ANTIBACTERIAL ACTIVITY OF *ZINGIBER OFFICINALE* ROSC. AGAINST TARGET PATHOGENS

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Abstract

Zingiber officinale is used in traditional medicine against different diseases because of its various properties (antimicrobial, antioxidant, anti-inflammatory, anticoagulant, etc.). It is "generally recognized as safe" by the Food and Drug Administration. The agar diffusion test was used to check the antimicrobial activity of the *Zingiber officinale* extract along with *Bacillus subtilis, Pseudomonas aeruginosa, Escherichia coli* and *Salmonella typhi* pathogens. The values of Zone of Inhibition were tabulated according to target pathogens. The Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal *Concentrations* (MBC) values were also recorded.The antimicrobial activities of *Zingiber officinale* extract highly active against *P. aeruginosa, Salmonella typhi and E. coli* but was less active against *Bacillus subtilis.*

Keywords: Zingiber officinale, *antibacterial activity, MIC, MBC, pathogens*.

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1. Introduction

Zingiber officinale Rosc. (Ginger)is a monocotyledon belonging to family *Zingiberaceae*, is an important spice and medicinal plant originated in South-East Asia and introduced to many parts of the globe (Park and Pizutto, 2002; Burkill, 1996). Ginger is truly a world domestic remedy. It is also used in India and other places like the ancient Chinese where the fresh and dried roots were considered distinct medicinal products. In nineteenth century Ginger serves as a popular remedy for cough and asthma when the juice of fresh Ginger was mixed with a little juice of fresh garlic and honey.A paste of powdered dried Ginger was applied to the temples to relieve headache and fresh Ginger was mixed with a little honey, tapped off with a pinch of burnt peacock feathers to alley nausea. (KaruppiahandRajaram, 2012).

Ginger is abundant in active constituents, such as phenolic and terpene compounds (Prasad andTyagi, 2015). The phenolic compounds in Ginger are mainly Gingerols, shogaols, and paradols. In fresh Ginger, Gingerols are the major polyphenols, such as 6-Gingerol, 8-Gingerol, and 10-Gingerol. With heat treatment or long-time storage, Gingerols can be transformed into corresponding shogaols. After hydrogenation, shogaols can be transformed into paradols (Stoner, 2013). There are also many other phenolic compounds in Ginger, such as quercetin, zingerone, Gingerenone-A, and 6-dehydroGingerdione (Ji et al., 2017;Schadich et al., 2016). Moreover, there are several terpene components in Ginger, such as β-bisabolene, α-curcumene, zingiberene, α-farnesene, and β-sesquiphellandrene, which are considered to be the main constituents of Ginger essential oils (Yeh et al., 2014). Besides these, polysaccharides, lipids, organic acids, and raw fibers are also present in Ginger (Prasad and Tyagi, 2015;Yeh et al., 2014).

Ginger has been widely used all over the world in Ayurvedic medicine, for a wide array of unrelated ailments including arthritis, cramps, rheumatism, sprains, sore throats, muscular aches, pains, constipation, vomiting, hypertension, indigestion, dementia, fever and infectious diseases. It has direct anti-microbial activity and thus can be used in treatment of bacterial infections. Gingeris relatively inexpensive due to their easy availability, universally acceptable and well tolerated by the most people. It has also been "Generally Recognized as Safe" (GRAS) by the US FDA.(Santo Grace andSankari, 2017).

2. Material and Methods

2.1 Preparation of extracts

Prepared plant extract were collected from Reeva Herbal Pvt. Ltd, Ahmedabad. Decoction method with PEG for plant extraction. Prepared plant extract dilute with distilled water in 5:1 ratios before testing it for antibacterial activity (Daswani et al., 2011).

2.2 Qualitative Phytochemical Screening (Tyagi and Agarwal, 2017; Roghini and Vijayalakshmi, 2018).

2.2.1 Test for Carbohydrates: The presence of carbohydrates was confirmed when 2 ml of extract was treated with 1 ml of Molisch's reagent and few drops of concentrated sulphuric acid which resulted in the formation of purple or reddish color.

2.2.2 Test for Tannins: To 1 ml of extract, 2 ml of 5% ferric chloride was added. Formation of dark blue or greenish black indicates the presence of tannins.

