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Antibacterial activity of selected ethnomedicinal plants from South India

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ABSTRACT

Objective: To screen the antimicrobial potential of three ethnomedicinal plants *Chassalia curviflora* Thw. (*C. curviflora*), *Cyclea peltata* Hook. F. & Thomson (*C. peltata*) and *Euphorbia hirta L (E. hirta)* used in folk medicines in Aarukani hills Kani tribe, Tamil Nadu, India against human bacterial pathogens. **Methods:** Antibacterial efficacy was performed by disc diffusion method against the pathogens viz., *Escherichia coli (E. coli)* (ATCC 35218), *Staphylococcus aureus* (*S. aureus*) (ATCC 6538), *Salmonella typhi (S. typhi)* (MTCC 733), *Proteus vulgaris (P. vulgaris)*, *Proteus mirabilis (P. mirabilis)* and *Streptococcus pyogenes (S. pyogenes)* and incubated for 24 h at 37 ℃. **Results:** The maximum degree of antibacterial activity was observed in *C. peltata* followed by *C. curviflora*. While *E. hirta* showed comparatively low degree of antibacterial activity. The methanolic extract of *C. peltata* showed the antibacterial activity against three pathogens viz., *S. pyogenes*, *P. vulgaris* and *E. coli* with the inhibition zones 12 mm, 10 mm and 9 mm, respectively. hexane extracts of *C. peltata* also showed the antibacterial activity against two selected pathogens *viz*., *P. vulgaris* and *P. mirabilis* with 15 mm and 12 mm of inhibition zones. All the three different concentrations (0.25, 0.50 & 0.75 mg/mL) of methanolic extract of *C. peltata* show the inhibitory effect on the three susceptible bacteria *S. pyogenes*, *P. vulgaris* and *E. coli* with the maximum inhibition in the highest concentration (0.75 mg/mL). The methanolic and hexane extracts of *C. curviflora* exhibited the antibacterial activity against only one bacterium each *i.e. P. vulgaris* and *S. typhi* with the maximum zone of inhibition 13 and 11 mm respectively. The methanolic and hexane extracts of *E. hirta* exhibited the antibacterial activity against only one bacterium *i.e. S. pyogenes* with the maximum zone of inhibition 13 and 11 mm respectively. **Conclusions:** The present investigation revealed that the *C. curviflora*, *C. peltata* and *E. hirta* are potentially good source of antibacterial agents and demonstrates the importance of such plants in traditional medicines.

1. Introduction

Since the beginning of civilization, people have used plants. Plants provide people with food, medicines, as well as materials for construction and the manufacture of crafts and tools and many other products like fuel, paints and poisons[1-3]. Nowadays the chemical and pharmacological constituents of medicinal plants used in different traditional systems around the world are being increasingly explored for human benefit[4-8]. India with about 45 000 plant species and 550 tribal communities belonging to 227 ethnic groups[9] inhabited in varied geographic and climatic zones with diversified plant species and varied culture rich traditional knowledge system. Living close to the nature the tribal communities are custodian of unique traditional knowledge system and wisdom about ambient flora and fauna and rich heritage of ethnomedicine. Since most of these ethnic communities do not have their own scripts and written language, the information about prescriptions, pharmacology, attitude towards diseases and diagnosis of the age old tribal medicine are lying unclaimed. The people of the modern society are totally unaware of this rich traditional medicinal system. However, the studies in tribal

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medicine have enabled to identify 1 600 new drug yielding plants. So that the collection of information, documentation, and the scientific analysis of ethnomedicine is became important. Many efforts have been made to discover new antimicrobial compounds from various kinds of sources such as micro-organisms, animals, and plants. One of such resources is folk medicines. Systematic screening of them may result in the discovery of novel effective compounds[10-13]. The Western Ghats of South India is one of the 29 biological hot spots identified in the world and gifted with large number of plants with exceptional medicinal properties[14-17]. These plants are mainly utilized by the local ethnic people inhabiting in this region[18,19]. One of the oldest tribes in the world, the Kani is the major tribal group settled here. They are a traditionally nomadic community, who now lead a primarily settled life in the forest. These people are known for their rich tradition in healing and other cultural activities.

