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ANTIBACTERIAL ACTIVITY OF SOME COMMON KITCHEN SPICES AGAINST *ESCHERICHIA COLI, STAPHYLOCOCCUS AUREUS, SALMONELLA TYPHIAND PSEUDOMONAS AERUGINOS*

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ABSTRACT: The current study investigated and compared the antibacterial activity of common kitchen spices; Ginger, Turmeric, Bay leaf, and Coriander, against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella Typhi*, and *Pseudomonas aeruginosa*. The antibacterial activity of different spices was calculated by the agar well cup plate method. The concentrations, 75%, 50%, and 25%, were made for all the test spices by diluting the concentrated extract with appropriate volumes of sterile distilled water. Ginger and turmeric are effective against all four pathogens. Ginger reported maximum activity against *Escherichia coli* with 14.5 zones of inhibition at 100% concentration. Bay leaf showed comparatively good antibacterial activity at higher concentrations and possessed maximum antibacterial activity against *Salmonella Typhi* with 15.4 zones of inhibition at 100% concentration. Coriander unveils comparatively good antibacterial activity against *Escherichia coli* and *Staphylococcus Aureus* at higher concentrations. It exhibits maximum antibacterial activity against *Pseudomonas aeruginosa* with an 18.7 mm zone of inhibition at 100% concentration. Coriander didn't reveal activity against *Salmonella Typhi* at any concentration. The results of the present study are quite promising. All four spices exhibited antimicrobial activity against most pathogens, but the antimicrobial activity varies widely, depending on the type of spices and microorganisms.

INTRODUCTION: Spices are defined as any dried, fragment or aromatic plant substance that contributes flavour in whole, broken, or ground form.

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Spices are the potential source of natural products and naturally derived compounds. Spices have been defined as plant substances from the indigenous or exotic origin, aromatic or with strong taste, used to enhance the taste of foods.

Spices include leaves (bay, mint, rosemary, coriander, laurel, and oregano), flowers (cloves), bulbs (garlic, onion), fruits (cumin, red chilli, and black pepper), stems (coriander, cinnamon), rhizomes (ginger) and other plant parts [1]. Although spices have been well known for their medicinal,

preservatives, and antioxidant properties, they have been currently used with the primary purpose of enhancing the flavour of foods rather than extending the shelf-life of foods.

Spices That Are Used In Experiment:

Zingiber Officinale (Ginger): Zingiber officinale (Ginger) and its constituents have cardiotonic, antibacterial, antioxidant, anti-inflammatory, antitumor activity, antimicrobial activity, neuroprotective effect, effect on osteoarthritis, gastroprotective effect, antiemetic, effective against migraine, effective against diabetic neuropathy anti-tussive, antithrombotic, hepatoprotective, stimulant, diaphoretic, diuretic, spasmolytic, immune stimulant, carminative and cholagogue action. Ginger is used to promote gastric secretion

Chemical Composition of Zingiber Officinale: The Zingiber officinale (ginger) contains steam volatile oil, fixed fatty oil, pungent compounds, resins, proteins, cellulose, pentosanes, and starch and mineral elements.

The dry ginger on average contains moisture (0.85%), volatile oil (1.8%), oleoresin (acetone extract) (19.6%), cold alcohol extract (6.0%), starch (53%), crude fibre (7.17%), crude protein (12.4%), total ash (6.64%), water-soluble ash (5.48%) and acid insoluble ash (0.14%) [2]. The characteristics organoleptic properties of ginger are due to steam volatile oil and non-volatile solvent extractable pungent components.

Medicinal Properties of Zingiber Officinale: It is widely used in tooth and gum infections, congestion of the lungs and tuberculosis of the lungs, eye inflammation, and digestive and lack of appetite.

***Curcuma Longa* (Turmeric):** *Curcuma longa* (Turmeric) comes from the root of Curcuma longa, a leaf plant of ginger family. The root or rhizome has tough brown skin and bright orange flesh. Ground turmeric comes from turmeric fingers, which extend from the root. Turmeric, with its brilliant yellow colour, has been used as a dye medicine and flavouring.

Chemical Composition of Curcuma Longa: The turmeric contains water (6.0%), food energy, protein (8.5%), fat (8.9%), carbohydrate (69.9%), ash (6.8%), calcium (0.2%), phosphorus (0.26%), sodium (30%), thiamine (0.09%) and niacin (0.04% [3].