2.2.3 Test for Saponins: 2 ml of extract, 2 ml of distilled water were added and shaken in a graduated cylinder for 15 min lengthwise. It resulted in the formation of 1 cm layer of foam that indicated the presence of saponins.

2.2.4 Test for Alkaloids: To 2 ml of extract, 2 ml of concentrated hydrochloric acid was added. Then few drops of Mayer's reagent were added. Presence of green color or white precipitate indicates the presence of alkaloids.

2.2.5 Test for Flavonoids: To 2 ml of extract, 1 ml of 2N sodium hydroxide was added. Presence of yellow color indicates the presence of flavonoids.

2.2.6 Test for Glycosides: To 2 ml of extract, 3ml of chloroform and 10% ammonia solution was added. Formation of pink color indicates presence of glycosides.

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2.2.7 Test for Quinones: To 1 ml of extract, 1 ml of concentrated sulphuric acid was added. Formation of red color indicates presence of quinones.

2.2.8 Test for Phenols: 2 ml of distilled water followed by few drops of 10% ferric chloride was added to 1ml of the extract. Formation of blue or green color indicates presence of phenols.

2.2.9 Test for Terpenoids: 0.5 ml of the extract was treated with 2 ml of chloroform and conc. sulphuric acid. Formation of red brown colour at the interface indicates the presence of terpenoids.

2.2.10 Test for Cardiac Glycosides: To 0.5 ml of the extract, 2 ml of glacial acetic acid and few drops of ferric chloride were added. This was under layered with 1 ml of conc. sulphuric acid. Formation of brown ring at the interface indicates the presence of cardiac glycosides.

2.2.11 Ninhydrin Test: To 2 ml of the fruit extract few drops of 0.2% ninhydrin reagent was added and heated for 5 min. Formation of blue colour indicates the presence of amino acids.

2.2.12 Test for Coumarins: 1 ml of 10% sodium hydroxide was added to 1ml of the extract. Formation of yellow colour indicates the presence of coumarins.

2.2.13 Anthraquinones: To 1 ml of fruit extract few drops of 10% ammonia solution was added, appearance of pink color precipitate indicates the presence of anthraquinones.

2.2.14 Steroids: To 1 ml of fruit extract equal volume of chloroform is added and a few drops of concentrated sulphuric acid added appearance of brown ring indicates the presence of steroids and appearance of bluish brown ring indicates the presence of phytosteroids

2.2.15 Test for Phlobatannins: Few drops of 2% hydrochloric acid were added to 1ml of the extract. Appearance of red colour precipitate indicates the presence of phlobatannins.

2.2.16 Anthracyanine: To 1 ml of the extract was added 1 ml 2N sodium hydroxide and heated for 5 min at 100 °C. Formation of bluish green color indicates the presence of anthocyanin.

2.3 Bacterial Cultures

The microorganisms used were as follows, *Pseudomonas aeruginosa* (NCIM 2036), *Bacillus subtilis* (NCIM 2250), *Escherichia coli* (NCIM 2109) and *Salmonella typhi*. The stock cultures were maintained at 4°C on slopes of Nutrient agar and sub cultured for 24 hrs before use. (Sundaram*et al.*, 2011).

2.4 Antibiotics

Hi-media antibiotics used in the study were Kanamycin (1000mcg), Rifampicin (15mcg), Vancomycin (5mcg), Gentamicin (10 mcg), Penicillin (10units), Penicillin-G (2units), Streptomycin (25mcg), Tetracycline (30 mcg), Erythromycin (60mcg), Colistin(Methane Sulphonate) (10mcg).

2.5 Preparation of Inoculums

Direct colony suspension method of choice organisms, e.g. *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Escherichia coli* and *Salmonella typhi* colonies are taken directly from plate into distilled water. The suspension ought to match or even exceed the density regarding the 0.5 McFarland standards (Andrews, 2001). These types of suspensions need to be employed inside of 30 minute of preparation.

