장뇌삼에서 추출한 진세노사이드를 이용한 몬모릴로나이트 복합소재의 합성 및 특성에 관한 연구

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The synthesis and characterisation of montmorillonite composite materials using ginsenoside extracted from wild ginseng

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Ginseng is a key herb in Chinese medicine, and has a wide range of therapeutic and pharmacological uses [1]. Panax ginseng is a slow growing perennial herb of the Araliaceae family usually cultivated in China, Japan, Korea and Russia, as well as in the United States and Canada. Ginseng root has been used as an oriental folk medicine for several thousand years [2]. It is a highly valued medicinal plant in the Far East that and also popular in the West in the past 20 years. A number of studies suggest that both Panax ginseng C.A. Meyer (also known as Asian ginseng, Chinese ginseng or Korea ginseng) and Panax quinquefolius (also known as American ginseng) have multiple components and pharmacological functions. Among the complex constituents of ginseng, ginsenosides (also known as ginseng saponins or triterpene saponins) are the major components responsible for biochemical and pharmacological actions of ginseng [3-4]. With the development of modern technology, more than 150 naturally occurring ginsenosides have been isolated from Panax species [5]. About 40 ginsenosides(GS) have been identified from the root of Panax ginseng. In order to explore the pharmacological actions, mechanisms and clinical applications of ginseng, some researchers focused on purified individual GS rather than whole ginseng extracts [6]. Individual GS may have different characteristics in chemistry, metabolism, and pharmacokinetics.

Montmorillonite (MMT) clay is one of the smectite group, composed of silica tetrahedral sheets layered between an alumina octahedral sheets. The imperfection of the crystal lattice and the isomorphous substitution induce a net negative charge that leads to the adsorption of alkaline earthmetal ions in the interlayer space. Such imperfection is responsible for the activity and exchange reactions with organic compounds. MMT also contains dangling hydroxyl end-groups on the surfaces [7]. MMT has large specific surface area; exhibits good adsorb ability, cation exchange capacity, standout adhesive ability, and drug-carrying capability. Thus, MMT is a common ingredient as both the excipient and active substance in pharmaceutical products [8]. The intercalation of organic species into layered inorganic solids provides a useful and convenient route to prepare organic-inorganic hybrids that contain properties of both the

inorganic host and organic guest in a single material [9]. In recent years, smectite clays intercalated by drug molecules have attracted great interest from researchers since they exhibit novel physical and chemical properties.

The present paper focused on the intercalation of GS into the interlayer of MMT under different reaction conditions, such as pH and initial concentration of GS. The MMT-GS hybrid was characterized by XRD, FT-IR, and TG-DTA.

Experimental

GS prepared through the extraction for 24hr by evacuation-extractor with cultivated wild ginseng. The MMT-GS hybrid materials were synthesized as 0.2:1, 0.4:1, 0.6:1 and 1:1 for GS:MMT. All the samples are obtained the product using centrifuge and freezing dryer after reacted for 2hr at the room temperature. This product is characterized using XRD, FT-IR and TGA-DTA.

Results and Discussion

The XRD patterns of MMT and different contents of GS-MMT (20wt%, 40wt%, 60wt%, 100wt%) shown in Fig. 1. The result characteristic reflections of GS-MMT shows a shift of (001) peak position between 3^o and 7^o (2Θ = (a) 6.95^o, (b) 5.29^o, (c) 4.37^o, (d) 4.09^o and (e) 3.44^o), respectively. These indicate that GS are intercalated into inter-layers of MMT.

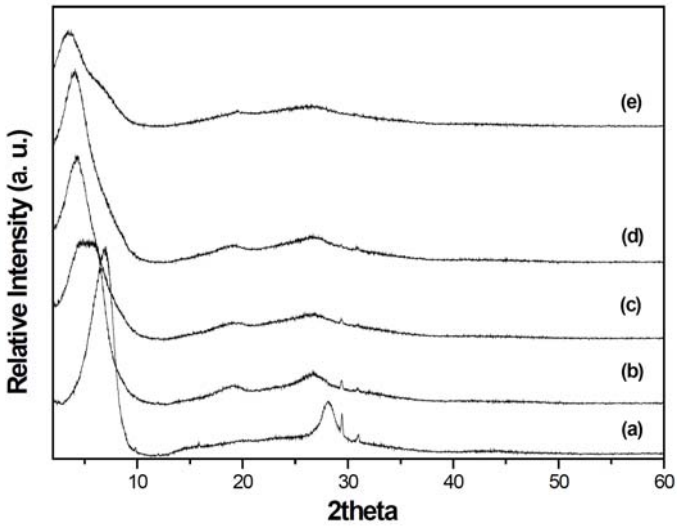

Fig. 1. X-ray diffraction patterns of MMT and different contents of GS: (a) MMT, (b) 20wt% GS-MMT, (c) 40wt% GS-MMT, (d) 60wt% GS-MMT, (e) 100wt% GS-MMT.