Medicinal Properties of Curcuma Longa: It is widely used for centuries in Indian, Chinese, and Nepali medical systems as an antibacterial and anti-inflammatory. It also helps in the following ailments: Inflammation of the liver and kidneys, bloating, colic, blood in the urine, menstrual pain, hemorrhages, hematoma, toothache, and chest pain. Other benefits of using turmeric include: Disinfection of cuts and burns, Combating rheumatoid arthritis, preventing cancer, and reducing the risk of leukemia in children. In combination with cauliflower - for example, Bhuteko Kauli - has the power to prevent or even reverse prostate cancer [4].

***Laurus Nobilis* (Bay Leaf):** The bay leaf is an aromatic leaf commonly used in cooking. It can be used whole or in a dried or ground form. Bay leaves are fragmenting leaves from the laurel tree used as an herb.

Chemical Composition of *Laurus Nobilis*: The chemical constituents of bay leaf are α-pinene, eugenol, phellandrene, esters (12.8%), free cinamic acid (1.3%), free phenol (2.0%), terpenes hydrocarbon (15.4%), & carbonyl compound (11.48%) *etc.* [5].

Medicinal Properties of *Laurus Nobilis*: Bay leaf was prized highly by the Greeks and the Romans, who believed that the herb symbolizes wisdom, peace, and protection. The spice contains many important plant-derived chemical compounds, minerals, and vitamins that are essential for optimum health. This spice has many volatile active components such as α-pinene, ß-pinene, myrcene, limonene, linalool, methyl chavicol, neral, α-terpineol, geranyl acetate, eugenol, and chavicol. These compounds are known to have been antiseptic, antioxidant, digestive, and thought to have anti-cancer properties [6].

***Coriandrum Sativum* (Coriander):** *Coriandrum sativum* has been used as folk medicine for the relief of anxiety and insomnia in Iranian folk medicine. An experiment in mice supports its use as an anxiolytic. Coriander seeds have also been used to prepare a traditional diuretic in India.

The diuretic is prepared by boiling an equal amount of coriander seeds and cumin seeds. The extract is then cooled and consumed as a diuretic.

Chemical Composition of *Coriandrum Sativum*: The chemical compositions of essential coriander are linalool (57.7%), geranyl acetate (15.9%), Beta-caryophyllene (3.26%), camphor (3.02%), and p-cymene (2.5%). The major chemical constituents of coriander are linalool [7].

Medicinal Properties of Coriandrum Sativum: It is also known by the name cilantro or dhaniya. Coriander comes packed with essential health benefits. It is not only beneficial when consumed fresh; adding coriander seeds to your daily food can also be very healthy. Coriander seeds have anti-oxidant properties and dietary fiber that advance the healthy working of the liver and facilitate bowel moments. They help in the generation of digestive compounds and juices that facilitate the procedure of digestion [8].

Bacteria Used For Determination of Antibacterial Activity of Spices: Bacteria or culture used in the experiment of determination of antibacterial activity of spices are ATCC (American Type Culture Collection culture type ATCC or the American type culture collection is a non-profit organization which collects stores and distributes standard reference microorganism, cell lines and other material for research and development. Established in 1925 to serve as a national center for depositing and distributing microbiological specimens. ATCC has since grown to distribute in over 150 countries. It is now the largest general culture collection in the world.

The four specimens from ATCC culture were used to determine of antibacterial activity of different types of spices; they are:

Escherichia coli, Staphylococcus aureus, Salmonella Typhi, Pseudomonas aeruginosa

***Escherichia coli* (*E. coli*):** *Escherichia coli,* also known as *E. coli,* was isolated by Escherich in 1885 from faeces of humans and named after him. *E. coli* is a Gram-negative, facultatively anaerobic, rod-shaped, coliform bacterium of the genus Escherichia commonly found in the lower intestine of warm-blooded animals.

Virulence Factors of *Escherichia Coli*: Somatic (O) antigens: - the gram-negative lipopoly saccharide comprises of lipid A, core polysaccharide and repeating chain of carbohydrates called somatic (O) antigens. Capsular/ surface (K) antigens: - K-antigens of *E. coli* are acidic polysaccharides and cover the O antigens. The K-antigen act as a virulence factor by preventing phagocytosis and antibody-mediated killing. Flagellar (H) antigens: - H-antigens are located on flagella and are thermolabile protein [9, 10].

