

## Anti-Typhoid Response of Selected Medicinal Plant Extracts Against Multi-Drug Resistance *Salmonella Enterica Serovar Typhi*

Amandeep Singh<sup>\*</sup>, Amandeep Kaur<sup>2</sup>, Gagandeep Kaur<sup>3</sup>

<sup>1</sup>PhD Scholar, Medical Microbiology, Centre for Interdisciplinary Biomedical Research, Adesh University, Bathinda, Punjab [amandeep.discovery@gmail.com](mailto:amandeep.discovery@gmail.com)

<sup>2</sup>Professor, Department of Microbiology, Adesh Institute of Medical Sciences and Research, Bathinda, Punjab

<sup>3</sup>Assistant Professor, Department of Anatomy, Maharishi Markandeshwar College of Medical Sciences and Research, Sadopur, Ambala [gagandeep1618@gmail.com](mailto:gagandeep1618@gmail.com)

**Keywords:** Multi Drug Resistance, antimicrobial activity, medicinal properties

**How to cite this article:** Singh A, Kaur A, Kaur G. Anti-Typhoid Response of Selected Medicinal Plant Extracts Against Multi-Drug Resistance *Salmonella Enterica Serovar Typhi*. Int J Drug Deliv Technol. 2026;16(17s): 753-757. DOI: 10.25258/ijddt.16.17s.88

### Introduction

*Salmonella enterica serovar Typhi* is Gram negative, rod shaped, facultative anaerobic bacterium belongs to *enterobacteriaceae* family that causes typhoid fever in humans. Bacteria are transmitted by the intake of faecal contaminated water or food (Newell et al., 2010). Headaches, chills, high fever, nausea and malaise are the characterized sign and symptoms of typhoid (Cock, 2008).

Almost 30% of the bloodstream bacterial infections in Asia and 10% in Africa that arise in the general populations are caused by the etiological agent *Salmonella enterica serovar Typhi* (Deen et al., 2012). About 0.2 million deaths due to typhoid have been reported by WHO in 2014, most of them were reported from Asia (Andrews et al., 2017, WHO, 2017).

Usually chloramphenicol, ampicillin, trimethoprim and sulfamethaxazole are the first line of therapy for the typhoid fever. As the cases of multi drug resistance (MDR) reported since 1970 and 1980, the efficiency of those drugs became uncertain (Klemm et al., 2018) alternatives were tested. At first, the second line of therapy regarding multi drug resistance fluoroquinolones was effective, but with passage of time resistance to fluoroquinolones has also been reported (Raveendran et al., 2008). Contrary to synthetic antibiotics medicinal plants are important antimicrobial

resources to combat multidrug resistance. Currently, more than 80% of world population uses medicinal plants as a source of treatment against different ailments (Riaz et al., 2021).

Isolation and validation of vibrant antimicrobial components from medicinal plants permits the production of new medicines. Thus, it is beneficial to explore the medicinal properties of plants collected from different sources (Mujaddidi et al., 2021). Plants play a vital role in the ecosystem because of their abundant secondary metabolites (phytochemicals), which are beneficial in treating many human diseases. Thus, herbal medications are globally essential to primary healthcare (WHO, 2019)

This study investigated the anti-*Salmonella* activities of different medicinal plants like *Unripe ananas sativus*, *Mangifera indica*, *Citrus aurantifolia*, *Azadirachta indica*, *Aloe barbadensis*, *Syzygium aromaticum* and *Buttermilk* by Mueller-Hinton agar (MHA) well method.

### MATERIALS AND METHODS

#### Experimental

#### design

In the present study, various plant extracts were used as indicated in Table 1 and were analysed using well diffusion method for screening their anti-*Salmonella* properties against clinical isolates.

**Table 1: List of selected medicinal plants used in the present study**

S.No.	Scientific Name	Common Name
1	<i>Citrus aurantifolia</i>	Lemon juice
2	<i>Syzygium aromaticum</i>	Clove oil
3	<i>Unripe ananas sativus</i>	Pineapple juice
4	<i>Mangifera indica</i>	Mango juice
5	<i>Azadirachta indica</i>	Neem oil
6	<i>Aloe barbadensis</i> Miller	Aloe vera gel
7	Buttermilk	Buttermilk

\*Author for Correspondence: [amandeep.discovery@gmail.com](mailto:amandeep.discovery@gmail.com)

Samples were subjected to antimicrobial activity of selected plants was detected through agar well diffusion method.