2.6 Preparation of the McFarland Standard

Add 0.05ml of $BaCl_2$ (1% w/v $BaCl_2$.$2H_2O$) to 9.95 ml of H_2SO_4 (1% v/v) along with continual mixing. Disperse the standard are hand out with the help of the same dimensions and volume screw cap tubes those utilized in expanding the particular broth cultures. Then close screw cap tube for the stop damage by evaporation. Retailer protected against gentle at 37°C. Energetically agitate the turbidity

standard over a vortex mixing machine just before use. Standards might be stored for up to 6 months after which period they must be dumped. (Andrews, 2001)

2.6.1 Adjustment to the Density of Organism Suspension of the 0.5 McFarland Standards

Add sterile distilled water for adjust density of bacterial suspension equal to the 0.5 McFarland standard compare with white background with contrast black line. (Andrews, 2001)

2.7 Antibacterial Sensitivity Testing

2.7.1 Kirby-Bauer Disc Diffusion Method

Antibacterial activities of the different antibiotics were determined using the agar disc diffusion by Kirby-Bauer method. Kirby-Bauer method is recommended by the National Committee for Clinical Laboratory Standards (1993) and the World Health Organization (WHO). Sterile Petri plates containing Mueller-Hinton agar (Hi-media) used for the assays and 100 µl standardized inoculum (which has been adjusted to be able to 0.5 McFarland standard), has been spread using a sterile glass spreader by spread plate method. The standard Hi-media antibiotic discs were aseptically placed above sterile Mueller-Hinton agar plates seeded with respective test organisms. The plate incubates for 5 min at 37˚C for the diffusion of compound. The plates were incubated inverted position at 37˚C or 24 hrs. At the end of incubation inhibition zone formed around the disc were assessed in mm (millimeter) and the results were recorded.

2.7.2 Agar-well Diffusion method

The antimicrobial activity of the different extracts of the plant was assayed by agar well diffusion method. 100 µl standardized inoculum (which has been adjusted to be able to 0.5 McFarland standard), has been inoculate in Mueller-Hinton agar (Hi-media).The plant extracts of 5,10,15,20,25,30,35,40,45 and 50µl concentrations were added in agar well. The plates were then incubated at 37°C for 24 h. The plates were incubated inverted position at 37˚C or 24 hrs and each extract was tested on three repeat plates. At the end of incubation inhibition zone formed around the well were assessed in mm (millimeter) and the results were recorded.

2.8 Minimum inhibitory concentration (MIC) & Minimum Bactericidal concentration (MBC)

Nutrient broth method test was carried out to check the antimicrobial activity of test solution against given microorganisms. 0.1 ml standardized inoculum (which has been adjusted to be able to 0.5 McFarland standards) has been inoculate in nutrient broth. The Nutrient-broth were incubated in incubator at 37℃ for 24 hrs and then observed the turbidity. The tubes that showed no turbidity in the MIC test were taken and a100 µl from each tube was spread on Nutrient agar plate. The nutrient agar plates were incubated for 24 h at 37°C and the absence of growth was observed. The concentration of the extracts that showed no growth was recorded as the Minimum Bactericidal Concentration (MBC).

3. Results

The present systematic examination shows the phytochemical analysis antimicrobial activity of the extract of Ginger.

3.1 Phytochemical Analysis

The phytochemical analysis with the extract of Ginger showed the presence of Flavonoids and Terpenoids. (Table 1)

Table 1: Qualitative Phytochemical Analysis of Extract of Ginger

Sr. No.	Test Name	Ginger
1	Carbohydrates	-
2	Tannin	-
3	Saponins	-
4	Alkloids	-
5	Flavonoids	+
6	Glycosides	-

7	Quinones	-
8	Phenols	-
9	Terpenoids	+
10	Cardiac Glycosides	-
11	Ninhydrin	-
12	Coumarins	-
13	Anthraquinones	-
14	Steroids	-
15	Phlobatannins	-
16	Anthraacyanine	-

