Pharmacological and Biological Activities

Few pharmacological or biological test reports have been reported on this plant in the literature like chloroform methanolic and ethanolic extracts of entire plant shows antibacterial activity, methanolic extracts of entire plant possess bronchodilator, neuromuscular blocking activity, antioxidant activity. Petroleum ether, methanolic and aqueous extracts of leaves shows anticrustacean activity (Kumar *et al.*, 2015). The alcoholic extract of the plant and compouds (**1**-**3**), isolated from the plant growing in Egypt, exhibited *in vitro* cytotoxic activity using two proliferating mouse cell lines, a normal fibrolast line NIH3T3 and virally transformed forms KA3IT (Ayyad, 2001). The cytotoxicity of the chloroform and aqueous extracts on larvae of *Culex* mosquito was also reported (Mukhtar *et al.*, 2004).

The plant extracts (mainly the leaves) exhibited the following activities: antidermatophytic (against *Trichophyton rubrum*, *Trichophyton mentagrophytes*, *Microsporum gypseum*, *Microsporum nanum* and *Epidermophyton floccosum*) (Premkumar and Shyamsundar, 2005), regulate hyperthyroidism (Tripathi *et al.*, 2010), antioxidant (Jha *et al.*, 2010), anthelmintic (Kumar *et al.*, 2010; Rahman *et al.*, 2011), analgesic, anti-inflammatory, antipyretic (Kumar *et al.*, 2011), CNS depressant, cytotoxic (Ali *et al.*, 2011), antinociceptive, antidiarrheal (Rahman *et al.*, 2011), antiprotease, antitubercular, emollient, antidiabetic, (Rahman *et al.*, 2011), antiarthritic (Kyei *et al.*, 2012a,b), antipyretic (Kyei *et al.*, 2012a), antispermatogenic (Singh *et al.*, 2014b), cytotoxic (Wasagu *et al.*, 2014), thrombolytic (Hossen *et al.*, 2014), bronchodilator, antitumor, antibacterial, antifungal, antiviral, antialgal, diuretic, antiprotease, emollient, antidiabetic and (Tulika and Mala, 2015). Also, the plant extracts showed other pharmacological activities *viz.* calcium channel blocking, bronchodilating, neuromuscular blocking actions and decrease blood pressure (Achola *et al.*, 1997). It has also larvicidal activity (against *Anopheles* mosquito larvae) (Imam and Tajuddeen, 2013) and allelopathic effect on terrestrial plants (Bich and Kato-Noguchi, 2012; Khan *et al.*, 2014). Extracts of *P. stratiotes*, growing in Egypt, showed moderate antimicrobial activities (Abu Ziada *et al.*, 2008; Daboor and Haroon, 2012).

Among the substances isolated from the ether extract of *P. stratiotes*, linoleic acid, γ-linolenic acid, (12*R*,9*Z*,13*E*,15*Z*)-12-hydroxy-9,13,15-octadecatrienoic acid, (9*S*,10*E*,12*Z*,15*Z*)-9-hydroxy-10,12,15-octadecatrienoic acid, α-asarone, and 24*S*-ethyl-4,22-cholestadien-3,6-dione were found to inhibit the growth of some microalgae (Aliotta *et al*., 1991).

The pharmacognostical characters (macroscopic, microscopic, behavior of powder with different reagents, etc.) were reported (Kumar *et al.*, 2015).

Phytoremediation and Other Uses

Okali and Attionu (1973) determined and compared the quantities of the nutrient elements N, P, K, Ca, and Na in *P. stratiotes* and in water from the Volta lake. The nitrate-N content of lake water alone was found to be most consistently related with plant characteristics. The data were used to estimate the amounts of the elements bound in *P. stratiotes* biomass on the lake. The importance of the nutrient composition of *P. stratiotes* for alternative approaches to control of the weed is indicated (Okali and Attionu, 1973).

The studies on the effect of heavy metal pollution on the plant revealed that the accumulation of metal ions in the roots was more than that in the leaves (Satyakala and Jamil, 1997). The accumulation of Hg, As, Se (Qian *et al*., 1999; Tripathi *et al.*, 2010), Fe, Zn, Cu, Cr and Cd (Mishra and Tripathi, 2008; Thilakar *et al.*, 2012) by the plant had been also reported (Mishra and Tripathi, 2008; Thilakar *et al.*, 2012). Infestation of *P. stratiotes* was monitored to assess the periodic changes in its pigment, mineral and nutrient contents brought about by water quality (Sobha and Harilal, 2006). According to Rahman *et al*. (2000), the purification of ephedrine factory's wastewater by the plant was found efficient. The effectiveness of urban an agricultural sewage purification (in Israel) by water hyacinth (*Eichhornia crassipes*) and water lettuce (*P. stratiotes*) has been studied. The results showed that the use of this free water surface flow system and its low maintenance system for treatment of urban and agricultural sewage is a viable option (Zimmels *et al*., 2006). The biosorption of oil from waste water by water lettuce has been also reported (Renganathan *et al*., 2009). Phytochelatins in the aquatic macrophyte, *P. stratiotes*, can serve as sensitive biomarker for heavy metal toxicity in a moderately polluted water environment (Wang *et al*., 2010). Also, the studies of Mufarrege *et al*. (2010) showed the important implications for the use of the macrophyte in constructed wetlands for industrial waste water treatment. In India, young leaves are cooked and eaten (Pareek and Kumar, 2014). It is a ‘hyperaccumulator’ by removing heavy metals, organic compounds and radio-nuclides from water. It is reported as a good candidate for *in situ* bioremediation of drug contaminated water (Tulika and Mala, 2015). The plant is one of the most suitable plants to be used in wastewater phytoremediation in tropical areas (Fonkou *et al.*, 2002). *P. stratiotes* can be utilized as a substrate for biogas production in batch digestion (Abbasi *et al.*, 1991). The Luvale use the ash of *P. stratiotes* as a source of salt (Watt and Breyer-Brandwijk, 1962).

Cultivation of *P. stratiotes* in wastewater of organic and mineral substances, as well as microorganisms, which suggests that this species of aquatic herbs behaves as an active biofilter and effective antagonist with respect to intestinal bacteria. The herb is especially suitable for treating poultry farm waste waters, in which it develops strong root systems and discharges a high amount of oxygen, thereby contributing to the development of aquatic saprophytic bacteria which degrade organic substances to produce readily available forms (Muzafarov *et al*., 1983).