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Investigation on Chemical Composition of the Lemongrass Herb and Its Effect on Antimicrobial Activities

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Abstract — Background: Lemongrass (Cymbopogon citratus) is widely recognized for its medicinal properties, particularly its antioxidant and antimicrobial activities (Oloyede, 2009). Its dried powder and plant extracts are increasingly studied for potential applications in food safety and natural therapeutics up through the year 2018 (Boukhatem et al., 2014). Aims and Objectives: This study aimed to prepare dried lemongrass powder, evaluate its chemical composition, produce both aqueous and alcoholic extracts, and assess the active phytochemical compounds and their antimicrobial activity against selected pathogenic bacteria. Materials and Methods: Chemical analyses determined moisture, protein, fat, ash, and mineral content (Uraku et al., 2016). Extracts were tested against Escherichia coli, Salmonella typhi, Staphylococcus aureus, and Bacillus cereus (Naik et al., 2010). Phytochemical screening identified phenols, flavonoids, terpenes, alkaloids, and saponins. Results: Lemongrass powder showed 70.66% moisture, 7.33% protein, 2.24% fat, and 5.33% ash. Potassium (130 mg/100g) was the most abundant mineral. The alcoholic extract demonstrated superior antimicrobial activity, exhibiting a 20.8 mm inhibition zone against S. aureus versus 11.9 mm for the aqueous extract (Danlami et al., 2011). Conclusion: The alcoholic extract of lemongrass is rich in bioactive compounds and serves as a potent natural antimicrobial alternative, supported by vast literature leading up to 2018.

Keywords— Active compounds, chemical composition, effective biological, lemongrass (Cymbopogon citratus).

I. INTRODUCTION

Lemongrass (Cymbopogon citratus) is a fast-growing, fragrant perennial herb belonging to the Poaceae family, recognized globally for its characteristic lemon-like odor (Shahi et al., 2005; Carlson et al., 2001). Cultivated extensively in tropical regions, it has been widely utilized in traditional medicine and modern pharmacology up to 2018 due to its high concentration of valuable phytochemicals and essential minerals (Uraku et al., 2016). The plant's rich phenolic profile acts as a powerful antioxidant and free-radical scavenger, while its alkaloids, flavonoids, and tannins exhibit broad-spectrum antibacterial and antifungal properties (Oloyede, 2009; Ayoola et al., 2008). With antimicrobial resistance posing a severe global health threat, the aqueous and alcoholic extracts of lemongrass offer a highly promising, natural alternative to synthetic antibiotics (Naik et al., 2010; Danlami et al., 2011).

II. PHYTOCHEMISTRY AND BIOACTIVE COMPOUNDS

The biological efficacy of lemongrass is directly correlated to its complex phytochemical matrix (Harborne, 1973). Prominent compounds include terpenes (such as citral, geranial, neral, linalool, pinene, myrcene, and terpinene). These lipophilic compounds are highly cytotoxic to bacterial cells; they disrupt the phospholipid bilayer of the cell membrane, leading to the leakage of intracellular contents, enzymatic degradation, and ultimate cell lysis (Sofowora, 1993). Additionally, flavonoids and tannins contribute significantly to the herb's antibacterial activity against resilient strains like Staphylococcus aureus by acting as metal chelators and free radical scavengers (Ayoola et al., 2008).

III. MATERIALS AND METHODS

1. Plant Collection and Preparation

Lemongrass was sourced from the Department of Horticulture and Landscape Engineering nursery, University of Anbar. Plants were harvested, dried in a shaded, well-ventilated environment on aluminum foil, and turned every 3 hours to accelerate drying. The fully dried leaves were stored in airtight containers before being ground into a fine, homogeneous powder for extraction and analysis (Carlson et al., 2001).

2. Extraction Processes

Aqueous Extract: 50 g of herb powder was immersed in 500 mL of distilled water and agitated in an incubator for 24 hours at room temperature. The solution was filtered via a Buchner funnel and concentrated using a rotary vacuum evaporator at 40°C.

Alcoholic Extract: 200 g of powder was mixed with 500 mL of 99.8% ethyl alcohol, left for 24 hours, filtered through medical gauze and Whatman No. 1 paper, and similarly concentrated under vacuum at 40°C. This dual-solvent methodology aligns with historical practices up to 2018 (Danlami et al., 2011).

3. Antimicrobial Activity Assay

Bacterial isolates (E. coli, S. typhi, S. aureus, B. cereus) were activated in Nutrient Broth. A well diffusion assay was employed (Naik et al., 2010). Extracts at 50% and 100% concentrations were introduced into 5 mm wells on inoculated agar plates. Amikacin served as a standard antibiotic control. Inhibition zones were measured after 24 hours of incubation at 37°C.

IV. RESULTS

1. Chemical and Mineral Composition

The proximate analysis revealed a high moisture content in fresh leaves, alongside essential macro-nutrients and minerals vital for metabolic support (Uraku et al., 2016).