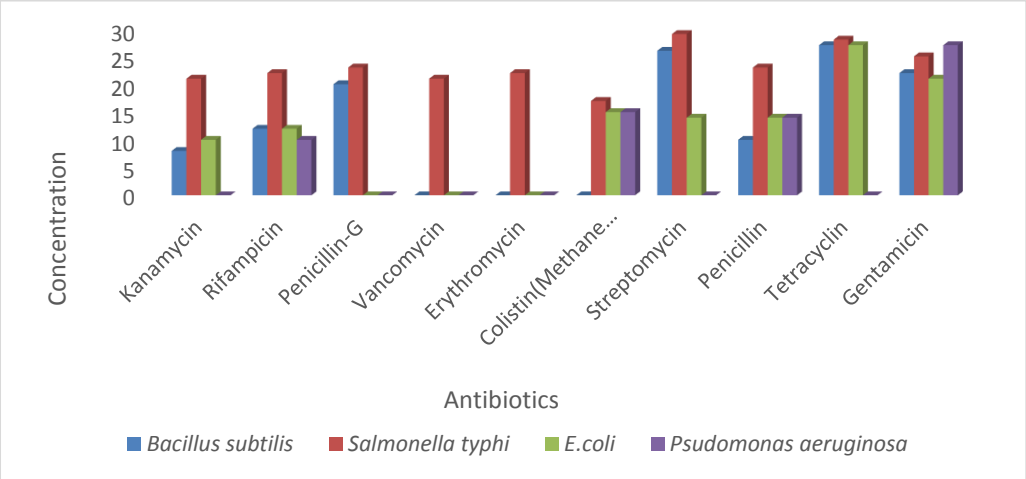
(+ = Positive, - = Negative)

3.2Antibacterial Sensitivity Testing

3.2.1 Kirby-Bauer Disc Diffusion Method

The significant antibacterial activities of the *Bacillus subtilis, Salmonella typhi, Pseudomonas aeruginosa, and Escherichiacoli*organisms were comparable to the standard Hi-media antibiotic disc by Kirby-Bauer disc diffusion method. The results show the antibiotic sensitivity testing against the *Bacillus subtilis, Salmonella typhi,Pseudomonas aeruginosa, and Escherichiacoli* microorganisms. The gram positive bacterium *Bacillus subtilis*was a sensitive to Tetracycline and Streptomycin whereas showed intermediate to Penicillin-G and Gentamicin antibiotic. Whereas showed resistant to Vancomycin, Erythromycin, and Colistin (Methane Sulphonate).Gram negative bacterium *Salmonella typhi* was a sensitive to Streptomycin, Tetracyclin, Penicillin-G, Kanamycin, Rifampicin, Vancomycin, Erythromycin, Penicillin, and Gentamicin. Whereas showed intermediate to Colistin (Methane Sulphonate). Secondgram negative bacterium *Escherichia coli*were a sensitive to Tetracyclin and Gentamicin whereas showed intermediate to Colistin (Methane Sulphonate), Streptomycin, Penicillin. Whereas showed resistant to Penicillin-G, Vancomycin and Erythromycin. Third gram negative bacterium *Pseudomonas aeruginosa*was a sensitive to Gentamicin whereas showed intermediate to Colistin (Methane Sulphonate) and Penicillin. Whereasshowed resistant to Kanamycin, Penicillin-G, Vancomycin, Erythromycin, Streptomycin and Tetracyclin. (Fig. 1)

Fig.1 Antibiogram results of Gram Positive and Gram Negative organisms withStandardHi-MediaAntibiotics



3.2.2 Antimicrobial Activity Well Diffusion Method

Generally Plant extracts are rich in antimicrobial compounds. The study of antimicrobial activity against most of the test organisms. Agar well diffusion method was used to check the antimicrobial activity of extracted plant samples. With the help of this test we determined if the culture we were using had antibacterial property or not. (Fig. 2& 3)

Fig. 2: Antibacterial activity of GingerExtract forGram Positive *Bacillus subtilis*organisms(Diameter of inhibition zone in mm*)

