International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 15s,2025
https://theaspd.com/index.php

Abundance Of Radionuclides And Antibacterial Activity Of Medicinal Plants Against Selected Human Pathogenic Bacteria

Umesha Reddy K[1], Femila Komahal F[2], Kaliprasad C S[3*], Srilatha M.C[4], K N Narasimha Murthy[5], Sreedhar R[6], Suresh C[7], Laveena K B[8*]
[1]Department of Physics, Government First Grade College, Hoskote- 562114.
[2]Department of Physics, Nrupathunga University, Bangalore-560001.
[3]Department of Physics, BMS College of Engineering, Bangalore-560019, India
[4,7]Department of Physics, Government First Grade College, Malleshwaram- 560003
[5]Department of Physics, Government First Grade College, Yelahanka- 560064 , Bangalore.
[6]Department of Physics, Government First Grade College, Hiriyur – 577598, Karnataka.
[8]Department of bioscience, Mangalore University, Mangalagangothri, Mangalore -574199
*kpkaliprasad23@gmail.com, laveenavenkatesh@gmail.com

Abstract:
In the present study few medicinal plants were collected from the Western Ghats. The activity concentration of radionuclides in soil and plant leaves was measured using gamma ray spectrometer. The antimicrobial activity was measured by Agar well diffusion assay. The result of the antibacterial study showed the presence of wide spectrum of antibacterial activities against bacterial pathogens. Calculated transport factor and risk assessment in medicinal plants, which shows good antibacterial activity even though the high radionuclides concentration.
Keywords: *Antimicrobial, Medicinal plants, Radionuclides, Radium, Thorium, Transport factor*

INTRODUCTION

Medicinal plants are unique type of natural product requiring special consideration due to their potential impact on human health. The pharmacological properties of the medicinal plants have been attributed to the presence of active chemical constituents which are responsible for important physiological function in living organisms (Fahad *et al.*, 2014). According to the International Food Safety Authorities Network, plants used as food commonly have ^{40}K, ^{232}Th and ^{238}U and their progenies (INFOSAN, 2011). It is expected that similarities would be found in plants used for medicinal purposes since plants are the primary pathway of natural radionuclides entering into the human body through the food chain. In many developing countries, pollution is the main causes for the contamination of vegetation with heavy metals, pesticides, or radioactivity. Therefore the medical properties and effectiveness of medicinal plants depend on environmental conditions, which also have a direct influence on their growth in the place of their occurrence and cultivation (Salaman, 2004). The medicinal quality of plants depends on their chemical constituents that have physiological activity in human systems (Kumar *et al.*, 2009). Leaf is considered to be one of the highest accumulatory parts of the plant containing bioactive compounds which are synthesized as secondary metabolites (Cowan, 1999). Microorganisms that form a parasitic association with other organisms are classified as pathogens. Some bacteria and fungi can be pathogenic while some are not. The search for novel potent plants and plant components against pathogenic microorganisms has become increasingly important, as a result of the development of antibiotic resistance in microbes (Ahmad *et al.*, 2006). Antimicrobial investigation of plant extracts and phytochemicals is the basis for antimicrobial drug discovery (Cseke *et al.*, 2006; Innocent and Chinelo, 2018). Therefore in the present investigation selected the medicinal plants to study the presence of concentration of radionuclides and to assess the radiological risk associated with the use of selected medicinal plants viz., *Alternanthera ficoidea* L., *Erythrina variegata* L., *Mussaenda belilla* L. and *Sauropus androgynus* L. which has great significance and also to study the antibacterial activity of *A. ficoidea* and *M. bellila* against human bacterial pathogens.

