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Pharmacological Activity of Basil (Ocimum basilicum) – A review

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ABSTRACT –
One of the most widely used fragrant herbs, basil (Ocimum basilicum L.) is full of bioactive components and used as flavour and scent meals. Many civilizations utilise the leaves as culinary element, both when they are fresh and when they are dried. O. basilicum is renowned for both its preservation and medicinal properties. Using the brine shrimp assay, the current research examined the toxicity of basil at 3 distinct growth stages (GS), namely GS-1 (58 days of development), GS-2 (69 days of growth), GS-3 (93 days of growth). The findings showed that GS and extract concentration had an impact on cytotoxicity. Basil aqueous extracts at concentrations ranging from 10-1000 µg/mL did not exhibit any discernible toxicity. Basil extracts, GS-2 had the lowest observed death rate of 8.9%. At 1000 µg/mL, it was discovered that the mortality rates at GS-1, GS-2, and GS-3 were 26.7 ± 3.34%, 8.91 ± 0.10%, and 16.7 ± 0.34%, respectively. The least toxicologically risky powdered basil, GS-2, was extracted using n-hexane, dichloromethane, ethanol, and water, among other solvents. Ethanol extracts showed the greatest quantity of plant secondary metabolites, such as total phenolic acid, flavonoids, and tannin content. In DPPH, FRAP, and H2O2 tests, ethanol extracts also demonstrated the greatest level of antioxidant activity. Basil ethanol extracts were shown by LC-ESI-MS/MS analysis to be a prospective source of well-known medicinal and health-promoting chemicals such umbelliferone, ellagic acid, catechin, rosmarinic acid, and liquiritigenin. The findings point to basil, a culinary plant, as a possible source of bioactive chemicals with a range of medicinal and health-promoting qualities.

Key Words –
Brine shrimp, liquiritigenin, coumarin, DPPH, catechin, FRAP, Chemical Assay, mass spectrometry, polyphenol

I. INTRODUCTION –

Plant-derived bioactive compounds are well recognised for their wide range of uses as active components in many medicinal products [1]. There is sufficient evidence to support the use of medicinal herbs in place of conventional and/or synthetic antimicrobials in the future. Similarly, there is need to investigate the possibility of using more natural components in food processing and preservation, given the data supporting the harmful health consequences of artificial food additives and their careless use in the food industrial business. Limiting the use of artificial food additives and investigating safer natural alternatives is recommended in light of mounting data about the potential health effects associated with their careless application [2, 3]. In recent times, polyphenols have garnered significant interest as potentially beneficial dietary additives that might enhance food quality and lower the risk of many illnesses such as cancer, inflammation, and oxidative stress [4]. Ocimum basilicum L., often known as sweet basil, is a well-known culinary herb category in the Lamiaceae family that is nearby to India and other Asian countries like Nepal, Bhutan, Pakistan, although it is currently grown all over the world [5]. Basil leaves have long been used as a traditional home based remedy in several illnesses. These comprise bronchitis, cancer, tremors, diarrhoea, mental illnesses, inflammation, biliousness, and teeth decay [6]. Pharmacological evidence—such as features such as anticancer, radical scavenging, anti-infective, antipain, and immunomodulatory effects—strongly supports the traditional assertions [7]. O. basilicum essential oils, including eugenol, chavicol, linalool, and α-terpineol, as well as flavonoids, rosmarinic acid, phenolic acids, and aromatic chemicals, are responsible for these bioactivities [8,9]. O. basilicum leaf extracts in ethanol and water have strong antibacterial and antioxidant properties against both Gram-positive and Gram-negative bacteria [10]. O. basilicum leaf extracts have also been shown to have anti-inflammatory, neuroprotective, immunoprotective, antidiabetic, cardioprotective, antistress, and antitussive qualities in recent research [11,12,13,14,]. It has also been found that O. basilicum leaves exhibit radioprotective and antimelanoma properties when it comes to metastatic melanoma cell lines [16].