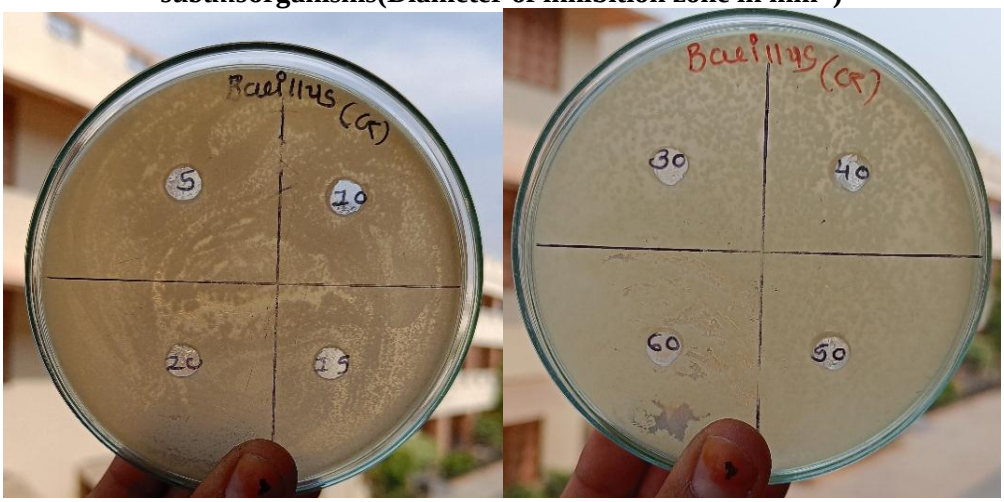


Fig. 3: Antibacterial Activity of Ginger Extract of Gram Negative organisms (Diameter of inhibition zone in mm*)

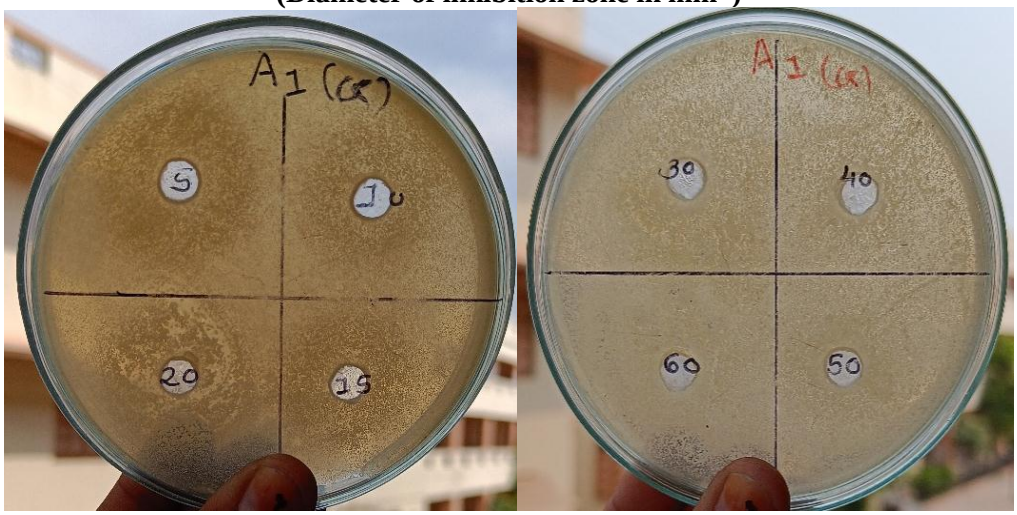


Fig. 3 (a) *Salmonella typhi*

Fig. 3 (b) *Escherichia coli*

Fig. 3 (c) *Pseudomonas aeruginosa*

The Ginger extract showed no zone of inhibition against gram positive organism *Bacillussubtilis*and against gram negative organism *Salmonella typhi*, *Escherichia coli*and *Pseudomonas aeruginosa.* (Table 2)

Table 2:Zone of Inhibition against Gram Positive and Gram Negative organism

Sr. No	Ginger Extract Concentration (µl)	Name of organism			
		Bacillus subtilis	***Salmonella typhi***	***E. coli***	***Pseudomonas aeruginosa***
1	5	-	-	-	-
2	10	-	-	-	-
3	15	-	-	-	-
4	20	-	-	-	-
5	30	-	-	-	-
6	40	-	-	-	-
7	50	-	-	-	-
8	60	-	-	-	-

(- = No Zone of Inhibition)

3.3 Minimum Inhibitory Concentration (MIC)

The Ginger extract showed an antibacterial action against*Bacillus subtilis*organismwith MIC value 11ml. (Table 3)

Table 3: Minimum Inhibitory Concentration (MIC) of Ginger extracts against *Bacillus subtilis*