Staphylococcus aureus: Staphylococcus aureus was first isolated by Pasteur in 1880 A.D. and named by Sir Alexander Ogston from "staphyle"- a bunch of groups, "kokkos"- berry (grain). Staphylococcus is the major human pathogen responsible for various pathogenic (pus-forming) infections and toxins-mediated infections. 10-40% of normal humans carry Staphylococcus aureus in their nostril. Staphylococcus aureus is a skin commensal associated with the prosthetic device and UTI [11].

Virulence Factors of *Staphylococcus aureus*:
Cell Wall Components:

- ✓ Polysaccharide capsule inhibits phagocytosis.
- ✓ Peptidoglycan activates complement, IL-1, *etc.*
- ✓ Teichoic acid species-specific, mediate binding to fibronectin.
- ✓ Protein A It binds to Fc region of IgG & complement, exerting an anti-opsonin effect.
- ✓ Fibronectic binding protein (FnBP): promote binding to mucosal cells and tissue matrices.
- ✓ Clumping factors FnBP enhances clumping of the organism in the presence of plasma [12].

Enzymes:

- ✓ Catalase enzyme conversion of H_2O_2 into water and oxygen.
- ✓ Coagulase enzyme and clumping factors an enzyme like protein that clots oxalated or citrated plasma.

- ✓ Other enzymes hyaluronidase, staphylokinase, proteinases, lipases, *etc.*
- ✓ Toxins Exotoxins & Enterotoxins

Salmonella typhi: Salmonellae are primarily intestinal parasites of humans and many animals, including birds, and are widely distributed in water and soil, where they do not multiply significantly. It is a Gram-negative, non-sporulating, non-capsulated rod, motile with flagella and facultative anaerobe. *Salmonella typhi* is bacteria that infect the intestinal tract and blood. The disease caused by *Salmonella typhi* is known as typhoid fever. *Salmonella typhi* is spread by the faecal-oral route [13].

Virulence Factors of *Salmonella typhi*: Salmonella possesses the following types of antigens or virulence factors; they are. Somatic (O) antigens the gram-negative lipopolysaccharide comprises of lipid A, core polysaccharide, and a repeating chain of carbohydrates called somatic (O) antigens.

Capsular/ surface (K) antigens K-antigens of *Salmonella typhi* are acidic polysaccharides and cover the O antigens. The K-antigen act as a virulence factor by preventing phagocytosis and antibody-mediated killing. Flagellar (H) antigens H-antigens are located on flagella and are thermolabile protein [14].

Pseudomonas aeruginosa: It is a common encapsulated, Gram-negative, rod-shaped bacterium that can cause disease in plants and animals, including humans. A species of considerable medical importance, *Pseudomonas aeruginosa* is a multidrug-resistant pathogen recognized for its ubiquity.

It's intrinsically advanced antibiotic resistance mechanisms and its association with serious illnesses-hospital acquired infections such as ventilator-associated pneumonia and various sepsis syndromes.

The organism is considered opportunistic in so far as serious infection often occurs during existing diseases or conditions, most notably cystic fibrosis and traumatic burns; it generally affects the immune-compromised but can also infect the immune-competent. It is found in soil, water, skin flora, and most manmade environment throughout the world [15].

Virulence factors of *Pseudomonas aeruginosa*: Pseudomonas aeruginosa possess.

- ✓ Both pilin and non-pilus adhesion are important for attachment
- ✓ Lipopolysaccharide (LPS): endotoxin
- ✓ Flagella
- ✓ Anti-microscopic resistance
- ✓ Iron capturing ability

Antibiotic Susceptibility Test (AST): Antibiotic susceptibility test or Antibiotic sensitivity testing is the measurement of the susceptibility of bacteria that may have resistance to some antibiotics; sensitivity results can allow a clinician to change the choice of antibiotics from empiric therapy, which is when an antibiotic is selected based on clinical suspicion about the site of an infection and common causative bacteria [16, 17]. Sensitivity testing usually occurs in a medical laboratory. It may be based on culture methods that expose bacteria to antibiotics or genetic methods that test to see if bacteria have genes that confer resistance culture method often involve measuring the diameter of without bacterial growth called zone of inhibition. Antibiotics susceptibility test is done when used antibiotics, and Antibiotics is a substance produced wholly or partly by microorganisms which is small concentration inhibits the growth of other microorganisms [18, 19].

MATERIALS AND METHODS:

Research Design: This study was a descriptive type of research design and qualitative nature. The research work was mainly focused on the antibacterial activity of four spices against common pathogenic bacteria from American type culture collection (ATCC).

