaccharides and enzymes (Bahuguna and Kashyap, 2016). Gondkatira serves as a thickening and cooling agent in the formulation (Chandran and Karthikeyan, 2017).

To prepare the hand wash, 400 ml of distilled water was warmed to around 40°C to aid dissolution (Powar *et al.*, 2015). To this, 50 ml of Gond Katira gel was added with constant stirring for uniform consistency (Rathi and Roy, 2019). Then, 200 ml of soapnut extract was incorporated for its natural foaming ability (Sharma and Bhardwaj, 2020). Next, 100 ml of coco glucoside was added and stirred gently to form a homogeneous mixture (Pandey and Kaur, 2022). Afterward, 100 ml of aloe vera gel was added, followed by an additional 100 ml of Gond Katira gel for enhanced texture (Afsar and Khanam, 2016). Finally, 100 ml of citrus peel extract was added to boost antimicrobial and aromatic properties (Terkar *et al.*, 2021). The complete mixture was stirred for 5–10 minutes to ensure uniformity (Rabe and Van Staden, 1997), then left to rest for 2–3 hours for proper binding of ingredients (Patel *et al.*, 2023). If the formulation became too thick, distilled water was added to achieve the desired consistency (Chatterjee and Biswas, 2011)). The final hand wash was stored in a clean, airtight pump bottle to prevent contamination and ensure stability (Ghosh and Mitra, 2020).

Results and Discussion

The prepared hand wash had a transparent appearance, pleasant aroma, and smooth consistency, contributing to its user appeal (Benny *et al.,* 2023). The formulation maintained excellent homogeneity with no signs of phase separation or grittiness (Khan and Ahmad, 2013). Its pH was recorded at 7.72, well within the skin-friendly range for topical applications (Farooq and Sehgal, 2021). This neutral pH helps preserve the skin's acid mantle, minimizing the risk of irritation (Ajayi and Fagade, 2006). Foam height measured 3 cm, while foam retention was 12 ml both indicating good foaming performance (Table 3) (Marzulli and Maibach, 1970). The dirt dispersion test showed the formulation could suspend dirt in water, with only minimal residue appearing in the foam layer (Bhardwaj and Gupta, 2018). Cleaning performance was evaluated using a wool piece pre-soiled with grease, where the formulation showed efficient degreasing capacity (Bureau of Indian Standards, 2005). No signs of itching, redness, or rashes were noted during the skin irritation test, confirming dermatological safety (Dhanapal and Kavita, 2012) Microbial testing (Table 4) showed that the formulation had no detectable levels of common pathogens such as *E. coli*, *S. aureus* and *P. aeruginosa*, all being below permissible limits (Mukherjee, 2002). This confirmed the hygienic quality and microbiological safety of the product for consumer use (Deshmukh and Rathod, 2020). The product showed excellent functional, physical, and dermatological characteristics, indicating its suitability for regular personal hygiene use (Patel *et al.,* 2021).

Conclusion

Herbal hand washes formulated with bio enzymes offer a potent, natural, and eco-friendly solution for everyday hygiene needs (Kampf & Kramer, 2004). Unlike traditional chemical-based hand washes, these formulations use biodegradable and non-toxic ingredients that are safer for humans and the environment (Saha and Debnath, 2021). They effectively eliminate germs while also reducing the risk of fostering antibiotic-resistant strains (Bureau of Indian Standards, 1999). Their gentle cleansing action, combined with moisturization and skin protection, makes them ideal for frequent use (Daverey and Dutta, 2021).

In addition to efficacy, the herbal hand wash demonstrates stability, skin compatibility, and microbiological safety (Babu and Varghese, 2018). As consumer awareness increases, the demand for green and sustainable hygiene products is also expected to grow (Ponce *et al.,* 2004). This shift will encourage further innovation and research in the area of plant-based personal care formulations (Bureau of Indian Standards, 2004). The present study validates the

effectiveness of herbal hand wash formulations and supports their use as a viable alternative to conventional products (Sharma and Bhardwaj, 2020). Adopting such eco-conscious products represents a forward-thinking approach to hygiene, benefiting both individuals and the environment.

Table 1: Formulation table of herbal hand wash for (1 litre)

S.No.	Ingredients	Quantity
1.	Citrus Peel Extract	100ml
2.	Soapnut (Reetha) Extract	200ml
3.	Aloe Vera Gel	100 ml
4.	Gond Katira (Tragacanth Gum) Gel	50 ml
5.	Coco Glucoside	100 ml
6.	Distilled Water	400 ml

Table 2: The microbiological safety of the formulated herbal handwash was assessed based on standard test methods.

S. No.	Test Parameters	Test Method
1	*Enterococcus faecalis*	ISO 7899-2:2001
2	*Pseudomonas aeruginosa*	IS 13428:2005 Annexure D
3	*Escherichia coli*	IS 5887 (Part-1):1976
4	*Staphylococcus aureus*	IS 5887 (Part-8/sec-1):2002
5	*Aspergillus brasiliensis*	IS 5403:1999
6	*Bacillus cereus*	IS 5887 (Part-6):2004

Table 3: Various evaluation parameters of the performed experiment.

Evaluation Parameters	Observations
Color	Yellow
Texture	Smooth
Odour	Luminous or Translucent
Homogeneity and Appearance	Translucent
Grittiness	Stable
pH	7.72
Viscosity	677 cPs
Foam retention	12 ml
Foam Height	3 cm
Dirt dispersion	Light
Cleaning action	Effective removal of grease observed

Table 4: Microbial Load Test Results of Herbal Handwash

Test Parameters	Test Method	Units	Test Results
Enterococcus faecalis	ISO 7899-2:2001	Cfu/g	<10
Pseudomonas aeruginosa	IS 13428:2005 Annexure D	Cfu/g	<10
Escherichia coli	IS 5887 (Part-1):1976	Cfu/g	<10
Staphylococcus aureus	IS 5887 (Part-8/sec-1):2002	Cfu/g	<10
Aspergillus brasiliensis	IS 5403:1999	Cfu/g	<10
Bacillus cereus	IS 5887 (Part-6):2004	Cfu/g	<10

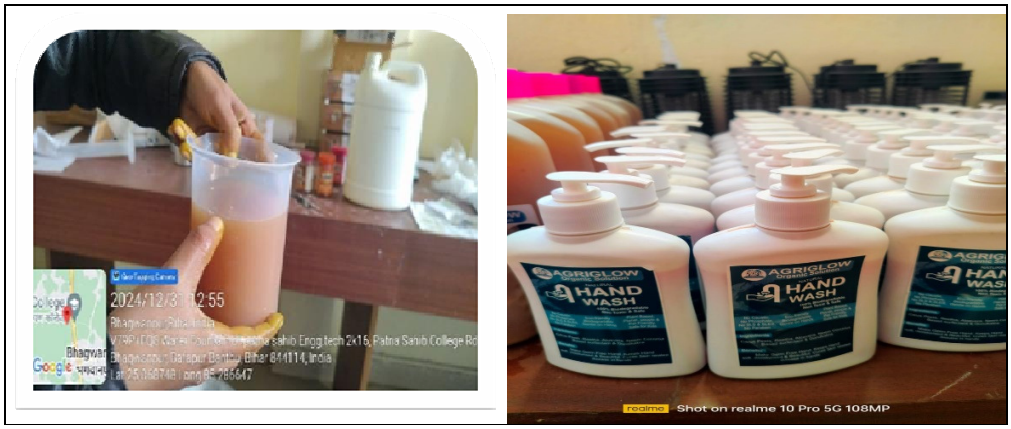

Fig. 1 : Final Packed Product

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