Name of organism *Bacillus subtilis*	
Extract (ml)	**Ginger**
1	+
2	+
3	+
4	+
5	+
6	+
7	+
8	+
9	+
10	+
11	-

Name of organism *Bacillus subtilis*	
Extract (ml)	**Ginger**
10	+
10.1	+
10.2	+
10.3	+
10.4	+
10.5	-
10.6	-
10.7	-
10.8	-
10.9	-
11	-

(+ = Growth, - = No Growth)

The Ginger extract showed an antibacterial action against *Salmonella typhi* organism with MIC value 5ml. (Table 4)

Table 4: Minimum Inhibitory Concentration (MIC) of Ginger extracts against *Salmonella typhi*

Name of organism *Salmonella typhi*	
Extract (ml)	**Ginger**
1	+
2	+
3	+
4	+
5	-
6	-
7	-
8	-
9	-
10	-

Name of organism *Salmonella typhi*	
Extract (ml)	**Ginger**
4	+
4.1	+
4.2	+
4.3	+
4.4	+
4.5	+
4.6	+
4.7	-
4.8	-
4.9	-
5	-

(+ = Growth, - = No Growth)

The Gingerextract showed an antibacterial action against*Escherichia coli*with MIC value 5ml. (Table 5)

Table 5:Minimum Inhibitory Concentration (MIC) of Ginger extracts against *Escherichia coli*

Name of organism *E. coli*	
Extract(ml)	**Ginger**
1	+
2	+
3	+
4	+
5	-
6	-
7	-
8	-
9	-
10	-

Name of organism *E. coli*	
Extract(ml)	**Ginger**
4	+
4.1	+
4.2	+
4.3	+
4.4	+
4.5	+
4.6	+
4.7	-
4.8	-
4.9	-
5	-

(+= Growth, - = No Growth)

The Ginger Extract showed an antibacterial action against *Pseudomonas aeruginosa* with MIC value 5ml. (Table 6)

Table 6: Minimum Inhibitory Concentration (MIC) of Ginger Extracts against *Pseudomonas aeruginosa*

Name of organism *Pseudomonas aeruginosa*	
Extract (ml)	**Ginger**
1	+
2	+
3	+
4	+
5	-

6	-
7	-
8	-
9	-
10	-

Name of organism *Pseudomonas aeruginosa*	
Extract (ml)	**Ginger**
4	+
4.1	+
4.2	+
4.3	+
4.4	+
4.5	+
4.6	+
4.7	+
4.8	-
4.9	-
5	-

(+ = Growth, - = No Growth)

The Gingerextract showed an excellent antibacterial action against *Salmonella typhi*, *Escherichia coli* and *Pseudomonas aeruginosa* organism with MIC value 5ml. but were moderate antibacterial action against *Bacillus subtilis*with MIC value 11ml.

3.4 Minimum Bactericidal Concentration (MBC)

The Ginger extract showed an antibacterial action against *Bacillus subtilis* organism with MBC value 10.6ml. (Table 7)

Table 7: Minimum Bactericidal Concentration (MBC) of Gingerextracts against *Bacillus subtilis*

Name of organism *Bacillus subtilis*	
Extract (ml)	**Ginger**
10.4	Lawn Growth & No Inhibition
10.5	Growth & No Inhibition
10.6	No Growth &Inhibition
10.7	No Growth &Inhibition
10.8	No Growth &Inhibition
10.9	No Growth & Inhibition
11	No Growth & Inhibition

The Ginger extract showed an antibacterial action against *Salmonella typhi* organism with MBC value 4.8ml. (Table 8)

Table 8: Minimum Bactericidal Concentration (MBC) of GingerExtracts against *Salmonella typhi*

Name of organism *Salmonella typhi*	
Extract (ml)	**Ginger**
4.6	Lawn Growth & No Inhibition
4.7	Growth & No Inhibition
4.8	No Growth &Inhibition
4.9	No Growth & Inhibition
5	No Growth & Inhibition

The Ginger extract showed an antibacterial action against*Escherichia coli*organismwith MBC value 4.8ml. (Table 9)

Table 9: Minimum Bactericidal Concentration (MBC) of GingerExtracts against *Escherichia coli*