Data Analysis: In this study, the method of data collection was observational and experimental for both qualitative and quantitative data. The collected data and information were processed, tabulated, and analyzed quantitatively by using different statistical methods such as tables and percentages.

Laboratory Procedure:

Collection of Spices: The fresh spices for sampling were collected from the Raj biraj local market. This experimental test was carried out for different concentrations of spice extract on different bacterial isolates from ATCC.

Preparation of Spices Extract: New spices have been purchased from the local market. The spices were, if possible, cleaned, decaled, and washed in sterile distilled water. Around 100 g of any washed spice was crushed with mortar and pestle to obtain the spice extracts. The extracts were sieved and sterilized using a membrane filter (0.45-micron sterile filter) *via* a fine mesh fabric [20].

Preparation of Different Concentration of Extract: The filtrate extract obtained was about 10 ml for each species and these extract was considered the 100% concentrations of the extract. The concentrations, 75%, 50% and 25% were made for all the test spices by diluting the concentrated extract with appropriate volumes of sterile distilled water. For 75% concentration, 2.5 ml of distilled water were poured in 7.5 ml of filtrate extract. Similarly, for 50% concentrations, 5ml of distilled water were poured in 5ml of filtrate extract, whereas for 25% concentrations, 7.5 ml of distilled water were poured into 2.5 ml of filtrate extract [21, 20]. All the stock solutions were collected in a small sterile container and stored at the refrigerator for preservation.

Collection and Maintenance of Culture: All the test organisms (ATCC) were collected from the authorized place. These organisms were first inoculated into 10 ml of sterile nutrient broth to revive, then were sub-cultured on NA (Nutrient agar) for *E. coli* and *Pseudomonas aeroginosa*, MSA (Mannitol salt agar) for *Staphylococcus aureus* and SS agar (Salmonella-Shigella agar) for *Salmonella typhi* and were tested for their purity by examining their morphological characteristics (by gram staining tests) and biochemical tests. Purely isolated colony of each organism was incubated at 37 ℃ for 4 h to bring them into log phase [22].

Antibacterial Activity Testing Using Agar Well Method (Cup Plate Method): Using a sterile cotton swab, the nutrient broth culture was swabbed on the surface of sterile Mueller-Hinton Agar (MHA) plates. Agar wells were prepared with the help of a sterilized cork borer with 6 mm diameter. Using a micropipette, 50 microlitres of different concentrations of spices extracts (100%, 75%, 50%, and 25%) were added to different wells in the plate. The plates were incubated in an upright position at 37 ºC for 24 h.

The diameter of inhibition zones was measured in mm, and the results will be recorded. The inhibition zones with a diameter less than 7 mm were considered as having no antibacterial activity [23].

Preparation of Control Plate: One control plate was prepared in each experiment by agar well diffusion to sterilized distilled water instead of ginger turmeric, bay leaf, and coriander extract (Kirby Bauer Technique). The control plate was essential and very important to measure and determine whether the spice extract was the substance that will kill the bacteria and not cause other elements and factors. The inhibitory effect of these spices was compared with that of 5 control antibiotics (chloramphenicol, ciprofloxacin, nalidixic acid, streptomycin, and tetracycline).

RESULT AND DISCUSSION:

TABLE 1: ANTIBACTERIAL ACTIVITY OF ZINGIBER OFFICINALE

Name of Organism	Zone of inhibition (mm)			
	100	75	50	25
Escherich coli	14.5±0.5	8.3±0.70	6±1.0	5.5±0.6
Staphylococcus aureus	7.4±0.60	6.2±0.8	5.6±0.4	4.2±0.6
Salmonella typhiand	8.1±0.9	6.2±0.8	5.5±0.5	3.3±0.7
Pseudomonas aeruginos	7.6±0.4	6.3±0.7	5.1±0.9	4.5±0.5

Antibacterial Susceptibility Testing of *Zingiber officinal* (Ginger) Against *Escherichia coli:* *Zingiber officinale* extract showed good antibacterial activity against *Escherichia coli* at different concentrations (100%, 75%, 50% & 25%) of stock solution of ginger prepared in the lab. It showed (14.5 ± 0.5) mm zone of inhibition which is the maximum inhibitory activity of ginger

against *E. coli* in 100% concentration of a prepared solution or stock solution. Similarly, in 75% concentration of the stock solution was determined as (8.3 ± 0.70) mm zone of inhibition. The zone of inhibition of ginger at 50% concentration showed (6 ± .0) mm whereas (5.5±0.55) mm zone of inhibition was shown by 25% concentration.