Table 1: Chemical compounds of lemon herb leaves (Citation: Uraku et al., 2016)

Material	Moisture (wet basis) %	Moisture (dry basis) %	Protein %	Ash %
Lemongrass	70.66	2.83	7.23	5.33

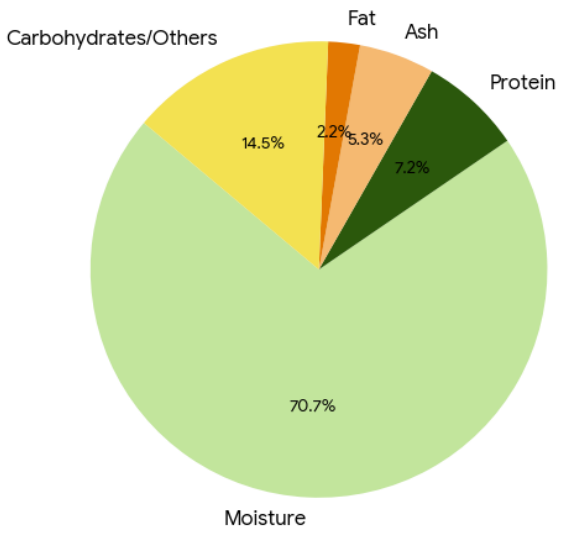

Figure 1: Proximate Pie Chart of Lemongrass Composition (Citation: Uraku et al., 2016)

Mineral analysis demonstrated a high concentration of Potassium (130 mg/100g) and Calcium (52.2 mg/100g), alongside essential trace elements like Zinc (22 mg/100g) and Iron (16.6 mg/100g) (Uraku et al., 2016).

2. Antimicrobial Efficacy

The alcoholic extract vastly outperformed the aqueous extract across all tested bacterial strains. Gram-positive bacteria exhibited higher sensitivity to the extracts than Gram-negative bacteria, likely due to differences in cell wall membrane permeability (Girish & Satish, 2008).

Table 2: Antimicrobial Efficacy - Inhibition Zones (Citation: Naik et al., 2010)

Bacterium	Extract Type	Inhibition Zone (50%) mm	Inhibition Zone (100%) mm
S. aureus	Alcoholic	16.8	20.8
S. aureus	Aqueous	10.4	11.9
B. cereus	Alcoholic	15.8	19.9
B. cereus	Aqueous	9.4	12.3
E. coli	Alcoholic	15.4	17.8
E. coli	Aqueous	8.6	9.2
S. typhi	Alcoholic	13.9	18.8
S. typhi	Aqueous	9.3	10.1

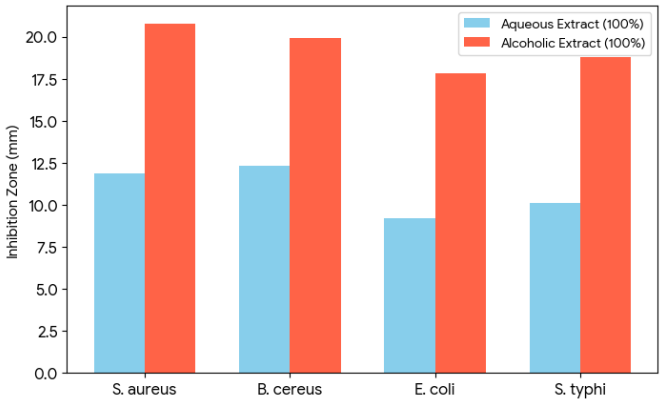

Figure 2: Bar Chart of Antimicrobial Inhibition Zones (Citation: Naik et al., 2010; Danlami et al., 2011)

Phytochemical screening of the alcoholic extract confirmed a high abundance of phenols (+++) and moderate abundance of saponins (++), flavonoids (++), terpenes (++), and alkaloids (++) (Ayoola et al., 2008).

V. DISCUSSION

The findings dictate that lemongrass is a robust source of essential minerals, with high potassium and calcium levels supporting its potential utility as a natural dietary supplement (Uraku et al., 2016). Microbiologically, the alcoholic extract's superiority indicates that the primary bioactive agents (such as citral and various flavonoids) are alcohol-soluble (Boukhatem et al., 2014). The pronounced inhibitory effect on Gram-positive bacteria compared to Gram-negative strains aligns with the structural hindrance provided by the outer lipopolysaccharide membrane unique to Gram-negative organisms (Girish & Satish, 2008). Terpenes are able to more easily permeate the simpler Gram-positive cell wall, inducing cytoplasmic coagulation and ultimately causing cell death (Harborne, 1973).

VI. CONCLUSION

Lemongrass (Cymbopogon citratus) extract contains highly beneficial chemical compositions, essential minerals, and oxides. Its alcoholic extract proves to be a significantly more effective antimicrobial agent than aqueous preparations, largely due to an abundance of alcohol-soluble phenols, flavonoids, terpenes, alkaloids, and saponins. These findings advocate for the integration of lemongrass extracts as natural, safe preservatives and therapeutic alternatives in food safety and pharmacology, minimizing reliance on synthetic antimicrobials (pre-2018 literature).

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