**Procedure:**

1. Preparation of Inoculum: A fresh culture of *Salmonella* isolation on XLD was adjusted to a standard turbidity (usually 0.5 McFarland standard).
2. Agar Preparation & Seeding: Mueller-Hinton agar (MHA) was poured into petri plates and allowed to solidify. The plate surface was then swabbed evenly with the microbial suspension to create a uniform "lawn" of growth.

3. Well Creation: A tube (9mm diameter) was used to punch wells into the solidified agar.
4. Loading the Samples: A specific volume of the test extracts were added into the well.
5. Incubation: The plates were incubated at 37°C for 24 hours to allow the bacteria to grow and the agent to diffuse.
6. Measurement: The antimicrobial activity was then measured by the diameter of the clear zone of inhibition around the well in millimetres (mm).

**Results:**

**Table 2: Anti-typhoid response of various medicinal plant extracts**

Scientific Name (Common Name)	Concentration	Resistance/Sensitive
<i>Citrus aurantifolia</i> (Lemon juice)	5, 10,15, 20, 25 µl	S
<i>Syzygium aromaticum</i> (Clove oil)	5, 10,15, 20, 25 µl	S
<i>Unripe ananas sativus</i> (Pineapple juice)	5, 10,15, 20 µl	S
<i>Mangifera indica</i> (Mango juice)	5, 10,15, 20, 25 µl	S
<i>Azadirachta indica</i> (Neem oil)	5, 10,15, 20, 25 µl	R
<i>Aloe barbadensis</i> Miller (Aloe vera gel)	5, 10,15, 20, 25 µl	R
Buttermilk	5, 10,15, 20, 25 µl	R

In the present study, it was observed that out of all the selected plant extracts *Citrus aurantifolia* (Lemon juice), *Syzygium aromaticum* (Clove oil), *Unripe ananas sativus* (Pineapple juice) and *Mangifera indica* (Mango juice) showed sensitive results for anti-Typhoid. On the other side, *Azadirachta indica* (Neem oil), *Aloe barbadensis* Miller (Aloe vera gel) and Buttermilk depicts resistant response.

**Discussion:**

According to research conducted on pineapple fruit extract, it demonstrated antimicrobial properties, particularly exhibiting antibacterial effects against *Staphylococcus aureus*. This was attributed to bromelain as the active compound, alongside phytochemical factors like Vitamin C and flavonoids (Loon et al., 2018). Another study focusing on the peel of *Ananas comosus* demonstrated its antimicrobial properties, suggesting its potential use in treating and preventing infectious diseases. The aqueous extract derived from the crown leaves of pineapple contained proteins exhibiting various enzymatic activities, including nonspecific proteolytic, gelatinolytic, collagenase, fibrinolytic, acid and alkaline phosphatase, nuclease, and peroxidase. Additionally, it displayed significant antibacterial and antifungal properties. Taken together, these characteristics suggest its potential application in the treatment of microbial infections (Dutta and Bhattacharyya, 2013).

In one of another study conducted in USA, ethanolic and methanolic extract of mango leaf showed relatively high

zones of inhibition against *S. typhi*. The leaves of *M. indica* have been analyzed chemically and reported to contain glucoside and mangiferin which is potent antimicrobial agent (Zakaria et al., 2006)

The antibacterial activity of the lime extract return to its different phytochemicals, these compounds have ability to disrupting the bacterial cell membranes, inhibiting the essential enzyme and destroying the resistance mechanisms of the bacterial cells (Guo et al., 2021). Also, in other study by (Olatunya et al., 2024) they work on fresh lime and dried lime and found the same high antibacterial activity against different bacterial species. The high levels of eugenol contained in clove essential oil are responsible for its strong biological and antimicrobial activities. It is well know that both eugenol and clove essential oil phenolic compounds can denature proteins and react with cell membrane phospholipids changing their permeability and inhibiting a great number of Gram-negative and Gram-positive bacteria as well as different types of yeast (Chaib et al., 2007 and Walsh et al., 2003).