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The two most prevalent flavonoids found in sweet basil, quercetin and rutin, have been shown to have anti-inflammatory and cytoprotective properties against a variety of malignancies [17, 18]. Seasoning soups, tomato-based dishes, spinach, sandwiches, cream cheese, dips, pasta, and a range of squashes are just a few of the common culinary uses for O. basilicum that have been mentioned [19]. The herb also provides shelf-life stability for nutrient-dense perishable goods [20]. It was recently discovered that bread made with extracts from O. basilicum has higher antioxidant activity than breads made with potassium sorbate and ascorbic acid [10]. Although the phytochemical composition of Oryza basilicum, a widely used culinary herb, has been thoroughly studied, there is still a suggestion that the biological potential and chemical composition of the plant's different anatomical fractions should be associated with distinct geographical locations due to their variability. The vegetative stage of the plant has a significant impact on the aromatic profile of basil, which is defined by the quality of its essential oil [19]. Little, immature basil leaves that grow to a height of 10–12 cm are said to be the most delicious for making pesto in Italy [19, 21]. Research indicates that basil plants growing at favourable phases have greater quantities of methyleugenol, which is harmful since it shares structural similarities with carcinogens, such estragole and safrole [22, 23, 24, 25,26]. Therefore, the goal of the current study was to ascertain how development phases and variations in toxicological reaction for O. basilicum leaf extracts grown in Southern Punjab, Pakistan's temperate environment, relate to one another. The phytochemical content and antioxidant qualities of the GS that showed the least amount of toxicity or non-toxic reaction were examined in further detail.

Chemicals and Equipment - Evaluation of Phytochemicals Qualitatively Screening for phenols, alkaloids, tannins, flavonoids, steroids, terpenoids, and saponins was done on the O. basilicum leaf extracts using the method of Kokate et al. [27], which is summarised in Table 1.

Test	Observation	Chemical Constituents
Wagner's Test	reddish brown precipitate Creamy color,	Alkaloids
Ferric Chloride Test	blackish red color Dark brown	Flavonoids
Folin–Ciocalteu reagent Test	black color , Grey	Phenols
Froth Test	Copious lather formation	Saponins
Salkowki's Test	Brown ring formation	Steroids
Ferric Chloride Test	Greenish brown, blue green or blue-black color	Tannins
Salkowki's Test	Red brownish precipitate	Terpenoids

Basil occurrence, cultivation, classification and variation in species

Growing in tropical and sub-tropical climates, basil (Ocimum basilicum L.) is a significant crop for essential oils, a culinary herb, and a member of the Lamiaceae family. Its essential oil is used in dental and oral health products, as well as in the food and fragrance industries.[25] O basilicm is a member of the class Magnoliopsida, phylum Magnoliopsida, kingdom Plantae, family Lamiacaea, order Lamiales, and genus Ocimum. In lab experiments, its germination rate ranges from 95% to 98%, whereas in field settings, it is closer to 10% to 15%.[26] The main stem, nodes, internodes, dominant growing point, future stem development, and leaves make up a basil plant's anatomy. Basil may be utilized for dried leaves, flowers, essential oil, and as an attractive plant in all of its components.[27, 28] Sweet basil, purple basil, lemon basil, cinnamon basil, anise basil, fine leaf basil, and bush basil are the most significant types of the plant. Aphids, leafhoppers, and whiteflies are the three principal pests associated with basil. Leaf spot, Botrytis, and Fusarium are the three main diseases that affect basil plants. Basil is susceptible to drought stress; previous research has shown a significant decline in the production of fresh and dry matter, essential oil content, and chemical components including proline, protein, and carbs.[29, 30] According to research by Kalamartzis et al. [31], basil cultivars in semi-arid areas should have greater water usage efficiency so they can conserve more water. The dry stem products are typically harvested at 1.2–2 t/ha (fresh weight 8–10).[32] Fusarium wilt (Fusarium oxysporum f. sp. basilicum), leaf spot