Name of organism *Escherichia coli*	
Extract (ml)	**Ginger**
4.6	Lawn Growth & No Inhibition
4.7	Growth & No Inhibition
4.8	No Growth & Inhibition
4.9	No Growth & Inhibition
5	No Growth & Inhibition

The Gingerextract showed an antibacterial action against *Pseudomonas aeruginosa* organism with MBC value 4.9ml. (Table 10)

Table 10: Minimum Bactericidal Concentration (MBC) of GingerExtracts against *Pseudomonas aeruginosa*

Name of organism*Pseudomonas aeruginosa*	
Extract (ml)	**Ginger**
4.7	Lawn Growth & No Inhibition
4.8	Growth & No Inhibition
4.9	No Growth & Inhibition
5	No Growth & Inhibition

The Ginger extract showed an excellentantibacterial action against*Salmonella typhi* and*Escherichia coli*organismwith MBC value 4.8ml but were good antibacterial action against *Pseudomonas aeruginosa*with MBC value 4.9ml while a moderate antibacterial action against *Bacillus subtilis*with MBC value 10.6ml.

4. Discussion

Silvia Del Carmen Beristain-Bauzareported, Ginger (*Zingiber officinale*) is a plant used in traditional medicine against

different diseases because of its various properties (antimicrobial, antioxidant, anti-inflammatory, anticoagulant, etc.). Ginger is "generally recognized as safe" by the Food and Drug Administration. Numerous studies have been carried out to characterize and isolate its main bioactive compounds to elucidate the mechanisms of its antimicrobial activity against pathogenic and spoilage microorganisms in foods. Results indicate that Ginger contains monoterpenoids, sesquiterpenoids, phenolic compounds, and its derivatives, aldehydes, ketones, alcohols, esters, which provide a broad antimicrobial spectrum against different microorganisms and make it an interesting alternative to synthetic antimicrobials. However, its application in foods has been scarcely explored and represents an opportunity area for further research. This review provides an updated overview of the main bioactive compounds of Ginger, its potential application, and toxicity as an antimicrobial in food products.(Silvia Del Carmen Beristain-Bauza et al.,2019).

Islam reported, *Zingiber officinale* has long been used as naturopathy due to their potential antimicrobial activity against different microbial pathogens. Moreover, in many countries like Bangladesh, Ginger is used in different boiled food preparations. This study was conducted to determine the antimicrobial activity of soybean oil extract of dried Ginger powder, using agar diffusion assay, against 24 isolates (4 of 6 different types) of food borne pathogens including *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Vibrio cholerae, Klebsiella spp*. and *Salmonella spp.* The present study showed the potent antimicrobial activity of the Ginger extract against the all tested bacterial pathogens. Soybean oil extract of Ginger showed highest zone of inhibition (11.67±1.53mm) against *Salmonella* spp. and lowest zone of inhibition (8.0±1.73mm) against *Escherichia coli*. Ginger extract also showed lower zone of inhibition (8.67±2.52mm) against *Staphylococcus aureus* compared to the Gram-negative bacteria. Soybean oil extract of Ginger at boiling temperature has potential antimicrobial activity and could be used in food preparation to get the synergistic effect of soybean and Ginger. (Islam & Kabir, 2014).

Abdalla reported, *Ginger rhizome* (*Zingiber officinale*), is a famous plant product consumed as a spice as well as many uses in food industries and traditional medicine. Numerous studies have been conducted on its antibacterial potential, which showed varied results. The objective of the current mini-review is to highlight the antibacterial properties of Ginger rhizome, based on the published data. It was found that, out of 40 published papers on the antibacterial properties of Ginger rhizome, 2 reported negative results, while 38 exhibited positive results against all or some of the tested bacteria. Even though, most of the positive results were not a competitor to the tested antibiotics (as positive controls). However, there were wide differences and contradictions between the positive results themselves even against the same bacterial species, indicating that the efficacy of this plant product is greatly affected by many reasons such as the method of extraction, antibacterial assay conditions, genetic variations among bacterial strains and its sources. Also, the source of plant sample is an important factor, since plants affected by geographic variations, environmental conditions and physiological factors which influence its bioactive phytochemical compounds. Accordingly, this mini-review suggests that the antibacterial properties of Ginger rhizome have yet to be adequately explored using advanced multidisciplinary approach (in vitro and in vivo). (Abdalla and Abdallah, 2018).

