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Synthesis and characterization of inclusion complexes of *Ageratum conyzoides* L. essential oil in β-cyclodextrin

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Ageratum conyzoides L. (Asteraceae) is an essential oil bearing weed shrub grown in various regions of the globe including Sri Lanka. *Ageratum conyzoides* L. essential oil (ACEO) possesses a wide range of chemical, biological and pharmacological properties which allow ACEO to be used in different applications, including in agricultural practices as herbicides and insecticides. However, low water solubility, high volatility and thermal instability of ACEO limit its uses. In order to overcome the aforementioned limitations of ACEO, host-guest inclusion complexes (ICs) of ACEO with β-cyclodextrin (β-CD) can be prepared. Therefore, this research focused on synthesis followed by physicochemical characterization of β-CD-ACEO ICs. The chemical composition of hydro-distilled ACEO was analyzed using gas chromatography-mass spectrometry (GC-MS). The ICs and physical mixtures (PMs) of β-CD-ACEO were synthesized using co-precipitation and grinding methods, respectively for two initial mass ratios of ACEO to β-CD, 1:2 and 1:4. The formation of β-CD-ACEO ICs and corresponding PMs along with their physicochemical properties were evaluated and compared using Fourier transform infrared spectroscopy, thermogravimetry/derivative thermogravimetry and differential scanning calorimetry. The encapsulation efficiency (EE) of β-CD-ACEO ICs was determined using ultraviolet-visible spectroscopy. The GC-MS profile of ACEO exhibited thirty-three chemical constituents, with precocene II, a chromene, being the major chemical component (62.7%). The co-precipitation method resulted in experimental yields of 38.7% and 51.9% for 1:2 and 1:4 ICs, respectively. The complementary treatment of qualitative and quantitative data obtained from the thermal analysis of ICs and PMs of β-CD-ACEO indicated characteristic volatility reduction and thermal stability enhancement of ACEO, leading to successful formation of ICs. EE values, up to 35%, were obtained for β-CD-ACEO ICs. The findings of this study suggested that the limitations in utilization associated with the properties of ACEO could be successfully overcome by preparation of β-CD-ACEO ICs.

Keywords: *Ageratum conyzoides* L., essential oil, encapsulation, β-cyclodextrin, inclusion complex

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Effects of anions on inhibition of corrosion of aluminium in acidic medium by extracts of *Lasia spinosa* and *Artocarpus camanci*

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Aluminium shows excellent resistance to corrosion under normal circumstances, which is however compromised in the formation of alloys. Moreover, aluminium corrodes under certain conditions in industrial environments, and thus, it is essential to know the conditions under which corrosion would occur, the products that corrosion would lead to, the rate of corrosion under different situations and possible preventative measures. In this respect, this research was focused on the use of an environmentally friendly and economical approach to inhibit the corrosion of aluminium in HCl acid medium, a highly corrosive and an industrially used pickling bath medium. As determined by the mass loss method, the corrosion

inhibition of aluminium in HCl was found to enhance significantly with aqueous extracts of *Lasia spinosa* (stalk and leaf) and *Artocarpus camanci* (fruit peel). The optimum values of the volume of extracts, inhibitor extract concentration, solution temperature, exposure time and HCl concentration determined by changing one variable at a time were found to be 3.5 ml, 0.035 (v/v), 30 ^{O}C, 1.0 h and 1.0 M, respectively. Moreover, the percentage inhibition efficiency and surface coverage were found to increase with increasing concentration of plant extract due to the increase in the extent of adsorption of plant components onto the aluminium surface, indicating that adsorption is a principal mode of corrosion inhibition. The effect of anions, commonly found in industrial environments and/or in the atmosphere, investigated under different experimental conditions, indicated that I^-, CO_3^{2-}, $C_2O_4^{2-}$ and SO_4^{2-} act as corrosion inhibitors for aluminium, and the inhibition effect further increases in the presence of plant extracts. On the other hand, the extent of corrosion of aluminium in the presence of Cl^-, MnO_4^- and $Cr_2O_7^{2-}$ is reduced by the addition of plant extracts into the HCl acid medium. More importantly, *Lasia spinosa* is a better corrosion inhibitor than *Artocarpus camanci* for aluminium in HCl medium.

Keywords: Acidic medium, aluminium, anions, *Artocarpus camanci*, corrosion inhibition, *Lasia spinosa*

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Inhibition of corrosion of aluminium by natural substances

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Use of economical and environmentally friendly materials for inhibition of corrosion of metallic substances has become an attractive alternative. Plant-based materials, owing to the presence of electron-rich compounds, would lead to increase in the electron density of metallic surfaces when in contact, thereby inhibiting corrosion. In this respect, inhibitive action of peel extracts of *Citrus aurantiifolia* and *Solanum lycopersicum* on aluminium corrosion in acidic and alkaline media was investigated using the mass loss method and electrochemical techniques. According to mass loss measurements, inhibition efficiency for both extracts in 0.50 M HCl medium increased with increase in inhibitor concentration and decreased with solution temperature and immersion time. Further, the inhibition efficiency of *Citrus aurantiifolia* is higher than that of *Solanum lycopersicum*. Open circuit potential (OCP) values shift to more negative values in HCl medium and to more positive values in NaOH medium when the concentration of both inhibitors is increased. Negative potentials indicate the adsorption of the inhibitor at the active sites of the electrode surface retarding both anodic dissolution of aluminium and the generation of hydrogen gas at the cathode. However, positive OCP displacement cannot be recognized as a cathodic or anodic inhibitor. The results thus reveal that both *Citrus aurantiifolia* and *Solanum lycopersicum* extracts behave as mixed-type inhibitors on aluminium.

Keywords: *Citrus aurantiifolia*, corrosion inhibition, mass loss, open circuit potential, *Solanum lycopersicum*