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Original Research Paper

Biochemistry

DEVELOPMENT OF NATURAL, ECO-FRIENDLY DISHWASHING LIQUID USING HIBISCUS SABDARIFFA L AND IN-VITRO ANTIOXIDANT AND ANTIMICROBIAL ACTIVITY

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ABSTRACT The increasing awareness of environmental sustainability and the harmful effects of chemical-based household cleaners has prompted the exploration of natural alternatives. This study focuses on the formulation of an eco- friendly dishwashing liquid using Hibiscus sabdariffa L., a plant known for its natural saponins, antioxidants, and antimicrobial properties. The extract of H. sabdariffa was incorporated into a liquid dishwashing formulation and evaluated for its physicochemical properties. Furthermore, the in-vitro antioxidant activity was assessed using DPPH radical scavenging assay, while antimicrobial activity was tested against common kitchen pathogens including Escherichia coli and Staphylococcus aureus. The results demonstrated promising antioxidant and antibacterial potential, indicating the suitability of H. sabdariffa-based formulations as a sustainable alternative to commercial dishwashing liquids. This study supports the application of plant-based bioactives in household cleaning products to promote eco-conscious consumer practices.

KEYWORDS : Hibiscus sabdariffa L., natural dishwashing liquid, eco-friendly cleanser, antioxidant activity, antimicrobial activity, DPPH assay, green household products.

INTRODUCTION

Dishwashing liquids are essential cleaning agents, formulated to remove food debris, grease, and grime from kitchenware. Modern formulations combine surfactants, solvents, preservatives, and fragrances to break down stubborn residues and reduce water surface tension, enhancing cleaning efficiency.

Products range from mild, skin-friendly options to powerful commercial solutions. Ingredient selection and eco-friendly considerations shape both performance and environmental impact, providing consumers with tailored choices for household or industrial use. (Patel et al., 2024)

Medicinal Plants:

Plants are very useful source of various bioactive compounds which have direct or indirect use in the treatment of various human ailments. From the time immemorial, human cultivation have been exploring and using various plants and plant products to cure the deadly diseases. World Health Organization (WHO, 201) surveyed that about 80% of the World's population, especially in the tribal and rural areas dependent upon herbal traditional medicines for their healthcare needs. (Kuldip S. Dorga et al., 2015)

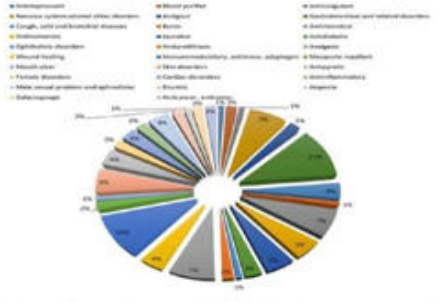

Figure 1: The main uses of medicinal plants encountered

Phytochemicals Of Medicinal Plants

Phytochemicals are plant-based bioactive compounds produced by plants for their protection. They can be derived from various sources such as whole grains, fruits, vegetables, nuts, and herbs, and more than a thousand phytochemicals have been discovered to date. Some of the significant phytochemicals are carotenoids, polyphenols, isoprenoids, phytosterols, saponins, dietary fibers, and certain polysaccharides. These phytochemicals possess strong antioxidant activities and exhibit antimicrobial, antidiarrheal, anthelmintic, antiallergic, antispasmodic, and antiviral activities. They also help to regulate gene transcription, enhance gap junction communication, improve immunity, and provide protection against lung and prostate cancers. (Ashwani Kumar et al., 2023)

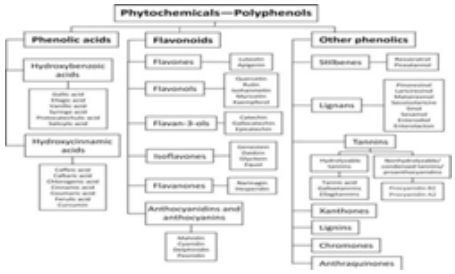

Figure 2: Phytochemicals Classification of phytochemical

Phytochemicals are classified as polyphenols, terpenoids, alkaloids, phytosterols, and organosulfur compounds. Chemical structure of polyphenols demonstrates one or more aromatic rings with one or more hydroxyl groups. They have been classified according to their chemical structure as phenolic acids, flavonoids, stilbenes, and isoflavones. (Krishna U M et al., 2023