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(Pseudomonas cichorii), gray mold (Botrytis cinerea), damping off or root rot (Rhizoctonia solani; Pythium spp.), and downy mildew (Peronosporabelbahrii) are the most common diseases that affect basil. Field conditions can affect the output and quality of essential oils produced by basil plants.[35–40] The two primary phenolic compounds in basil are phenolic acids and flavonol-glycosides.[41, 42] Stearic acid, Oleic acid, Palmitic acid, Linoleic acid, Myristic acid, α-Linolenic acid, Carpic acid, Lauric acid, and Arachidonic acid are the primary fatty acid compositions of basil species. Increased levels of temperature and light have an impact on antioxidant capacity.[43] The caffeic, vanillic, rosmarinic, quercetin, rutin, apigenin, chlorogenic, and p-hydroxybenzoic acids are the most significant antioxidant chemicals found in basil.[44] α-Pinene, β-Pinene, Methyl chavicol, 1,8 cineole, Llinalool, Ocimene, Borneol, Geraneol, B-Caryphyllone, n-Cinnamate, and Eugenol are the essential oils of basil. [45]

Medicinal uses and potential HEALTH benefits in traditional medicine

Basil is utilized in both religious orthodox Christian ceremonies and traditional medicine in India. It is also revered as the goddess Tulsi in several regions of Asia.[52] This plant's traditional uses include its use as a flavoring ingredient in culinary goods, as well as in dental and oral hygiene products and perfumes.[53] Iran is a country where this herb is widely grown and utilized as a vegetable as well as a medicinal medicine.[54] Its seeds are used as a nutritional fiber component in Asian drinks and sweets in traditional medicine.[55] Infections of the skin, worms, diarrhea, cough, and headaches are also treated with it.[56] Additionally, it is a component of Mediterranean diets, particularly those in Southern Europe, such as Greek and Italian cuisines.[57] Traditional Chinese medicine has utilized basil polysaccharides to treat cancer [58] and continues to employ them in daily life.[59]

Medicinal uses and potential health benefits in modern medicine industry

In addition to controlling and lowering blood glucose, it has been used to treat a variety of illnesses, including anxiety, pyrexia, infections, stomach aches, coughs, headaches, and constipation. Previous research has also shown that it has anti-spasmodic and anti-diabetic properties, as well as anti-bacterial, anti-fungal, and anti-oxidant properties.[65,66] Eugenol's anti-fungal, nematocide, and antibacterial properties against food-borne pathogenic microorganisms are its most significant therapeutic qualities.[67,68] In diabetic rats, the ethanol extract from basil leaves can lower blood glucose and advanced glycation end products.[69] In traditional medicine, basil leaves are used as a stomachic, carminative, and antispasmodic.[70] Alkaloids, tannins, flavonoids, and saponins are the constituents of essential oil molecules found in basil leaves.[71–76] Components of basil essential oil include antimicrobial, anti-inflammatory, and anti-oxidative properties.[77–95] Basil leaves are stomachic, diuretic, antipyretic, and antispasmodic.[96,97] Numerous advantages of basil seed mucilage include its hydrophilicity, biocompatibility, low cost of manufacturing, suitable film formation, edibility, and viscoelastic qualities.[98–102]Basil polysaccharides are beneficial in the treatment of diabetes mellitus and have anti-tumor, anti-oxidant, and anti-aging properties. They also have antibacterial and anti-atherosclerotic properties.[103]BSG is a high molecular weight (2320 kDa) anionic polysaccharide that comes in two fractions: PER-BSG (6000 kDa) and SUPER-BSG (1045 kDa).[104] A minor fraction of highly branched arabino-galactan and glucan (2.31%), gluco-mannan (43%), (1-4)-linked xylan (24.3%), a small fraction of protein (1.32% wt/wt), and a typical uronic acid content between 12.1 and 19.5% provide the polyelectrolyte behavior to extract make up BSG.[105,106] It has been applied to change the composition of processed bread, ice cream, and cheese.[107–109] Glucuronic acid, galacturonic acid, rhamnose, mannose, arabinose, galactose, and glucose make up the BSG. Because of its unpredictable coil conformation, BSG is prone to the SUPER-BSG faction due to its great chain flexibility.[110–112] BSG is a hydrocolloid that has surface-active properties, thickening, stabilizing, fat-substituting, texurizer, and emulsifying properties.[107,112,113] Frozen food quality can be enhanced using BSG. The food business views it as a commercial hydrocolloid due to its unique behavior and ease of extraction.[114] Edible films may be produced by BSM, and thermostable, ultra-thin nanofibers can be produced using BSM and Polyvinyl alcohol for a variety of uses in the food industry. Studies on the cytotoxicity and cell adhesion of BSM hydrogel sponge revealed that the sponge was neither cytotoxic nor adherent.[115,116] When BSG is