Antibacterial Susceptibility Testing of *Zingiber officinal* (Ginger) Against *Staphylococcus aureus*: The antibacterial activity of ginger against lawn culture of *Staphylococcus aureus* on MHA at 100% concentration of the prepared solution was measured as (7.4 ± 0.60) mm. Likewise, at concentration level of 75%, 50% & 25% were measured as zone of inhibition of (6.2 ± 0.8) mm, (5.6 ± 0.4) mm & (4.2 ± 0.6) mm against lawn culture of *Staphylococcus aureus*.

Antibacterial Susceptibility Testing of *Zingiber officinal* (Ginger) Against *Salmonella typhi*: The antibacterial susceptibility test of ginger against lawn culture of *Salmonella typhion* MHA, were observed to be (8.1 ± 0.9) mm zone of inhibition at 100% concentration, (6.2 ± 0.8) mm zone of inhibition at 75% concentration, (5.5 ± 0.5) mm zone of inhibition at 50% concentration and (3.3 ± 0.7) mm zone of inhibition at 25% concentration of a stock solution of ginger.

Antibacterial Susceptibility Testing of *Zingiber officinale* (Ginger) Against *Pseudomonas aeroginosa*: Ginger showed 7.6 ± 0.4 mm zone of inhibition at 100% concentration of stock solution, 6.3 ± 0.7 mm zone of inhibition at 75% concentration of the stock solution, 5.1 ± 0.9 mm zone of inhibition at 50% concentration of stock.

Solution and 4.5 ± 0.5 mm zone of inhibition at 25% concentration of stock solution against lawn culture of *Pseudomonas aeroginosa* on MHA culture media.

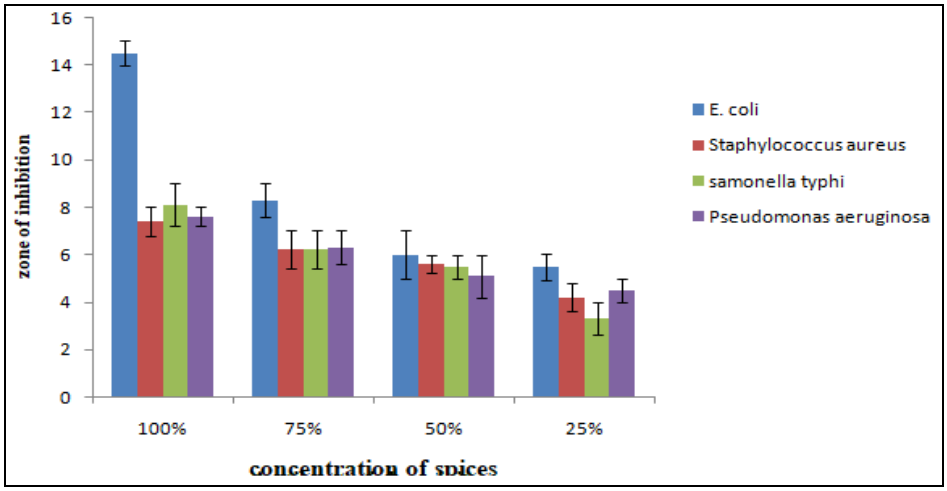

FIG. 1: ANTIBACTERIAL ACTIVITY OF *ZINGIBER OFFICINALE*

Antibacterial Susceptibility Testing of *Curcuma longa* Against *Escherichia coli*: Curcuma longa showed 7.5 ± 0.5 mm at 100% concentration of the prepared solution, 6.6 ± 0.4 mm at 75% concentration of the prepared solution, 5.4 ± 0.6mm at 50% concentration of the prepared solution and 4.3 ± 0.7 mm at 25% concentration of prepared solution against lawn culture of Escherichia coli on MHA.

Antibacterial Susceptibility Testing of *Curcuma longa* Against *Staphylococcus aureus*: It was observed that 9.2 ± 0.8 mm zone of inhibition shown by 100% concentration of prepared solution similarly, 7.4 ± 0.6 mm zone of inhibition were shown by 75% concentration of prepared solution whereas 6.5 ± 0.5 mm and 5.2 ± 0.8 mm were shown by 50% and 25% concentration of prepared solution respectively against lawn culture of *Staphylococcus aureus* on MHA.