The antibacterial action of neem samples against 21 strains of food endured pathogens was assessed and recommended that neem have compounds holding antibacterial functions that can be beneficial to resist food endured pathogens and decomposer organisms (Bohnenstengel et al). Another research was carried out to assess the antibacterial action of the leaf, seed, bark and fruit extracts of *Azadirachta Indica* (neem) on microbes obtain from mouth of adult and effects revealed that leaf and bark extracts possess antibacterial

action against bacteria (Chauhan *et al.*, 2015). A study carried out antimicrobial activity against cyanobacterium *Fischerella spp.* isolate from neem bark. Methanolic bark extract of neem (*Azadirachta indica*) initiate to be active against *Enterobacter aerogenes*, *Mycobacterium tuberculosis*, *Staphylococcus aureus*, *Salmonella typhi*, *Pseudomonas aeruginosa* and *Escherichia coli* (Asthana *et al.*, 2006). A large number of natural anti-oxidant compounds exist in *A. vera* such as ascorbic acid, carotenoids, flavonoids, glutathione peroxidase, phenolics, superoxide dismutase, tannins and vitamins C and E. It mechanically works as reducing the oxidative stress of cell devastation and also reduces physiological and biochemical changes (Nazir and Ahsan, 2017, Mikoiajczak 2018). The antiseptic capability of *A. vera* is basically due to the presence of six novel compounds specifically cinnamomic acid, lupeol, phenol, salicylic acid, sulfur and urea nitrogen. Their assortments have obstructive action on various diseases, organisms and parasites (Pathak and Sharma, 2017).

One of the study reported that cultured buttermilk prepared by blending dahi and fermented whey in 60:40 ratio by employing *L. helveticus* MTCC 5463 showed antimicrobial activity against *S. aureus*, *S. typhi* and *E. coli*. Buttermilk is a refreshing drink obtained in the preparation of butter from dahi or by churning cream. Therapeutic Properties of Buttermilk is described in Ayurveda texts. Consuming buttermilk on regular basis offers mainly health benefits. Cultured buttermilk also serves as a good source of bioactive peptide which can offer additional therapeutic values. (Sonali *et al.*, 2017)

#### Conclusion:

Due to increasing antibiotic resistance in microorganisms and side effects of synthetic antibiotics medicinal plant are now growing popularity in the treatment of many infections. Use of medicinal plants being considered as clinically effective and safer alternatives to the synthetic antibiotics. Extensive research in the area of isolation and characterization of the active principles of different medicinal plant is essential so that better, safer and cost effective drugs for curing various diseases and infections can be developed.

#### References:

1. Cock I.E. Antimicrobial activity of Aloe barbadensis Miller leaf gel components. Internet J. Microbiol. 2008;4(2):17.
2. Newell, D.G., Koopmans, M., Verhoef, L., Duizer, E., Aidara-Kane, A., Sprong, H., Opsteegh, M., Langelaar, M., Threfall, J., Scheutz, F., vanderGiessen, J., 2010. Food-borne diseases—the challenges of 20 years ago still persist while new ones continue to emerge. Int. J. Food Microbiol. 139, S3-S15.

3. Andrews J.R., Vaidya K., Bern C., Tamrakar D., Wen S., Madhup S., Shrestha R., Karmacharya B., Amatya B., Koju R., Adhikari S.R., Hohmann E., Ryan E.T., Bogoch I.I. High rates of enteric fever diagnosis and lower burden of culture-confirmed disease in peri-urban and rural Nepal. J. Inf. Dis. 2017;218(suppl-4):S214–S221.
4. Deen J., Von Seidlein L., Andersen F., Elle N., White N.J., Lubell Y. Community-acquired bacterial bloodstream infections in developing countries in south and southeast Asia: a systematic review. Lancet Infect. Dis. 2012;12(6):480–487. doi: 10.1016/S1473-3099(12)70028-2.
5. World Health Organization. Immunization, vaccines and biologicals. Typhoid. 2017.
6. Klemm E.J., Shakoor S., Page A.J., Qamar F.N., Judge K., Saeed D.K., Wong V.K., Dallman T.J., Nair S., Baker S., Shaheen G. Emergence of an extensively drug-resistant *Salmonella enterica* serovar Typhi clone harboring a promiscuous plasmid encoding resistance to fluoroquinolones and third-generation cephalosporins. MBio. 2018;9(1):e00105–e118. doi: 10.1128/mbio.00105-18.
7. Riaz I., Bibi Y., Ahmad N., Nisa S., Qayyum A. Evaluation of nutritional, phytochemical, antioxidant and cytotoxic potential of *Capsella bursa-pastoris*, a wild vegetable from potohar region of Pakistan. Kuwait J. Sci. 2021;48(3):1–11. doi: 10.48129/kjs.v48i3.9562.
8. Ramachandra Y.L., Ashajyothi C., Padmalatha S., Thanekar S.K.S., Shruthi S.D. Antibacterial Activity of Leaf Extracts of *Adhatoda vasica*. Int. J. Biomed. Pharm. Sci. 2012;7(1):45–47.
9. Mujaddidi, N., S. Nisa, S.A., Ayoubi, Y., Bibi, S., Khan, M. Sabir, M., Zia, S., Ahmad, S. A. Qayyum, A., 2021. Pharmacological properties of biogenically synthesized silver nanoparticles using Endophyte *Bacillus cereus* extract of *Berberis lyceum* against oxidative stress and pathogenic multidrug-resistant bacteria. Saudi J. Bio. Sci. 28 (11), 6432–6440.
10. World Health Organization. Immunization, vaccines and biologicals. Typhoid. 2019.
11. Loon YK, Satari MH, Dewi W. Antibacterial effect of pineapple (*Ananas comosus*) extract towards *Staphylococcus aureus*. Padjadjaran J Dent. 2018;30(1):1.
12. Dutta S, Bhattacharyya D. Enzymatic, antimicrobial and toxicity studies of the aqueous extract of *Ananas comosus* (pineapple) crown leaf. J Ethnopharmacol. 2013;150(2):451-457.
13. Zakaria ZA, Mat Jais AM, Sulaiman MR, Mohamed Isa SSP and Riffin S (2006). The *in vitro* antibacterial activity of methanol and ethanol extracts of *Carica*