In other words, the shift of basal spacing in GS-MMT describes that GS molecules were intercalated between layers of MMT and expended inter-lamellar spacing.

FT-IR spectra of MMT-GS composite are shown in Fig. 2. The GS showed asymmetric and symmetric stretching vibrations at 1630 and 1417cm^{-1} due to carboxyl anions, and at 1073cm^{-1} due to cyclic ether bridge. MMT shows a broad band centered near 3400cm^{-1} due to -OH stretching band for interlayer adsorbed water. The bands at 3620 and 3698cm^{-1} are due to -OH

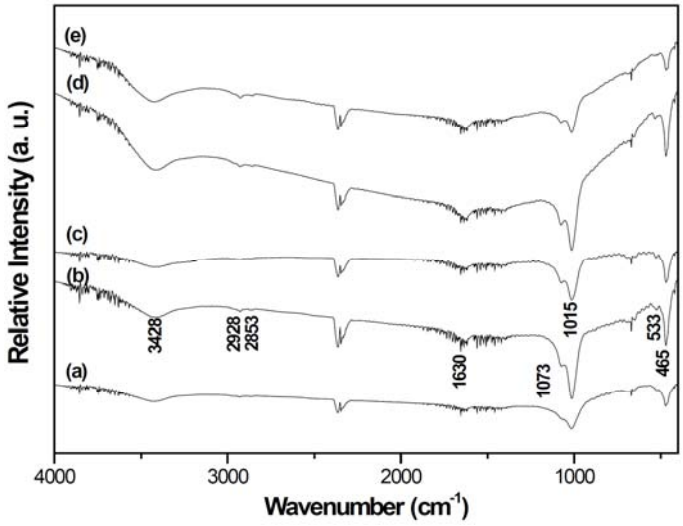

Fig. 2. FT-IR spectra of MMT and different contents of GS: (a) MMT, (b) 20wt% GS-MMT, (c) 40wt% GS-MMT, (d) 60wt% GS-MMT, (e) 100wt% GS-MMT.

band stretch for Al-OH and Si-OH. The shoulders and broadness of the structural -OH band are mainly due to contributions from several structural -OH groups present in MMT. The overlaid absorption peaks in the region of 1640cm^{-1} is attributed to -OH bending mode of adsorbed water. The characteristic peak at 1115cm^{-1} is due to Si-O stretching (out-of-plane) and the peak at 1035cm^{-1} is attributed to Si-O stretching (in-plane) vibration for MMT. The IR peaks at 915, 875 and 836cm^{-1} are attributed to AlAlOH, AlFeOH and AlMgOH bending vibrations, respectively. FT-IR spectra of GS showed C-H, C=O, C-R stretching vibration at 3398, 1675 and 1335cm^{-1}, respectively. In the FTIR spectra of DS-AL beads, the asymmetrical band of carboxylate ion was shifted from 1617cm^{-1} to 1635cm^{-1} whereas carboxyl group of DS was shifted from 1575cm^{-1} to 1454cm^{-1}. The hydroxyl band of sodium AL was shifted from 3493cm^{-1} to 3438cm^{-1} due the interaction between GS and MMT.

Fig. 3 depict the TGA and DTA profile for GS-MMT. Two major weight loss patterns were observed in the temperature range of 80–100 and 600–750^{o}C for MMT. The first weight loss corresponds to evaporation of adsorbed water, which is resulted in a strong endothermic peak at 100^{o}C. The second prominent weight loss was observed at 600–750^{o}C due to the loss of structural hydroxyl group. GS shows a sharp weight loss at around 180–350^{o}C, resulting in strong endothermic peak at this temperature. GS-MMT hybrid shows weight loss in three steps in the temperature region of 80–100, 200–300, and 600–750^{o}C. It is explicable that decomposition of intercalated GS took place in the temperature range of 200–350^{o}C. A weight loss at 100 and 650^{o}C is due to loss of water and structural hydroxyl group in the GS-MMT hybrids, respectively.