Antibacterial Susceptibility Testing of *Curcuma longa* Against *Salmonella yyphi*: The antibacterial effect of Turmeric *against Salmonella Typhi* were found to be 7.3 ± 0.7 mm at 100% concentration of prepared solution whereas 6.5 ± 0.5 mm at 75% and 5.4 ± 0.6 mm at 25% concentrations of the prepared solution but there is no zone of inhibition shown by 25% concentration of prepared solution

which indicates no antibacterial activity at 25% concentration against *Salmonella typhi*.

Antibacterial Susceptibility Testing of *Curcuma longa* Against *Pseudomonas aeroginosa*: The zone of inhibition were measured as 14.1 ± 0.9 mm at 100%, 11.2 ± 0.8 mm at 75%, 10.5 ± 0.5 mm at 50% and 9.2 ± 0.8 mm at 25% concentrations of prepared solutions against lawn culture of *Pseudomonas aeroginosa* on MHA.

Determination of Antibacterial Activities of *Curcuma longa* (Turmeric)

TABLE 2: ANTIBACTERIAL ACTIVITY OF *CURCUMA LONGA*

Name of Organism	Zone of inhibition (mm)			
	100	75	50	25
Escherich Coli	7.5±0.5	6.6±0.4	5.4±0.6	4.3±0.7
Staphylococcus Aureus	9.2±0.8	7.4±0.6	6.5±0.5	5.2±0.8
Salmonella Typhiand	7.3±0.7	6.5±0.5	5.4±0.6	5.2±0.8
Pseudomonas Aeruginos	14.1±0.19	11.2±0.8	10.5±0.5	9.2±0.8

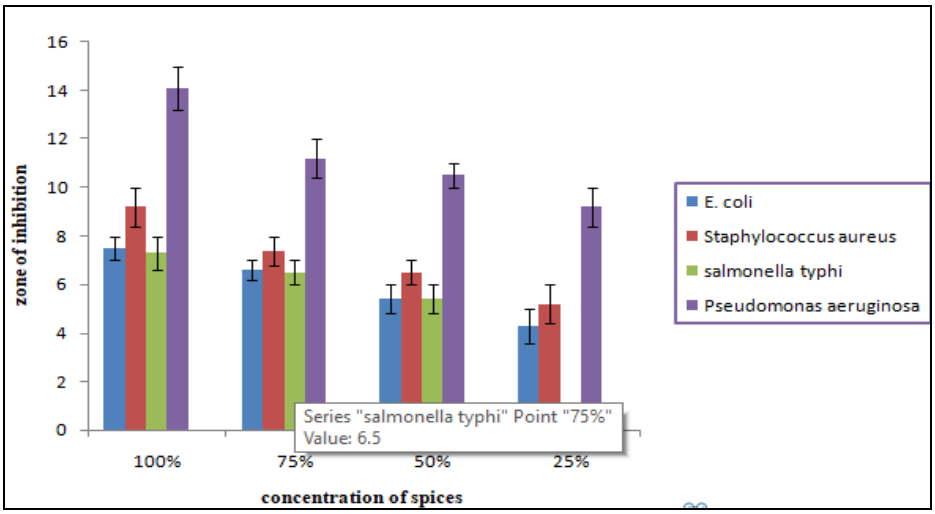

FIG 2: ANTIBACTERIAL ACTIVITY OF *ZINGIBER OFFICINALE*

Antibacterial Susceptibility Testing of *Laurus nobilis* Against *E. coli*: *Laurus nobilis* showed inhibition measurements of 7.5 ± 0.5 mm at 100% concentration and 6.6 ± 0.4 mm at 75% concentration of prepared solutions whereas it showed no any zone of inhibition at 50% and 25% concentrations of prepared solutions against *Escherichia coli*.

Antibacterial Susceptibility Testing of *Laurus nobilis* against *Staphylococcus aureus*: The antibacterial susceptibility test of *Laurus nobilis* against *Staphylococcus aureus* was determined as 12.4 ± 0.6 mm at 100%, 11.8 ± 0.2 mm at 75%, 10.6 ± 0.4 mm at 50%, and 8.8 ± 0.2 mm at 25% concentrations of prepared solution.

