

## 1. INTRODUCTION

Herbal preparations have been increasingly used for therapy in an attempt to assist in killing tumour cells, as antimicrobial agents, anti-malarial, lowering of blood cholesterol and reducing the toxicity of combined chemotherapeutic agents (Biçer and Özdemir, 2010; Chai *et al.*, 2010; Adebayo and Krettlia, 2011; Desouky *et al.*, 2015). Plants have had an essential role in the folklore of ancient cultures. In addition to the use as food and spices, plants have also been utilized as medicines over 5000 years. It is estimated that 70-95% of the population in developing countries continues to use traditional medicines even today. A new trend that involved the isolation of active compounds from plants began during the early nineteenth century. This trend has led to the discovery of different active compounds that are derived from plants. In the last decades, more and more new materials derived from plants have been authorized and subscribed as medicines (Fridlender *et al.*, 2015).

The use of and search for drugs and dietary supplements derived from plants has accelerated in the recent years. Ethnopharmacologists, botanists, microbiologists and natural-products chemists are combing the earth for phytochemicals and “leads” which could be developed for treatment of infectious and other diseases. While half of today’s medicines are from plants, none of these are used as antimicrobials. However, some plants have been used traditionally to prevent or cure infectious conditions (Ngarivhume *et al.*, 2015). Plants are rich in secondary metabolites, like phenols, flavonoids, alkaloids, tannins and terpenoids, which exhibit antimicrobial properties *in vitro*. These formulations with no or least toxicity can prove better alternatives to synthetic drugs (Rathore *et al.*, 2015).

Reactive oxygen species (ROS) are formed in mammalian cells as a consequence of aerobic respiration. Despite multiple conserved redox modulating systems, a given proportion of ROS continuously escape from the mitochondrial respiratory chain, being sufficiently potent to damage cells in various ways, including numerous carcinogenic DNA mutations. Oxidative

stress resulting from an imbalanced ratio between ROS production and detoxification may also disturb physiological signal transduction, lead to chain reactions in lipid layers, and damage DNA repair enzymes. The significance of ROS and antioxidant systems in carcinogenesis is still complicated and in many ways contradictory. Enhanced antioxidant mechanisms in tumor cells *in vivo* have been implicated in chemo resistance and lead to poor prognosis, whereas most *in vitro* studies have reported tumor-suppressing properties of antioxidant enzymes. Reactive oxygen and nitrogen species have been shown to cause oxidative damage to biomolecules, contributing to the development of a variety of diseases (Karihtala and Soini, 2007).

Plants have many phytochemicals with various bioactivities like antioxidants, anticancer, antimicrobial and hepato protective activities (Hosseini and Ghorbani, 2015; Gupta *et al.*, 2015; Ram *et al.*, 2015; Yusuf *et al.*, 2015). Cancer, infection, atherosclerosis and many other diseases are treated with drugs that cause significant negative side effects. Therefore, there is a need to develop new drugs with novel modes of action that do not produce serious side effects. Natural product-based agents can lower the risk of side effects, offer promising treatment and prevent such diseases.

Previous studies conducted in our research group revealed that the leaves of *Clitoria ternatea* is a rich source of antioxidants, protects against oxidative damage induced in RBC ghosts from goat blood, goat liver, protects against H<sub>2</sub>O<sub>2</sub>-induced DNA damage in λDNA and pUC 18 DNA, protects against free radicals and oxidative DNA damage (Thiruselvi, 2007), protects against H<sub>2</sub>O<sub>2</sub>-induced apoptosis in yeast (Vijayachandran, 2007) and protects against etoposide-induced apoptosis in chick embryo fibroblasts (Devi, 2008). Further, antioxidants can be the remedy for cancer, inflammation, infection and atherosclerosis. Though, Cornelius Celsus, a physician in 1<sup>st</sup> Century Rome, characterized Inflammation first, it was Rudolf Virchow, a German physician in 19<sup>th</sup> century who suggested a link between inflammation and cancer, cardiovascular diseases, diabetes, pulmonary diseases, neurological diseases and other chronic diseases (Aggarwal *et al.*, 2011).

In the recent years, efforts are concentrating not only on the search of effective medicines from natural sources, but also on effective targeted drug-delivery systems that can enhance the efficacy of the drugs. A significant route in this has been the preparation of nanoparticles as drug delivery system. Nanoparticles, with the advantage of small size, have higher penetrating power and, therefore, can deliver drugs more efficiently (Desai *et al.*, 2010).

Several types of nano drug formulations have been attempted by researchers, of which the plant extract-based green synthesis of metal nanoparticles has gained much attention (Iravani, 2011). Many metals like silver, gold, iron, copper, nickel, palladium and ruthenium have been tried in this regard, and have been found to possess higher efficiency than their non-nano counterparts (Rao *et al.*, 2005; Mishra *et al.*, 2013; Kumar *et al.*, 2015).

With this backdrop, the present study was formulated to assess the antibacterial and anti-inflammatory activities of *Clitoria ternatea* and the silver and gold nanobioconjugates prepared from them. The hypothesis drawn for the study is as follows:

**Hypothesis:**

*Clitoria ternatea* exhibits good antibacterial and anti-inflammatory activities, which can be effectively enhanced by preparing silver or gold nanobioconjugates with them.

The study was planned with the following objectives to test the above hypothesis.

## 1.2. Objectives :

- To analyze the leaves, seeds and roots of two varieties of *Clitoria ternatea*, bearing blue and white flowers, for their antioxidant and antibacterial activity
- To synthesize and characterize silver and gold nanobioconjugates from the potential extract and assessing their comparative bioactivity *in vitro*
- To analyze the safety and biocompatibility of the synthesized nanobioconjugates
- To study the anti-inflammatory activity of the potential extract and nanobioconjugates *in vivo* to validate the results obtained *in vitro*.

In order to understand the present status of research in the field, the vast literature pertaining to the proposed study was collected, and a brief review of this is presented in the next chapter.