Chapter 8. Summary

About this Chapter

This chapter explains a general summary of the present research work and its future prospects.
Chapter 8

SUMMARY

World is showing great interest in searching new, effective and cheap drugs from natural sources, especially from medicinal plants. The reason is that a natural phenomenon called ‘natural selection’ has been playing a major role in developing drug resistance by microorganisms, which decreases the efficiency of the available antibiotics. This situation of increased drug resistance is critically dangerous to a developing country like India, because the density of population in India is very high. Increased number of people over a small stretch of land area increases the chance of developing and spreading of infectious and epidemic diseases. In such situations, cheaper, non-resistant and effective drugs are necessary to save life as well as economy of the country. Unfortunately, most of our drugs are costly, resistant and with many side effects. India, being a rich source of medicinal plants, research activities are going on, primarily in search for developing new drugs from medicinal plants.

In the present study, thirty fruits were primarily selected for identifying medicinal properties like antibacterial, antifungal and antiprotozoal activities. Effort was made to isolate the active compound to suggest as an effective drug in antimicrobial therapy. In preliminary study, only the antibacterial activity was taken into consideration. Fruit extracts in different solvents were tested against standard MTCC bacterial strains. Preliminary results showed that out of thirty fruits tested, two of them - Punica granatum and Flacourtia inermis have powerful activity against all the tested strains. As various
authors have already studied about the fruit of *Punica granatum*, fruit of *Flacourtia inermis* was selected for searching its medicinal properties like antibacterial, antifungal and antiprotozoal properties and also to isolate its active principle to suggest it as a prototype for developing new drugs in antimicrobial therapy.

As a first step, crude extracts of its fruit in different solvents were tested against standard bacteria. Study showed that the acetonic crude extract was the one having powerful activities against the tested organisms. Therefore, acetonic crude extract was used for testing antifungal activity against saprophytic fungi and antiprotozoal activity against non-pathogenic fresh water protozoa and end-commensal intestinal protozoa of frog. Results showed that the acetonic crude extract is very powerful against the tested organisms. Since, the crude acetonic extract showed antibacterial, antifungal and antiprotozoal activities, it was subjected to purification of active principle through chromatographic techniques. Various physico-chemical properties of the purified compound were also studied. The yield of purified compound was 1.22% of the dried fruit powder, which shows that a significant amount of active compound is present in its fruits.

Another approach made was the investigation of efficiency of the purified compound as an antibacterial, antifungal and antiprotozoal agent. For antibacterial study the activity of the purified compound against standard and clinical strains were tested and the results were compared with standard antibiotics. It was found that the active compound, even after purification processes, retained its antibacterial potency similar to that of its crude extracts. MIC test showed that a concentration of 6-8mg/ml was sufficient to inhibit the growth of tested organisms. More over, purified compound was
effective against clinical strains when they were resistant to the tested antibiotics. These studies revealed that the isolated compound could be considered as a prototype for developing new antibacterial drug.

For determining antifungal activity and MIC, isolated compound was tested against dermatophyte and opportunistic saprophytic fungi. Study showed that the activity of isolated compound was similar to that of crude extracts even after purification. An MIC of 15mg/ml against the tested fungi shows that this compound is significant in antifungal therapy.

Isolated compound also showed antipROTOzoal activity against fresh water protozoa and endo-commensal rectal ciliates of frog. More studies with pathogenic protozoa are necessary to have a conclusion on its antipROTOzoal potency against human pathogenic protozoa. However, it is a first attempt for identifying its antipROTOzoal activity.

Since the isolated compound of *Flacourtia inermis* was found to be an effective antibacterial, antifungal and antipROTOzoal agent, its structure was elucidated through spectroscopic studies. For that, various spectroscopic techniques such as UV, IR, GCMS, $^1$HNMR and $^{13}$CNMR were made. It was found that the active compound belongs to phenolic class and its IUPAC name is identified as 2, 3-dihydroxybenzoic acid, a compound with molecular formula C$_7$H$_6$O$_4$.

Previous studies showed that 2, 3-dihydroxybenzoic acid (2, 3-DHB) is an effective antioxidant as well as an iron-chelating agent. Present study shows that 2, 3 DHB is an effective antimicrobial agent against bacteria, fungi and even protozoa.
Based on the previous and present findings, we suggest that this compound, 2, 3-dihydroxybenzoic acid can be developed as an effective broad-spectrum antioxidant-antibiotic.

However, in the present investigation only in-vitro studies were conducted. That means, the above compound showed various antimicrobial activities in an in-vitro condition. Therefore, in-vivo experiments are inevitable to assess the in-vivo efficiency of the 2, 3 DHB as a broad spectrum antibacterial, antifungal and antiprotozoal antibiotic. Previous reports show that this compound is non-toxic to animal cell. However, detailed pharmacological and cytotoxic studies are necessary before developing this compound as a prototype for antibiotic production.

In Kerala, few decades ago, almost all houses had the tree of Flacourtia inermis. Due to increased urbanization and modern agricultural practices, it has disappeared even from the village areas and today number of houses having this tree is very rare. One of the main reasons is that, in the past, this tree was not recognized for its medicinal significances and thereby its economic relevance. On the contrary, present study reveals that this tree, especially its fruit, is a powerful medicinal agent against different infectious microbes. Study from Sri Lanka about the antioxidant property of Flacourtia inermis fruit also supports the medicinal significance of its fruits.

We believe that this first report on the medicinal significances of fruit of Flacourtia inermis against bacteria, fungi and protozoa will be an inspiration for scientists and researchers for recognizing and identifying its other medicinal, social and economic values as well as to initiate steps to protect this tree from its extinction.

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195
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195