Antibacterial Susceptibility Testing of *Laurus nobilis* against *Salmonella typhi*: Against *Salmonella typhi*, 100% concentration of a stock solution of Bay leaf produced 15.4±0.6mm zone of inhibition. Similarly at 75%, 50% & 25% concentrations, it produced 14.7 ± 0.3 mm, 13.6 ± 0.4 mm & 12.5 ± 0.5 mm zone of inhibition respectively.

Antibacterial Susceptibility Testing of *Laurus nobilis* against *Pseudomonas aeroginosa*: There is the less antibacterial effect of *Laurus nobilis* against *Pseudomonas aeruginos*a. It showed a 5.5 ± 0.5 mm zone inhibition at 100% concentration of prepared only (as shown in **Table 3.**

Antibacterial Susceptibility Testing of *Coriandrum sativum* against *Escherichia coli*: Coriander was found to be measured 12.5±0.5mm, 11.4 ± 0.6 mm, 8.2 ± 0.8 mm, and 6.3 ± 0.7 mm zone of inhibition at 100%, 75%, 50%, and 25% concentration of prepared solutions respectively against *Escherichia coli*.

Antibacterial Susceptibility Testing of *Coriandrum sativum* against *Staphylococcus aureus*: At 100% and 75%, concentration of a prepared solution of Coriander was determined as 11.7 ± 0.3 mm, 8.2 ± 0.8mm zone of inhibition against *S. aureus*. There are no antibacterial activities of Coriander against *S. aureus* at 50% and 25% concentrations.

Antibacterial Susceptibility Testing of *Coriandrum sativum* against *Salmonella typhi*: No antibacterial activities were shown by Coriander at any of its concentrations against *Salmonella typhi*.

Antibacterial Susceptibility Testing of *Coriandrum sativum* against *Pseudomonas aeruginosa*: *Coriandrum sativum* at its different concentration level produced good potential inhibitory measurement against *Pseudomonas aeruginosa i.e.*, at 100% 18.7 ± 0.2 mm, at 75% 9.4 ± 0.6 mm, at 50% 8.6 ± 0.4 mm & at 25% 7.5 ±0.5mm respectively.

Maximum inhibition of *E. coli* exhibited by Ginger at 100% with 14.5 ± 0.5 zone of inhibition whereas, Bay leaf shown maximum inhibition of *Staphylococcus aureus* as well as *Salmonella typhi* at 100% with 12.4 ± 0.6 and 15.4 ± 0.6 respectively. Coriander revealed maximum potential inhibition against *Pseudomonas aeruginosa* at 100% with 18.7 ± 0.2 mm of the zone of inhibition.

Determination of Antibacterial Activities of *Laurus nobilis* (Bay Leaf):

TABLE 3: ANTIBACTERIAL ACTIVITY OF LAURUS NOBILIS.

Name of Organism	Zone of inhibition (mm)			
	100	75	50	25
Escherich Coli	7.5±0.5	6.6±0.4	-	-
Staphylococcus Aureus	12.04±0.6	711.8±0.2	10.6±0.4	8.8±0.2
Salmonella Typhiand	15.4±0.6	14.7±0.3	13.6±0.4	12.5±0.5
Pseudomonas Aeruginos	5.5±0.5	-	-	-

