INTERCALATION OF BIOACTIVE NATURAL PRODUCTS INTO LAYERED DOUBLE HYDROXIDES AND CATIONIC CLAYS

D.M.D.S. Dissanayake

Department of Chemistry, University of Peradeniya, Peradeniya, Sri Lanka
Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka

The need of secure, therapeutically and economically effective drug delivery systems leads scientists to design novel strategies with improved properties. The present work examines the potential of Fuller's earth, cation-exchanged montmorillonite (M^{n+}-MMT) and layered double hydroxide (LDH) (a) to intercalate phenylacetic acid, a medicine and a well-known auxin, (b) to pull out active compounds from the extracts of *Salacia reticulata* and *Curcuma longa* which are known to contain potent α-glucosidase inhibitors and antioxidants, respectively, and (c) to intercalate the calcium salt of (-)-hydroxycitric acid, a potent metabolic regulator of obesity and lipid abnormalities in mammalian system. Ca^{2+}-exchanged montmorillonite (Ca^{2+}-MMT) and Al^{3+}-exchanged montmorillonite (Al^{3+}-MMT) were prepared by treating commercially available Na^{+}-montmorillonite with aqueous calcium chloride and aluminium nitrate, respectively. The layered double hydroxides, Mg-Al-CO_3^{2-}-LDH and Mg-Al-NO_3^{-}-LDH, were prepared by mixing aqueous magnesium nitrate and aqueous aluminium nitrate, in the presence and absence of aqueous sodium carbonate under alkaline conditions, respectively. The intercalation of bioactive material was performed by treating the desired compound or extract with the appropriate M^{n+}-MMT or LDH under alkaline/neutral conditions. Treating the desired compound with LDHs was carried out by both co-precipitation (mixing the organic compound/extract with aluminium mixture and magnesium mixture) and indirect method (mixing the organic compound/extract with LDH). Intercalated products were characterized by X-ray diffraction (XRD), Fourier Transform infrared spectroscopy (FT-IR) and thermal analysis – thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC).

As revealed by FT-IR, XRD and TGA analysis it can be concluded that the phenylacetic acid and compounds from *Salacia reticulata* exteracts were successfully intercalated into Fuller's earth and LDHs. Intercallation into LDH was more effective by the direct co-precipitation of LDH in the presence of bioactive material than by the indirect method where bioactive material was treated with pre-formed LDH. Whether the compounds from *Curcuma longa* extracts had been intercalated into the clays or adsorbed on the clays was not established unequivocally due to lack of sophisticated analytical techniques such as scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The calcium salt of (-)-hydroxycitric acid did not show significant intercalation into clays.

Releasing studies of phenylacetic acid from phenylacetic acid-LDH hybrids was attempted by stirring or sonicating the appropriate aqueous suspensions at pH 2, 3, 5, 7.4 and 9 at ambient temperature, and the maximum release, as estimated by UV spectroscopy, was observed at pH 2. The amount of phenylacetic acid released after 24 h at pH 2 was found to be 11.4, 9.6 and 4.2 mg for each gram of LDHs prepared via co-precipitation method (and released by stirring), indirect method prepared via sonication (and released by stirring) and indirect method prepared via stirring (and released by stirring), respectively.