- papaya* flowers and *Magnifera indica* leaves. *J. Pharmacol. Toxicol.*, 1: 278-83.
14. Guo, F., Chen, Q., Liang, Q., Zhang, M., Chen, W., Chen, H., and Chen, W. (2021). Antimicrobial activity and proposed action mechanism of linalool against *Pseudomonas fluorescens*. *Frontiers in Microbiology*, 12, 562094.
  15. Olatunya, A. M., Olatunya, O. S., Hassan, G. F., Adeyemi, L. A., Oyelami, O. A., & Akintayo, E. T. (2024). Antimicrobial activities of essential oils from three species of citrus fruits against six infectious tropical bacteria: implications for the care and control of common bacterial tropical diseases in developing countries. *Discover Applied Sciences*, 6(4), 209.
  16. Chaib, K.; Hajlaoui, H.; Zmantar, T.; Kahla-Nakbi, A.B.; Rouabhia, M.; Mahdouani, K.; Bakhouf, A. (2007). The chemical composition and biological activity of clove essential oil, *Eugenia caryophyllata* (*Syzigium aromaticum* L. *Myrtaceae*): a short review. *Phyther. Res.* 21, 501-506.
  17. Walsh, S.E.; Maillard, J.-Y.; Russell, A.D.; Catrenich, C.E.; Charbonneau, D.L.; Bartola, R.G. (2003). Activity and mechanisms of action of selected biocidal agents on Gram-positive and -negative bacteria. *J. Appl. Microbiol.*, 94, 240-247.
  18. Bohnenstengel FI, Wray V, Witte L, Srivastava RP, Proksch P. Insecticidal meliacarpins (C-seco limonoids) from *Melia azedarach*. *Phytochemistry*. 199;50(6):977-82.
  19. Chauhan S, Jindal M, Singh P, Tewari S. Antimicrobial Potential of Aqueous, Methanolic and Ethanolic Extracts of *Azadirachta indica* against Bacterial Pathogens Isolated from Urinary Tract Infection Patients. *Int J Curr Microbiol App Sci*. 2015;4(7):211-4
  20. Asthana RK, Srivastava A, Singh AP, Singh SP, Nath G, Srivastava R, *et al*. Identification of an antimicrobial entity from the cyanobacterium *Fischerella* sp. isolated from bark of *Azadirachta indica* (Neem) tree. *J Appl Phycol*. 2006;18(1):33-9
  21. NAZIR A., AHSAN H. Health benefits of *Aloe vera*: a wonder plant. *Int. J. Chem. Stud.* 5 (6), 967, 2017.
  22. MIKOŁAJCZAK N. Potential health benefits of *Aloe vera*. *J. Educ. Health Sport.* 8 (9), 1420, 2018.
  23. PATHAK D., SHARMA R. Review on “*Aloe vera* medicinal plant”. *International Journal of Advance Research and Innovative Ideas in Education.* 3 (1), 661, 2017.
  24. Sonali, L.P., Smitha, B., Subrota, H. & Aparnathi, K.D. 2017. Biofunctional properties of cultured buttermilk prepared by incorporation of fermented paneer whey. *International Journal of Current Microbiology and Applied Sciences*, 6(2): 1-13.

Anti-Typhoid Response of Selected Medicinal Plant Extracts Against Multi-Drug Resistance *Salmonella Enterica*  
*Serovar Typhi*