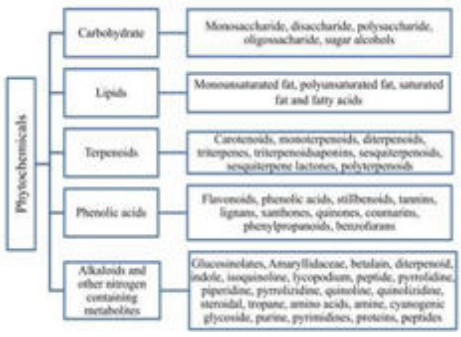

Figure 3: Uses of phytochemicals of plants

Antioxidant In Plants

In plants, phenolics can act as antioxidants by donating electrons to guaiacol-type peroxidases for the detoxification of H_2O_2 produced under stress conditions. Phenolics also provide protection against UV radiation through their potent

radical scavenging ability. In addition, they function as enzyme inhibitors and feeding deterrents for herbivores while providing resistance against pathogens. Synthesis of flavonoids is known to be induced by UV stress, heavy metal toxicity, or low temperature and low nutrient conditions, which might be attributed to their UV- absorbing, radical scavenging, and metal-chelating ability. UV-B radiation was found to affect the production of various high molecular secondary metabolites, such as tannins and lignin. Moreover, plants growing in tropical and high-altitude conditions have been shown to contain a higher proportion of flavonoids than those growing in temperate conditions, owing to overexposure to light or UV radiation. (Deepak M. Kasote et al., 2015)

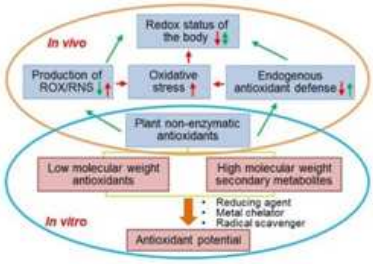

Figure 4: Mechanism of Antioxidant Potential (Deepak M. Kasote et al., 2015)

Anti-Microbial Effects Of Plants

Plant secondary metabolites are mostly responsible for their antimicrobial activity. Major groups of phytochemicals which possess antimicrobial properties are phenolics and polyphenols (flavonoids, quinones, tannins, coumarins), terpenoids, alkaloids, lectins, and polypeptides. There are several mechanisms that underlie antimicrobial action of plantderived compounds. Phytochemicals can act by disrupting microbial membranes (carvacrol, thymol, eugenol, etc.) or impairing cellular metabolism (cinnamaldehyde). (Mikayel Ginovyan et al., 2017).

The antimicrobial plant compounds that have received more attention in plant defense are the phytoalexins. Phytoalexins are antimicrobial compounds that require de novo expression of the enzymes involved in their biosynthetic pathways after elicitation. Therefore, the production of phytoalexins requires transcriptional and/or translational activity in the plant once the pathogen has been detected. The induced response mechanism also involves the trafficking and secretion of antimicrobial compounds to the infection site (Rocío GonzálezLamothe et al., 2009).The antibacterial action mechanisms of plant-derived compounds are shown in Figure 3 (Sana Alibi et al., 2021).

Therapeutic Plant Taken For The Current Study

Hibiscus sabdariffa L Hibiscus (Hibiscus sabdariffa L.), commonly known as roselle, is a plant valued for its medicinal, nutritional, and industrial applications. Recently, its potential as a natural ingredient in dishwashing liquids has gained attention due to its bioactive compounds, including organic acids, flavonoids, and saponins (Ali et al., 2019). These compounds contribute to its degreasing, antimicrobial, and environmentally friendly properties, making it a promising alternative to conventional dishwashing agents (Chang et al., 2020)

Scientific Classification

- **Kingdom:** Plantae
- **Phylum:** Angiosperms
- **Class:** Eudicots
- **Order:** Malvales
- **Family:** Malvaceae
- **Genus:** Hibiscus
- **Species:** Hibiscus sabdariffa L

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