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Effect of Chitosan-modified Fatty Acid Liposomes on the Rheological Properties of the Carbohydrate-based Gel

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Abstract:
Incorporation of liposome into gel is the most common approach for the preparation of topical and transdermal liposomal formulation, due to the ability of liposome to improve the drug deposition and permeation rate within the skin. In this study, the liposomal gel consisted of iota-carrageenan, carboxymethyl cellulose, and chitosan-coated-oleic acid liposome were prepared. The effect of liposomes on the rheological properties of the iota-carrageenan-carboxymethyl cellulose mix gel was evaluated. The rheological result indicated that the presence of the chitosan-coated-oleic acid liposomes in the gel had modified the viscoelastic and flow characteristics of the gel. The input energy from the oscillatory test could be stored more effectively in the elastic component of the liposomal gels, as compared to the original gel itself. This result showed that the liposomal gels exhibited greater elasticity and were more solid-like when compared with the original gel system. The complex viscosity of the liposomal gels was slightly higher than the original gel. The complex viscosity of the liposomal gels was also found to decrease with increasing frequency, indicating the shear thinning behavior of the liposomal gels. The lower Power Law Index *PLI* of the liposomal gels indicated a greater shear thinning behavior and better spreadability.

Key words:
rheology, fatty acid vesicle, chitosan, carboxymethyl cellulose, ι-carrageenan

1 INTRODUCTION

Polysaccharide-based gels play an important role in modern cosmetic and pharmaceutical formulations. This is mainly due to the characteristics of the polysaccharides, which are, biocompatible, biodegradable, edible, and are available from natural sources such as seaweeds [1]. The polysaccharide-based gels are commonly used as a matrix to disperse medicinal or cosmetic-active ingredients. The fluid-filling interstitial space within the gel network provides a continuous moisturizing effect to the skin [2–4]. Carboxymethyl cellulose (CMC) and ι-carrageenan (ι-C) are frequently used polysaccharides in food and pharmaceutical industries. CMC is a derivative of cellulose, with the carboxymethyl group bound to some of the hydroxyl groups of the glucopyranose monomer backbone [5]. In general, CMC is commonly used as binding, thickening, and stabilizing agent of various products in cosmetic and pharmaceutical industries [6, 7]. ι-C is a linear sulfated polysaccharide with alternating three-linked β-D-galactopyranose and four-linked 3,6-anhydro-α-pyranose residues [8]. ι-C has been used in the preparation of food stuff such as dairy products and jellies, due to its typical gelling strength [9, 10]. Besides the food industry, ι-C has also been used in the preparation of soft gel for the oral drug delivery system [11, 12].

The liposome drug carrier has been widely investigated since it was discovered by Bangham and co-workers (Figure 1a) [13]. However, single type, non-surface modified liposomes have been found to hardly survive in the blood stream, due to fast elimination by the mononuclear phagocyte system [14, 15]. The recognition and removal of the liposomes from the blood stream, as foreign particles, has been promoted by the adsorption of proteins that circulate from the blood stream onto the surface of the liposome [14]. This disadvantage inhibits the liposome's function as a drug carrier and reduces its circulation half-life [15]. In order to overcome this disadvantage, surface-modified lipo-

somal gels were prepared by mixing the oleic acid, chitosan-coated oleic acid liposome, and acylated chitosan-coated oleic acid liposome into the 5:5G. The result demonstrated that the presence of liposomes in the gel matrix had increased the elastic property of the gel. This was explained by the rigidity of the loaded liposomes. The low *CE* value of liposomal gels is favorable because high *CE* will limit the transfer of liposomes from the gel matrix to the targeted site. Besides elastic properties, the higher complex viscosity of the liposomal gels when compared with 5:5G will enhanced the stability of the dispersed liposomes during storage. The presence of liposomes was also found to exhibit greater shear thinning behavior indicated higher spreadability of the liposomal gel when compared with 5:5G.

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