NurulHikmahHarun reported, The available synthetic drugs to treat infectious diseases have many side effects on the consumer. *Zingiberofficinale* which is known as Ginger or "halia" in Malaysia has a good prospect as an alternative for safer treatment and has a low risk of side effects. It is because this herb is used as a traditional medicine in the community to treat several ailments, including infectious diseases. Several studies have shown that crude extracts and bioactive components of *Z. officinale* possessed diverse pharmacological properties such as anticancer, anti-inflammatory, antimicrobial, antioxidant, and immunomodulatory. The goal of this research is to find out the effects of *Z. officinale* on the antimicrobial activities from

the selected previous studies (years 2000–2020). Briefly, this study involves 10 randomized controlled trials (RCTs) that determined the antimicrobial activities of *Z. officinale*. The results of the systematic analysis showed that Z. officinale exhibits antimicrobial activities for both in vitro and in vivo evaluations. The meta-analysis of appropriate data from four sources presented a substantial distinction between this plant and controls. The results present no significant difference between *Z. officinale* and positive controls for the antimicrobial analysis related to the overall outcome and inhibition zone [overall outcome standardized mean difference (SMD): −0.6003 (95% CI; −0.7092 to −0.4913), I2 = 100%, inhibition zone SMD: 0.8771 (CI; −8.1288 to 9.8829), I2 = 99%]. In conclusion, the results presented the antimicrobial activities of *Z. officinale* to be similar to the activity of the positive control. However, one should be aware of some limitations with the detailed reporting on the controls used in the included studies. Future well-designed RCTs with detailed reporting on the controls are required to provide additional data to prove the consequences of *Z. officinale* on the antimicrobial activities as well as safety data of consuming this plant. (NurulHikmah and Mohamad, 2023).

Aleem reported, Antibiotic resistance in every corner of the planet is growing to dangerously high levels. New mechanisms of resistance are emerging and spreading globally which threatens our ability to treat common infectious diseases. Many scientists documented some plants having antimicrobial properties. *Zingiber officinale* Roscoe (ZO), the most recognised member of Zingiber, is one of them. This review aims to validate the antimicrobial activity of Ginger. The information and data on ZO were collated from various resources like ethnobotanical textbooks, Pub Med, Google Scholar, Science Direct, Web of Science, and Scopus. ZO has many medicinal, nutritional and ethnomedical values and is commonly used as a spice, flavouring agent and herbal remedy worldwide. In addition to giving Ginger its pungent aroma, volatile oil Gingerol and other pungent principles are the most medically potent since they inhibit the production of prostaglandin and leukotriene, which are chemicals that affect blood flow and inflammation. Traditionally, it has been used as an herbal remedy for centuries in Ayurvedic, Tibb Unani, Chinese, Islamic, Africans, the Caribbean and many other medicinal systems to cure a variety of diseases like throat infections, asthma, inflammation, dyspepsia, loss of appetite, palpitation, constipation and indigestion, colds, arthritis, nausea, hypertension, migraines, and many more. It has a high proportion of α-Zingiberene, β-sesquiphellandrene, (E,E)- α-farnesene, geranial and ar-curcumene. The ZO extracts, essential oil and chemical constituents exhibited antimicrobial, anticonvulsant, analgesic, anti-inflammatory, antiulcer, immune-modulatory, and other beneficial activities. The research suggests that there are marked antimicrobial activities in the Ginger that could be beneficial and applied in various research areas, such as the pharmaceutical and food industries. To understand the molecular mechanisms by which these effects are exerted, more research may be required. (Aleem et al.,2020).

5. Conclusion

From the results of this study, it can be concluded that contain bioactive compound and found to have a strong antibacterial activity in the Ginger extract. Further, it can also be confirmed that these herbs can be used as traditional medicines. It can be used as a source of novel antibacterial drugs.The antimicrobial activities of Ginger extract highly active against *P. aeruginosa*, *Salmonella typhiand E.coli*but was less active against *Bacillus subtilis.*

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