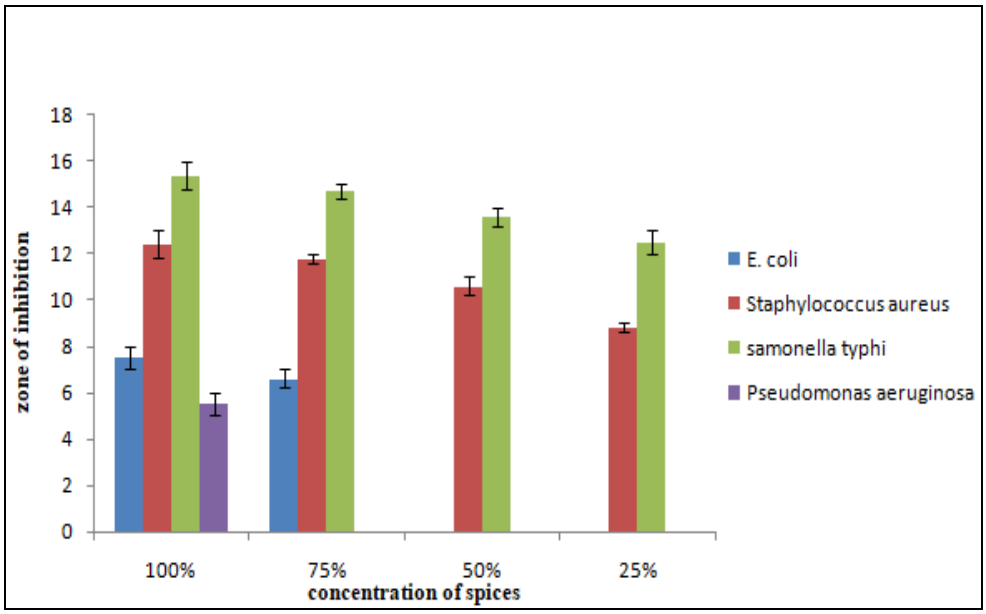

FIG. 3: ANTIBACTERIAL ACTIVITY OF *LAURUS NOBILS*

TABLE 4: ANTIBACTERIAL ACTIVITY OF *CORIANDRUM SATIVUM*

Name of Organism	Zone of inhibition (mm)			
	100	75	50	25
Escherich Coli	12.5±0.5	11.4±0.6	8.2±0.8	6.3±0.7
Staphylococcus Aureus	11.7±0.3	8.2±0.8	-	-
Salmonella Typhiand	-	-	-	-
Pseudomonas Aeruginos	18.7±0.2	9.4±0.6	8.6±0.4	7.5±0.5

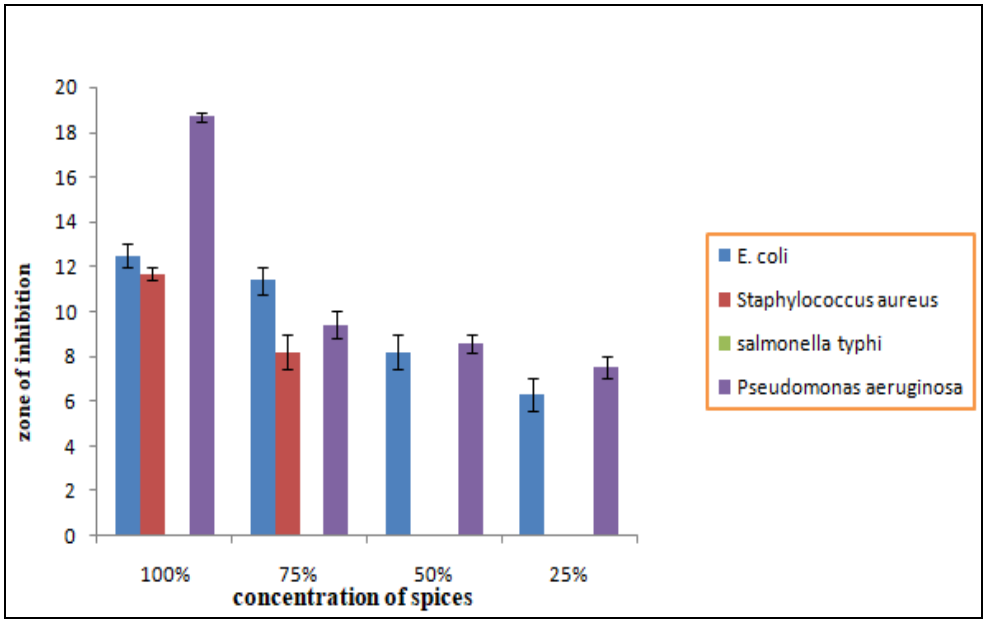

FIG. 4: ANTIBACTERIAL ACTIVITY OF *CORIANDRUM SATIVUM*

CONCLUSION: Spices are food additives that have been shown to be medicinal, with special herbal and aromatic flavourings. This is especially of urgent concern when considering the growth rate of multi-resistant bacterial strains worldwide. The above finding offered the basis for the therapeutic potential of spices.

The antibacterial activity of the different spices was measured using the agar cup plate process. The findings of this study are very promising for all four spices with antimicrobial activity against most pathogens, but antimicrobial activity varies significantly depending on the type of spice and microorganism.

According to the present study, Ginger and Turmeric are effective against all four pathogens (*Escherichia coli, Staphylococcus aureus, Salmonella Typhi, Pseudomonas aeruginosa*). Bay leaf showed comparatively good antibacterial activity at higher concentrations. Coriander exhibits the maximum activity against *Pseudomonas aeruginosa*, but no activity against *Salmonella Typhi* at any concentration.

CONFLICTS OF INTEREST: There was no conflict of interest.

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