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added, heat-induced egg albumin gels that are tougher may be produced for use in various food applications or to deliver active ingredients in functional meals.[117] In the food business, it can serve as a novel source of edible hydrocolloids.[118,119] There is a lot of promise for using basil seed gum to make edible films for several food applications.[115] Gum in reasonable levels and with acceptable functional qualities may be found in basil seeds.[120] The maximal hardness and consistency were displayed by the freeze-dried basil seed gum; an increase in temperature had a detrimental effect on the color changes of the basil gum solution.[121] Basil seed gum can be used as a textural and rheological modifier in the formulation of foods subjected to heat and freezing temperatures because of its remarkable resistance to freeze-thaw treatment and its increased textural qualities after freezing.[122]

II. CONCLUSION

Ocimum tenuiflorum L., Ocimum sanctum L., Ocimum americanum L., Ocimum basilicum L., Ocimum hispidulum Schum, and Ocimum ratissimum L. are the most significant members of the Ocimum genus. Eugenol, methyl chavicol, methyl cinnamate, linalool, and bergamotene are the main volatile ingredients in basil. Additionally, Indian, Chinese, Italian, and Persian cuisines are linked to basil. Basil plants are classified as having the following anatomical features: (a) main stem; (b) node; (c) internode; (d) dominant growing tip; (e) future stem development; and (f) leaves. The two primary phenolic compounds in basil are phenolic acids and flavonol-glycosides. Stearic acid, Oleic acid, Palmitic acid, Linoleic acid, Myristic acid, α-Linolenic acid, Carpic acid, Lauric acid, and Arachidonic acid are the primary fatty acid compositions of basil species. Increased temperatures and light levels affect an antioxidant's ability. The most significant antioxidants found in basil include p-hydroxybenzoic, quercetin, rutin, apigenin, vanillic, and rosmarinic acids. α-Pinene, β-Pinene, Methyl chavicol, 1,8 cineole, Llinalool, Ocimene, Borneol, Geraneol, B-Caryphyllone, n-Cinnamate, and Eugenol are the essential oils of basil. Terpenoids, chavicol, and eugenol are the three most significant essential oils found in basil. It is extensively grown and used as a vegetable and medicinal tincture in traditional herbal treatments. Basil's most significant pharmacological applications include its use as a prophylactic agent, in the treatment of cardiovascular disease, and its anti-cancer, radioprotective, anti-microbial, anti-inflammatory, immunomodulatory, anti-stress, anti-diabetic, anti-arthritic, and anti-oxidant properties. Often called basil seed gum, basil seed mucilage. Glucuronic acid, galacturonic acid, rhamnose, mannose, arabinose, galactose, and glucuronic acid make up the BSG. Because of its unpredictable coil conformation, BSG is prone to the SUPER-BSG faction due to its great chain flexibility. BSG is a surface-active, emulsifying, thickening, stabilizing, fat-substituting, texurizer, and hydrocolloid that can enhance the quality of frozen meals. The food business views it as a commercial hydrocolloid due to its unique behavior and ease of extraction. Based on the results, it is recommended that basil be used in the food and pharmaceutical industries.

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