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Antioxidant Potential of Dried *Enicostemma littorale*

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Medicinal plants act as alternative source of disease treatment due to which their use is increasing day by day. These plants are mostly herbaceous and are used to treat various human ailments; either solely or in combination with other plants (Odhiambo *et al*., 2011; Karim *et al*., 2011; Sohail *et al*., 2011). For this, generally leaves and roots are harvested, which are processed as concoction and decoction. *Enicostemma littorale* is one of the important medicinal herbs and one of its important attributes includes antitumor activity (Kavimani and Manisenthlkumar, 2000). Its methanolic extracts protected the albino mice from Dalton's ascitic lymphoma and promoted the growth of peritoneal (membrane lining the abdominal cavity) cells. Its methanolic extracts also have antiulcer activity, as they protected the rat from aspirin, ethanol and pyloric ligation-induced gastric ulcers (Roy *et al*., 2010). These extracts maintain the pH levels of gastric tract and showed the anti-inflammatory effects; moreover these extracts were able to inhibit the albumin denaturation. Its other uses are due to its anti-diabetic, antioxidant property; it increases serum insulin levels of diabetic rat and improves antioxidant level in oxidatively stressed rats (Gopal and Udayakumar, 2008; Maroo *et al*., 2003). It modulates the levels of reduced glutathione, catalase etc. and inhibits the lipid peroxidation. This plant has many important traditional medicinal uses also; it was used to treat diabetes, insect bites, itching, swelling, ulcer, peritoneal and joints problems (Abirami and Gomathinayagam, 2011). This may be due to its phytochemical (alkaloids, phenols, flavonoids, sterols etc.) and mineral (calcium, silica, phosphate, iron etc.) profile. But competent use of medicinal plants and their products is often suffered by the contamination of fungus, which produces several toxic compounds like fumonisin and aflatoxin (Katerere *et al*., 2008). This can severely affect human health and in Africa 15 out of 16 tested herbal products are contaminated with fungus (majorly with *Aspergillus, Fusarium* and *Penicillium*). This contamination was the result of poor storage and transport conditions. Thus reliable and durable storage method is essentially required to stop the contamination of herbal product. Drying is one of the usually used storage techniques; it reduces the chances of plants product contamination with microbes (Elrashid and Iqbal, 2000; Muller and Heindl, 2006). But drying temperature, air and humidity can affect the products quality and quantity; moreover these conditions are plant specific. Therefore to facilitate the storage of *E. littorale* the estimation of drying techniques effect would help in finding correct drying conditions.

Sthishkumar *et al*. (2009) studied the efficiencies of different drying methods (sun, shade and oven) in preserving the antioxidant properties of *E. littorale*. According to them drying brought a significant loss in total phenolic (antioxidant) contents of plant extracts and they judged it against methanolic, distilled and boiled distilled water extracts. These three extracts of fresh plant parts showed relatively high concentration of phenols and maximum concentration of these antioxidant compounds were obtained from the boiled water extracts. Thus boiling offered a good opportunity of phenolic compounds extraction from fresh samples with a significantly higher (2.15 mg g^{-1}) concentration of phenols. But when plants were subjected to drying some changes occurred due to loss of moisture and altered activity of enzymes, which reduced the phenols concentration in them. As phenolic contents obtained from shade drying technique were 1.82 in methanol, 1.77 in distilled and 1.95 mg g^{-1} phenols in boiled water extracts. On the other hand phenols of sun dried plant were 1.93, 1.54 and 1.91 mg g^{-1} in methanol, distilled water and boiled water extracts, respectively. While minimum concentration were obtained from the oven dried extracts, hence the availability of phenolic compounds was drying and extraction technique dependant variable. But extracts' DPPH (2, 2-diphenyl-1-picrylhydrazyl) antioxidant activity was not determined by the concentration of these phenols and maximum antioxidant activity was observed in oven dried methanolic extracts. Its value was 89.362 mg Ascorbic Acid (AA) g^{-1} followed by sun dried extracts (76.579 mg AA g^{-1}), while the maximum antioxidant property of fresh methanolic extracts was only 10.99 mg AA g^{-1}. On the other hand when these extracts were subjected to FRAP (Ferric Reducing Antioxidant Power) test, a direct proportionality was observed in fresh, shade dry and oven dried extracts' phenolic compounds and ferric ion reduction. Their antioxidant activity was increased with increasing phenol concentration; however there was a difference in phenols concentration and relative antioxidant property of sun

dried plants. As their methanolic extracts were with maximum phenols (1.93 mg g^{-1}) but their ferric reduction activity was less than distilled and boiled distilled water extracts. Hence the antioxidant potential of *E. littorale* was influenced by drying and extraction method, which was due to difference in drying method efficiencies and possible enzymatic changes. As oven drying provided more intense heat than sun and shade drying techniques, which more strongly caused a decrease in heat unstable compounds and inactivated the polyphenol oxidase. It might also cause some chemical conversion of compounds, which produced other compounds with more strong antioxidative property. As oven dried methanolic extracts were depleted with phenolic compounds but showed highest antioxidative potential. Since this can be said that oven drying technique was good for preserving DPPH antioxidants, while sun dried technique was efficient for preserving ferric reducing agents.

E. littorale remained an important part of traditional medicines and its extracts could be used to reduce oxidative stress, diabetes, cancer ulcer etc. Thus the development of storage technique for its long time preservation will assist its use at required time. For this purpose Sthishkumar *et al.* (2009) studied the effect of drying technique on antioxidants of *E. littorale*. According to their results drying techniques differentially affects the concentration of antioxidative agents and their relative antioxidative property. But, a further detailed investigation of *E. littorale* phytochemicals is necessary to understand the role of drying technique in storing its medicinal properties. This will help in economical use of dried plant's products.

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