

## *Introduction*

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Medicinal plants prevail as a persuasive alternative to synthetic drugs (Kettner et al., 2005) with around 80% of the world population of developing countries relying on plants as their primary health care (Akerele, 1993). Medicinal equity of plants has given momentum to the ethnopharmacological investigation for evaluating their efficacy, safety and drug-discovery potentials (Karou et al., 2007). Ethnopharmacology is an integrative interdisciplinary frontier for research (Etkin and Elisabetsky, 2005) involving observation, description, and experimental investigation of indigenous drugs and their biological activity. It underlines relevance of plant-derived drugs (Ortega, 2006), based on assimilation of validated conscientious facet and anthropological directed research as well as introduction of historical perspectives of indigenous knowledge systems (Ningthoujama et al., 2012).

As per World Health Organization (WHO), the ancient existing therapeutic systems used for human health and wellbeing are defined as Traditional Medicine or Complimentary Medicine and Alternative Medicine (TM/CAM). Traditional Medicine has firm authentic and cultural roots having practical experience based on evidence. Presently numerous traditional medicine or complimentary medicine and alternative medicines from various part of the World are attaining acceptance. Traditional Medicine entails origin in the remote past and herbal drugs used therein have thus a long history of use, which adds much credibility to their therapeutic value. Being recognized globally, WHO has accepted Ayurveda as Traditional system of medicine of India, has its roots more than 5000 years ago and still practiced thrivingly all over India. It is based on speculative expertise of the observations and the experience over

millennia. About 80 % of plants, 12% animals and 8% minerals are used as medicinal substance for treating disease (Joshi, 2014).

Plants, parts of plants and their products have been used since time immemorial for the prevention and treatment of various health ailments. Around 25% of the drugs prescribed worldwide are plants based and 121 such active compounds are in use. Of the total 252 drugs in WHO's essential medicine list, 11% is exclusively of plant origin. Nearly 80% of African and Asian population depends on traditional medicines for their primary healthcare. In India, about 80% of the rural population uses medicinal herbs or indigenous systems of medicine. About 960 plant species are used by the Indian herbal industry of which 178 are of high volume exceeding 100 metric tonnes a year (Sahoo et al., 2010).

WHO has defined “herbal medicine” as a plant-derived material or preparation with therapeutic or other human health benefits which contains either raw or processed ingredients from one or more plants. Recently a marked increase in worldwide utilization of herbal medicines has been evident (Zhang et al., 2012). Therefore, quality control of herbal medicines becomes an important aspect for ascertaining their safety and efficacy. WHO has developed a series of technical guidelines regarding safety, efficacy and quality assurance of medicinal plants and herbal products. Quality, safety and efficacy are integral part of standardization which helps to prevent adulteration from substandard species. Plant conservation and biological piracy can be prevented by application of molecular markers. Also study of plant diversity, genetic transformation and clonal fidelity can be done by techniques such as amplified fragment length polymorphism (AFLP) and random amplified polymorphic DNA (RAPD) (Moyo et al., 2008). DNA fingerprinting of medicinal plants using PCR techniques has become an invaluable tool for identification, quality control and detection of adulteration in herbal

medicines (Shinde and Dhalwal, 2010). DNA fingerprints, resembling barcodes are unique to the individual and hence can be used in the same way as conventional fingerprints to identify individuals (Jaffreys et al., 1985).

Wounds especially chronic wounds are primary concerns for the patient and physician, which influences enormous number of patients and in turn reduces their lifestyle quality. Patients suffering from surgical and traumatic wounds, abrasions, or superficial burns are indicated with acute wound care. Incision or any kind of tearing trauma results in wound. Wounds following surgery are highly prone to bacterial infections resulting in complications. This necessitates wound care post-surgery. Acute wound care may be of very high value in occupational health because of the nature of related infection. An important factor in the failure of a sore to heal is the presence of multiple species of bacteria. Currently, it has been estimated that about 6 million people are ailing from chronic wounds worldwide. It has been reported that the prevalence of chronic wounds in the community was found to be 4.5 per 1000 population whereas that of acute wounds was nearly doubled at 10.5 per 1000 population (Gupta et al., 2004). Balick and Cox (1996) reported that only 1–3% of drugs listed in Western pharmacopoeia are proposed for treating wounds; while, at least one third of herbal drugs are for such use. Around US\$25 billion is being spend per annum for treating chronic wound while the burden is expeditiously increasing healthcare cost, an aging population, and a rapid growth in the prevalence of diabetes and obesity throughout the world (Sen et al., 2009).

Current therapy for wound treatment is associated with inadequate effectiveness along with serious adverse effects. Plants and their phytoconstituents have been long-established to treat wounds and prevent infection without side effects. Therefore, research is now focused on biologically active principles from plant source that may be

used as a potential wound healing agent (Joshi et al., 2013). Several drugs of plant, mineral and animal origin are described in the traditional texts of Indian systems of medicine like Ayurveda for their healing properties under the term 'Vranaropana'. Besides the classical systems of Indian Medicine, the folk and the tribal medicine also employ a number of plants and animal products for treatment of cuts, wounds and burns. Some of these plants have been screened scientifically for the evaluation of their wound healing activity in different pharmacological models and human subjects, but the potential of most of the plants remain unexplored (Kumar et al., 2007).

*Leea macrophylla* Roxb. ex Hornem. (Leeaceae), commonly known as Hastikarnapalasa is a wild edible plant with high nutritive value in terms of minerals and vitamins content (B1, B2, C and B12) (Jadhao et al., 2009). The dried powdered root of *Leea macrophylla* is taken along with clarified butter in the morning as age sustainer (Jadhao and Wadekar, 2010). Traditionally, the plant has been reported to be effective against guinea worm, ringworm and is applied on sores and wounds (Kirtikar and Basu, 1975; Misra, 2010). Roots are applied externally to allay pain and are alexipharmic (Kirtikar and Basu, 1975). In Uttar Pradesh (India) its local name is Bado hanshia where the local tribes use the root tubers orally and locally for treating wound (Anonymous, 1999). Pharmacologically, the plant has been reported to possess anti-urolithiasis (Nizami et al., 2012) and anti-inflammatory activities (Dewanjee et al., 2013). However, the root tubers have not been scientifically validated for its wound healing activity.

Hence, the present study intends to investigate pharmacognostical standardization of *Leea macrophylla*, which includes macroscopical, microscopical, physicochemical and phytochemical evaluations and DNA fingerprinting analysis. Further, the study also scientifically validates the traditional wound healing claims of

*Leea macrophylla* root tubers. Several factors were selected to optimize soxhlet extraction using Box Behnken design. Apart from employing statistical descriptors to optimize the extractive process, the current manuscript also entails development and thorough mechanical characterization of a bioadhesive hydrogel for topical application of obtained extract and comparison of its wound healing effect with its oral formulation, to discern the most feasible route of administration.