MATERIALS AND METHODS:

Sample Collection and Preparation of Extraction:

The medicinal plants and associated soil samples were collected from different regions of Western Ghats following standard procedure (EML 1983). The collected medicinal plants, its common name, uses and parts used were tabulated in table 1. The leaves of these plants were washed under running tap water and rinsed well with distilled water, oven dried (40° C) and powdered. For extraction with, 25 g of powdered plant material was dissolved in enough sterilized ethanol and water to make 100ml of ethanol and aqueous extract (25% w/v). The mixture was kept undisturbed at room temperature for 24 hrs in a sterile flask covered with aluminum foil to avoid evaporation and subjected to filtration through sterilized Whatman no.1 filter paper. After filtration, the extract was evaporated in water bath until 25 ml extract was left in the container. Extracts thus obtained were immediately evaluated for antibacterial using agar well diffusion method (Chen *et al.*, 1987, Barreto *et al.*, 2002). The soil samples were dried in hot air oven till constant weight is obtained and samples were processed as per EML standard procedure (EML. 1983). The dried samples were sieved through 250 micron mesh and stored in PVC container for 30 days to obtain secular equilibrium between Radium-226 and its daughter products.

Table 1. Scientific name and uses of selected traditional medicinal plants

Sl.No	Scientific Name	Common Name	Medicinal uses	Part(s) used
1	*Erythrina variegata* L.	Indian coral tree	It is used especially for menstrual disorders and fissures at penis tip.	Leaves
2	*Sauropus androgynus* L.	Vitamin plant	Used as Vegetable with high antioxidant potential	Leaves
3	*Alternanthera ficoidea* L.	Joseph's coat	The plant might be useful as an antiviral agent.	Leaves
4	*Mussaenda belilla* L.	Wild mussaenda	A decoction of the leaves is used to rid the body of intestinal worms.	Leaves and sepals

Activity measurement

The activity concentration of radionuclides in soil and plants samples were measured using NaI(Tl) based gamma ray spectrometer with standard procedure. The size of detector is 5 cm ×5 cm was used along with Multichannel Analyser. The detector was shielded with lead blocks all the four sides to reduce backgrounds counts due to terrestrial gamma ray radiations. The spectrometer was calibrated using RG-U, RG-Th and RG-K, as standard Uranium, Thorium and Potassium sources procured from International Atomic Energy Agency, Vienna. The full-width half maximum (FWHM) was 60.78 KeV with resolution 8.46%, for the 137Cs (661 KeV) peak. The samples were analyzed with an acquisition time of 80,000 s, using GSPEC software to obtain the gamma-ray spectrum with good statistics.The activity concentration of ^{226}Ra was estimated from 1764 KeV (15.9%) gamma peaks of ^{214}Bi. ^{232}Th activity was estimated using 2614 KeV (35.8%) gamma transition of ^{208}Tl. ^{40}K radionuclide was estimated using 1460.8 KeV (10.7%) gamma peak from ^{40}K itself to determine the concentration of ^{40}K in different samples (Alnour *et al.*, 2012; Harb, Abbady, El-Kamel and El-Mageed, 2012; Shams, Uosif, and Abd, 2011; Venunathan *et al.*, 2016).

Antibacterial Activity
Agar well diffusion assay

The leaf extracts were first subjected to standard analysis for the presence of phytoconstituents as described by Harborne, 1988. The antimicrobial activity was measured by Agar well diffusion assay (Perez *et al.*, 1990). The *A. ficoidea* and *M. bellila* plant extracts were allowed to diffuse out into the medium and interact in a plate freshly seeded with the test organisms. Petri plates containing 15 ml Nutrient agar medium were seeded with the bacterial strains. Each labelled medium plate was uniformly inoculated with a test organism by using a sterile cotton swab rolled in the suspension to streak the plate surface in a form that lawn growth can be observed. Wells were punchered and 25, 50, 75 and 100µl of the methanolic plant extracts were added. The plates were then incubated at 37 °C for 24 hours. Chloramphenicol (0.05%) was used as positive control. The antibacterial activity was assayed by measuring the diameter of the inhibition zone formed around the well. The diameter of zone of inhibition was measured in millimetres (Shakouie *et al.*, 2012).