Conclusion

Intercalation of GS into MMT depends on the pH of the interaction medium. XRD patterns of hybrid material shows an increase in the d-spacing, conforming the intercalation of GS into the interlayer of MMT. TG-DTA of GS-MMT shows a sharp weight loss at about 200^{o}C due to decomposition of exchanged GS. These studies indicate that MMT can be used as the sustained release carrier of GS in oral administration.

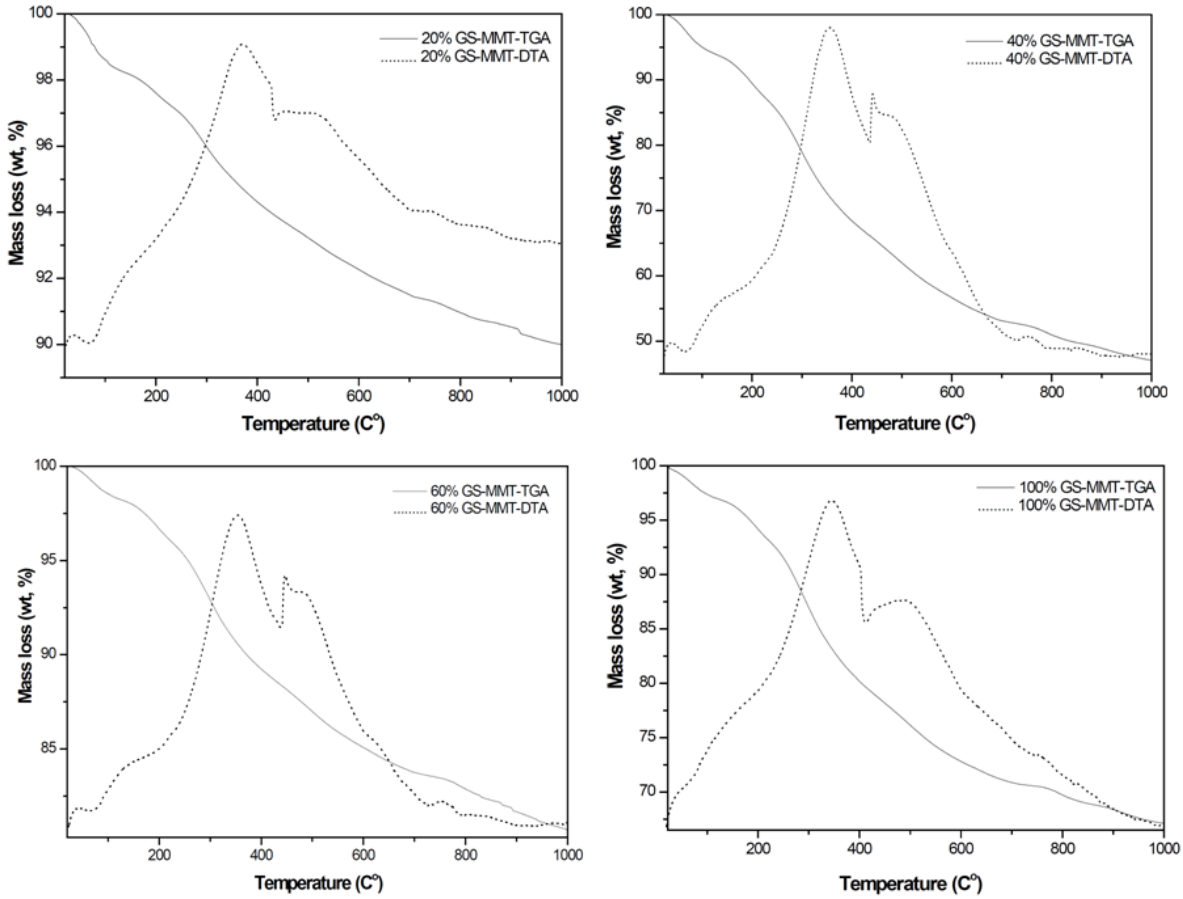

Fig. 3. TG-DTA curve of a different content of GS for MMT: (a) 20wt% GS-MMT, (b) 40wt% GS-MMT, (c) 60wt% GS-MMT, (d) 100wt% GS-MMT.

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