The World Health Organization (WHO) estimated that 80% of the population of developing countries relies on traditional medicines, mostly plant drugs, for their primary health care needs[20]. Also, modern pharmacopoeia still contains at least 25% drugs derived from plants and many others which are synthetic analogues built on prototype compounds isolated from plants[21,22]. The primary benefits of using plant derived medicines are that they are relatively safer than synthetic alternatives, offering profound therapeutic benefits and more affordable treatment[23]. For instance, the plants are generally readily available and their products are biodegradable. Antimicrobial drug resistance is a global problem today as the resistant microorganisms have emerged and spread throughout the world because of their genetic plasticity[24,25]. Natural products of plants have been considered as the active ingredients of most of the modern medicines. The potential of higher plants as source for new drugs is still largely unexplored. Among the estimated 250 000 - 500 000 plant species, only a small percentage has been investigated phyto-chemically and the fraction submitted to biological or pharmacological screening is even smaller[26,27]. Several works on plants are pointing out that, the plants utilized by different ethnic communities of the world have the capability to control the growth of various disease causing micro organisms. The increasing failure of chemotherapeutics and antibiotic resistance exhibited by pathogenic microbial infectious agents has led to the screening of several medicinal plants for their potential antimicrobial activity[28,29]. It is well known that in drug discovery screening of ethnomedicinally important plants is more successful than the random screening. The Kani tribes in Tamil Nadu are using various plants to treat various diseases including pathogenic diseases. The Kani tribes in Aarukani Hills use the root and root bark of *Chassalia curviflora* Thw. (*C. curviflora*) to treat jaundice and wounds; tuber and leaves of *Cyclea peltata* Hook. f. & Thomson (*C. peltata*)to treat Chicken pox, diarrhoea, wounds, scabies and entire plant and latex of *Euphorbia hirta* L. *(E. hirta)* to treat wounds, skin diseases, asthma, and dysentery. Thus all the above three plants are being used by the Kani tribes to cure mostly the pathogenic diseases. Hence, in the present investigation, the antimicrobial potential of these three plants (*C. curviflora*, *C. peltata* and *E. hirta*) have been evaluated against selected human bacterial pathogens.

2. Materials and methods

Healthy, disease free, plant parts *i.e.*, roots of *C. curviflora* (Wall.) Thw.,var. ophioxyloides (Wall.). Deb. & B. Krishna tuber of *C. peltata* Hook. f. & Thomson and entire plants of E. hirta were collected from wild. The fresh materials were shade dried. Methanolic and hexane extracts were prepared from powdered materials and the extracts were used for antimicrobial studies. Antimicrobial study was carried out by disc diffusion method[20] against the pathogens viz., *Escherichia coli (E. coli)* (ATCC 35218), *Staphylococcus aureus* (*S. aureus*) (ATCC 6538), *Salmonella typhi* (*S. typhi*) (MTCC 733), *Proteus vulgaris (P. vulgaris)*, *Proteus mirabilis (P. mirabilis)* and *Streptococcus pyogenes (S. pyogenes)*.

3. Results

The methanolic and hexane extracts were tested for antibacterial activity against six human bacterial pathogens by using three differ concentrations viz., 0.25, 0.50 and 0.75 mg/mL. The maximum degree of antibacterial activity was observed in *C. peltata* followed by *C. curviflora*. While, *E. hirta* showed comparatively low degree of antibacterial activity.

The methanolic extract of *C. peltata* showed the antibacterial activity against three pathogens viz., *S. pyogenes*, *P. vulgaris* and *E. coli* with the inhibition zones 12 mm, 10 mm and 9 mm respectively (Table 1). Hexane extracts of *C. peltata* also showed the antibacterial activity against two selected pathogens viz., *P. vulgaris* and *P. mirabilis* with 15 mm and 12 mm of inhibition zones. *E. coli*, *S. aureus*, *S. typhi* and *B. streptococci* are resistant to hexane extracts of *C. peltata* (Table 1). All the three different concentrations (0.25, 0.50, 0.75 mg/mL) of methanolic extract of *C. peltata* show the inhibitory effect on the three susceptible bacteria *S. pyogenes*, *P. vulgaris* and *E. coli* with the maximum inhibition in the highest concentration (0.75 mg/mL). In contrast, the different concentrations of hexane extract shows inhibitory effect on only two bacteria *P. vulgaris* and *P. mirabilis* with the maximum inhibition in the highest concentration (0.75 mg/mL).

The methanolic and hexane extracts of *C. curviflora* exhibited the antibacterial activity against only one bacterium each *i.e. P. vulgaris* and *S. typhi* with the maximum zone of inhibition 13 and 11 mm respectively (Table 1). The methanolic and hexane extracts of E. hirta exhibited the antibacterial activity against only one bacterium *i.e. S. pyogenes* (Table 1) with the maximum zone of inhibition 13 and 11 mm respectively (Table 1). *E. coli*, *S. aureus*, *S. typhi*, *P. vulgaris* and *P. mirabilis* are resistant to the methanolic and hexane extracts of *E. hirta* (Table 1).

Table 1
Antibacterial activity of Methanolic and Hexane extracts of *C. peltata*, *C. curviflora* and *E. hirta*.