RESULT AND DISCUSSION

The activity concentration of radionuclides in soil and plant leaves was measured using gamma ray spectrometer as shown in table 2 and 3. The activity concentration of ^{40}K in medicinal plants ranges from 34.1 Bq kg^{-1} to 117.1 Bq kg^{-1} and ^{226}Ra ranges from 3 Bq kg^{-1} to 8.3 Bq kg^{-1} for different plants. The activity concentration of ^{232}Th ranges from 9.8 Bq kg^{-1} to 16.4 Bq kg^{-1}. The variation in activity concentration was observed from plant to plant and soil to soil. The variation may be due to the presence of minerals in the soils and absorption rate of plants. Hence, the transfer factor (TF) was calculated to know the accumulation of radionuclides by plant leaves and other parts of the plants and also to know the rate of absorption by the plant. The transfer factor has been calculated for radionuclides from soil to plant as shown in table 4. The transfer factor value ranges from 0.08 to 1.32 for different radionulcides and plants. Results predict that transformation from soil to plant leafs, potassium has highest average TF factor. This is because potassium is one of the important element to plant fertility, even though potassium is a radioactive element. Extracts from leaf samples are important in treatment of various illnesses. So the study showed that these leaves have low TF of the radionuclides.

Table 2: Activity concentration of Radionuclides in Medicinal Plants

Sl.No	Medicinal plants	Radionuclides Activity (Bq kg^{-1})		
		^{40}K	^{226}Ra	^{232}Th
1	*E. varigata*	43.3	3.00	9.8
2	*S. androgynus*	34.1	4.8	8.8
3	*A. ficoidea*	117.1	5.8	16.4
4	*M. belilla* (leaves)	61.8	4.9	6.4
5	*M. belilla* (sepals)	34.3	8.3	11.2

Table 3: Radionuclides Activity concentration of Soil Sites

Sl.No	Soil sites	Radionuclides Activity (Bq kg^{-1})		
		^{40}K	^{226}Ra	^{232}Th
1	Mangalore University Campus	88.5	12.9	23.0
2	Western Ghats of Karnataka	49.8	7.4	16.8

Table 4. Transfer factor from soil to plant

Sl. No	Medicinal plants	Transfer factor ratio soil to plant		
		^{40}K	^{226}Ra	^{232}Th
1	*E. varigata*	0.87	0.40	0.58
2	*S. androgynus*	0.69	0.64	0.52
3	*A. ficoidea*	1.32	0.45	0.71
4	*M. belilla*(leaves)	0.89	0.17	0.08
5	*M. belilla* (sepals)	0.69	1.12	0.66

Primary phytochemical screening revealed the presence of major groups that includes carbohydrats, proteins, carotenoids, terpenoids, flavonoids, phenolic compounds, alkaloids, tannins, saponins, pigments and minerals that have antimicrobial and antioxidant activity. The result of the antibacterial study showed the presence of wide spectrum of antibacterial activities against all the above bacterial pathogens studied shown in **table 5.** In *A. ficoidea* and *M. bellila* leaves, the maximum zone of inhibition was observed in ethanolic extract of leaf compared to aqueous extract for each bacterium. *M. bellila* sepal showed maximum zone of inhibition in aqueous extract compared to ethanolic extract. It was compared against radionuclides transport factor ratio in leaf and sepal against soil. In this study the average activity concentration obtained for ^{40}K is less which did not show any effect on antibacterial activity of plants. The mean activity of radionuclides in plant shows no risk to the consumption of plant.

Table 5: Antibacterial Activity of *A. ficoidea* and *M. bellila* against selected pathogenic bacteria (Diameter of Zone of inhibition in mm)

Plant Species	Leaves Extracts	-ve Control	***Staphylococcus aureus***				***Bacillus subtilis***			
			25µl	30µl	35µl	40µl	25µl	30µl	35µl	40µl
Alternanthera ficoidea	Aqueous Ethanolic	0 0	20mm 16mm	20mm 14mm	18mm 17mm	20mm 21mm	21mm 17mm	22mm 16mm	19mm 16mm	17mm 20mm
Mussaenda bellila **(leaf)**	Aqueous Ethanolic	0 0	- 16mm	- 19mm	- 16mm	- 20mm	5mm 13mm	6mm 13mm	9mm 5mm	9mm 5mm
Mussaenda bellila **(sepal)**	Aqueous Ethanolic	0 0	13mm 12mm	10mm 11mm	10mm 9mm	12mm 9mm	14mm 10mm	13mm 15mm	12mm 13mm	14mm 6mm
			Proteus vulgaris				***Escherichia coli***			
Alternanthera ficoidea	Aqueous Ethanolic	0 0	16mm 12mm	19mm 15mm	17mm 12mm	18mm 15mm	18mm 10mm	18mm 15mm	19mm 15mm	20mm 19mm
Mussaenda bellila **(leaf)**	Aqueous Ethanolic	0 0	7mm 14mm	7mm 10mm	9mm 20mm	12mm 16mm	11mm 14mm	14mm 12mm	12mm 13mm	12mm 15mm
Mussaenda bellila**(sepal))**	Aqueous Ethanolic	0 0	5mm 5mm	10mm 10mm	10mm 10mm	10mm 10mm	15mm -	18mm -	18mm -	18mm -

CONTROL Chloramphenicol (0.05%)	Aqueous Ethanolic	0 0									

The study of medicinal plants has become the focus of research ever more extensive in all over the world, due to the diversity and potential that plants have as source of medicinal products. The presence of radionuclides in plants constitutes the pathway for their migration to the human. A medicinal plant containing high concentrations of these radionuclides can cause health problems, since medicinal plants are commonly used for long periods of oral treatment. An attempt was made to analyse the accumulation of radionuclides and antibacterial activity in a selected medicinal plants against human bacterial pathogens. The result of the present study showed the presence of wide spectrum of antibacterial activities against all the above bacterial pathogens studied. In A. *ficoidea* and M .*bellila* leaf the maximum zone of inhibition of observed in ethanolic extract compared to aqueous extract for each bacterium. M. *bellila* sepal showed maximum zone of inhibition was observed in aqueous extract compared to ethanolic extract and it was compared against radionuclides transport factor ratio in leaf and sepal against soil. The average activity concentration obtained for ^{40}K obtained in this study is less which did not show any effect on antibacterial activity of plants. The mean activity of radionuclides in plant shows no risk to the consumption of plant. The present study showed that the selected medicinal plant is potentially good sources against selected human bacterial pathogens. The activity concentration of radionulcides and antibacterial activity has been correlated to find the any relation between them and as shown in table 6. The bold letter indicates the positive correlation between the parameters. The ^{40}K shows good correlation with antibacterial activity in both aqueous and ethanolic solution. But the ^{226}Ra showing negative correlation with respect to all antibacterial activity, in ethanolic solution the correlation is highly negative.

Table 6. Correlation coefficients for radionulcides activity and antibacterial activity

					A		B		C		D	
		^{40}K	^{226}Ra	^{232}Th	a	*b*	a	*b*	a	*b*	a	*b*
	^{40}K	1.000										
	^{226}Ra	-0.563	1.000									
	^{232}Th	0.673	0.233	1.000								
A	a	0.517	0.417	0.981	1.000							
	b	**0.755**	**-0.967**	0.023	-0.171	1.000						
B	a	**0.600**	0.324	**0.995**	0.995	-0.072	1.000					
	b	**0.994**	-0.649	0.588	0.421	0.822	0.509	1.000				
C	a	**0.987**	-0.423	**0.783**	0.647	0.640	0.720	0.964	1.000			
	b	**0.599**	**-0.999**	-0.189	-0.375	0.977	-0.281	0.683	0.463	1.000		
D	a	**0.996**	-0.486	**0.736**	0.592	0.693	0.669	0.980	0.997	0.525	1.000	
	b	0.544	**-1.000**	-0.255	-0.437	0.961	-0.346	0.632	0.402	0.998	0.466	1.000

A- ***Staphylococcus aureus, B- Bacillus subtilis, C- Proteus vulgaris, D- Escherichia coli, a-*** Aqueous
b- Ethanolic

CONCLUSION

In the present, the risk factor due to radionuclides in the selected plants was measured. The activity concentration in the selected plants show below the world average, but the transport factor very high in *A. ficoidea* compared to the other parts of plants. The statistical analysis showed that the selected medicinal plants *A. ficoidea* L. and *M. bellila* L. are potentially good sources against selected human bacterial pathogens. Hence, the medicinal plants samples are considered safe in terms of the radiological hazard.