Solvents	Concentration (mg/mL)	Zone of inhibition (mm)																	
		C. peltata						*E. hirta*						*C. curviflora*					
		Ec	*Sa*	*St*	*Pv*	*Pm*	*Sp*	*Ec*	*Sa*	*St*	*Pv*	*Pm*	*Sp*	*Ec*	*Sa*	*St*	*Pv*	*Pm*	*Sp*
Methanol	0.25	4	–	–	3	–	5	–	–	–	–	–	4	–	–	–	6	–	–
	0.50	9	–	–	8	–	12	–	–	–	–	–	8	–	–	–	13	–	–
	0.75	10	–	–	9	–	12	–	–	–	–	–	13	–	–	–	13	–	–
Hexane	0.25	–	–	–	5	6	–	–	–	–	–	–	3	–	–	4	–	–	–
	0.50	–	–	–	11	14	–	–	–	–	–	–	6	–	–	7	–	–	–
	0.75	–	–	–	12	15	–	–	–	–	–	–	11	–	–	11	–	–	–

Ec – *E. coli*; *Sa* – *S. aureus*; *St* –*S. typhi*; *Pv* – *P. vulgaris*; *Pm* – *P. mirabilis*; *Sp* – *S. pyogens*.

4. Discussion

In the present investigation, *in vitro* antibacterial efficacy of the crude extracts of three plants was quantitatively assessed on the basis of zone of inhibition. All the plants studied in the present investigation exhibited varying degree of inhibitory effect against the selected bacterial human pathogens. Eloff[31] reported that methanol was the most effective solvent for plant extraction than hexane and water. In the present study we used methanol and hexane for extraction. The present study confirmed the Eloff observations with maximum activity.

The present study indicates anti bacterial property of the three plants against the selected strains of human pathogenic bacteria varies depends upon the solvent medium used for extraction. *C. peltata* shows highest activity (4/6) against the bacterial pathogens followed by *C. curviflora* (2/6) and *E. hirta* (1/6). Based on the previous literature on these three plants, there is no experimental study on *C. curviflora*. There are some studies on phytochemistry and pharmacology on *C. peltata*[32, 33], but there is no report on antimicrobial activity. Ngemeny *et al*[34-43] observed the antibacterial activity of *E. hirta* against *B. cereus*, *K. pneumoniae* and *P. aeruginosa*. Thus, the present study shows the presence of antibacterial activity in *C. curviflora* and *C. peltata* for the first time. In the case of *E. hirta*, in addition to the previous observation, the present study revealed and supplemented the antibacterial activity against the bacterial pathogen *S. pyogenes*.

The presence of antimicrobial activity in a particular part of a particular species may be due to the presence of one or more bioactive compounds such as alkaloids, glycosides, flavonoids, steroids, saponins *etc*.[44]. Recently, a number of plants have been reported for antimicrobial properties across the world[22,28,29]. In the present investigation, three ethnomedicinal plants from India have been screened for antimicrobial potential. As mentioned earlier, the roots and root bark of *C. curviflora* are used to treat jaundice and wounds. Among the two susceptible bacteria *P. vulgaris* is known to cause urinary tract infections and wound; *S. typhi* is known to cause fever and food borne illness. In the present study the methanolic extract and hexane extract of *C. curviflora* show the inhibitory activity against the above two bacteria and thus the present study confirms the traditional medical practice of the Kani tribe. Since the above two bacteria are susceptible to different extract (*P. vulgaris* for methanol extract and *S. typhi* for hexane extract), it is clear that the active compound may be of entirely different ones. Base on the present results, it is suggested that the same plant can also be used to treat urinary infection, typhoid fever and food borne illness.

Present study on *C. peltata* revealed the high degree of antibacterial activity against four different bacteria namely *E. coli*, *P. vulgaris*, *P. mirabilis* and *S. pyogenes*. In general the above four bacteria are known to cause gastroenteritis, food borne illness, urinary tract infections, neonatal meningitis, nosocomial infections, wound, septicemia, pneumonias and from mild superficial skin infections to life-threatening systemic diseases. The Kani tribes, without having any scientific knowledge, for several decades they are successfully using the plant *C. peltata* to treat various pathogenic diseases such as diarrhea, wounds, scabies and chicken pox. The present experimental study confirms the traditional practice and supplement to treat other health problems such as urinary tract infections, neonatal meningitis, nosocomial infections, septicemia and pneumonias. In the meantime the roots of *C. peltata* were also found to contain high concentration of saponins[45] which may be responsible for the antibacterial activity against various bacteria.

The results of the present study supplement the folkloric usage of the studied plants which possess several known and unknown bioactive compounds with antibacterial properties. By isolating and identifying these bioactive compounds new drugs can be formulated to treat various infectious diseases. Further phytochemical and pharmacological studies on the lesser known plants, *C. curviflora* and *C. peltata*, are necessary to utilize these ethnomedicnally important plants successfully. The presence of intraspecific variation in *C. curviflora* with the presence of three distinct varieties (var. *curviflora*, var. *ophioxyloides* and var. *longifolia*) shows the presence of more diversified chemicals with different bioactivities which are yet to be studied.

Conflict of interest statement

We declare that we have no conflict of interest.

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