REFERENCES

1. Ahmad, I., Aqil, F., Owais, M. (2006) Modern Phytomedicine: Turning Medicinal Plants into Drugs, Wiley-VCH, India, 404.
2. Barreto, M., Critchley, A. T. and Straker, C. J. 2002. Extracts from seaweeds can promote fungal growth. J. Basic Microbiol. 42: 302-310.
3. Chen, C. P., Lin, C. C. and Namba, T. 1987. Development of natural crude drug resources from Taiwan. In vitro studies of the inhibitory effects on 12 microorganisms. Shouyakugaku Zasshi. 41: 215-225.
4. Cowan, M. M. (1999). Plant products as antimicrobial agents. *ClinicalMicrobiology Reviews*, 12(4), 564–582.
5. Cseke, L. J., Kirakosyan, A., Kaufman, P. B. (2006). Natural Product from Plants, 2nd edn, CRC Press, Taylor & Francis Group, L.L.C, Boca Raton, Florida, 611.
6. EML Procedure Manual. (Ed. Volchok HL, dePlanque G). 26th ed. New York, NY: Environment Measurement Laboratory; 1983.
7. Fahad, S.M., Abdin, M.J., Hasan, M.M., Rahman, M.O., Islam, S.M.A., Akramuzzaman, M.M. and Russell, M. (2014) Study of Elemental Profile of Some Medicinal Plants of Bangladesh. Journal of Nuclear and Particle Physics, 4, 1-6.
8. Harborne, J. B. (1998). Phytochemical methods: A guide to modern techniques of plant analysis. 3rd edition. Chamman of Hall Pub. London, UK.
9. INFOSAN (2011) Information on Nuclear Accidents and Radioactive Contamination of Foods International Food Safety Authorities Network. World Health Organization (WHO), Geneva.
10. Innocent Okeke, C., Chinelo Ezeabara, A. (2018). Phytochemical screening and in vitro antimicrobial activity of various parts of Cleome ciliata Schum. & Thonn. *Bioscience Horizons, 11*, 1-7.
11. Kumar, A., Rajput, G., Dhatwalia, V. K. (2009). Phytocontent screening of Mucuna seeds and exploit in opposition to pathogenic microbes. *Journal of Biological and Environmental Sciences, 3,* 71–76.
12. Narayana ,Y., Kaliprasad, C.S., Ganesh Sanjeev. (2016) Natural radionuclide levels in sediments of Cauvery riverine environment. Radiat. Prot. Dosimetry. 171(2), 229-233.
13. Perez C, Pauli M, Bazerque P (1990) An antibiotic assay by the agar well diffusion method. Acta Biologiae et Medecine Experimentalis 15:113-115.
14. Ram Kumar Pundir and Pranay Jain. Comparitive studies on the antimicrobial activity of black pepper and turmeric extracts. International journal of Applied Biology and Pharmaceutical Technology, Vol.1, Issue.2, 2010.
15. Salaman, I. and Haban, M. (2004) The Radioactivity Evaluation of Selected Species of Medicinal Plants. Acta Fytotecnica and Zootecnica, 4,103-106.
16. Shahidi B G H (2004) Evaluation of antibacterial properties of Iranian medicinal plants against *Micrococcus aureus, Serratia marcescens, Klebsiella pneunomiae* and *Bordella bronchoseptica*. Asian Journal of Sciences 3(1): 82-86.
17. Shakouie S, Eskandarinezhad M, Mokhtari H, Frough M, Soroush M, et al. (2012) Antimicrobial efficacy of AH-Plus, adseal and endofill against *Enterococcus faecalis*- An *in vitro* study. African Journal of Microbiology Research 6(5): 991-994.
18. Venunathan N. Kaliprasad C. S., Narayana Y. Natural radioactivity in sediment and river bank soil of Kallada river of Kerala , South India and its associated radiation risk. Radiation Protection Dosimetry (2016), Vol. 171, No. 2, pp. 271–276