Name: **Showkat Ali Ganie**

Supervisor Name: **Prof. Nasreen Mazumdar**

Department: **Chemistry**

Thesis Title: **Biopolymer based delivery systems for Nutrients and Food Components**

ABSTRACT:

This thesis comprises of six chapters, chapter one is introduction and the other five chapters consists of the chemical modifications of various polysaccharides and their complexation with various nutrients like iodine, iron, folic acid and niacin.

Chapter II

In an attempt to develop natural polymer-based iodine release systems, gum arabic, an edible plant produced gum has been used as the polymer. It was first chemically modified by reacting with an acetylating agent and the derivative produced is further reacted with iodine monochloride to prepare the iodine derivative of the acetylated gum. The different degrees of substitution were attained by varying the reaction time. Structural elucidation of the derivatives was confirmed by FT-IR and ^{1}H-NMR Spectroscopies. Thermal stabilities of the modified derivatives were analyzed by thermogravimetric analysis and differential scanning calorimeters. Based on these studies, a reaction scheme has been proposed that shows the conversion of acetate groups to -O-C (OI)=CH_2. The release of iodide ions is proposed in the mechanism and is confirmed by the UV spectrum that shows a peak at 225 nm. Encapsulation of iodinating agents KI and KIO_3 was done by using gum arabic an edible biopolymer by casting method. Available iodine from the salt iodinated with GA-KI was 22.29%. From the salt iodinated with GA-KIO_3 the value of available iodine was 18.09%. (Available iodine from commercial salt was 25.44%). These natural gum-iodine complexes could be useful as a dietary supplement as these are thermally stable, non-vaporizing and releases nutritional form of iodine.

Chapter III

Gum arabic with different aldehyde contents were successfully prepared by oxidization reaction using sodium meta periodate which on further oxidation with sodium chlorite were converted to carboxyl groups. This double oxidized derivative of gum arabic was used as a complexing agent for iron to obtain a polysaccharide bound iron (II) complex. All the products were characterized by spectroscopic and thermal methods of analysis. Based on characterizations, a reaction scheme

has been proposed. The powdered complex was dispersed in hydrochloric acid, simulated gastric and intestinal fluids and the released iron content of the samples was evaluated by 1, 10-phenanthroline method. The total iron available from the prepared complex was compared with that obtained from ferrous fumarate under similar conditions and the results were found to be comparable. Release results demonstrate the pH-sensitive behavior of the gum arabic based delivery system towards the controlled release of iron.

Chapter IV

Macromolecular derivatives based on guar gum and the preparation of complexes with these derivatives with ferrous sulphate were carried out. Guar gum was successfully subjected to double oxidized reactions first by using sodium meta periodate and secondly by sodium chlorite. Doubly oxidized guar gum was treated with ferrous sulphate to obtain iron polysaccharide complex. All the derivatives and the complex were characterized by various sophisticated techniques. To obtain sustained release, various formulations in the form of tablets were prepared from polysaccharide based hydrophobic and hydrophilic coating materials. Release studies of the complex were carried out in two different mediums of different pHs. Tablets encapsulated with hydrophilic material show sustained/prolonged release as compared with hydrophobic material. It is evident from the release and cumulative percentage release behaviors that pH of the medium and hydrophilicity play an important role in the sustained release of iron from the prepared guar gum iron complexes.

Chapter V

In order to design and develop polysaccharide-based delivery system for vitamins, folic acid was covalently bound to chemically modified inulin. Inulin was subjected to various modifications like oxidation and amination. The aminated derivative of inulin was complexed with folic acid. The effect of periodate concentration on the degree of oxidation and aldehyde content of inulin was evaluated. FTIR and ^{1}H-NMR spectroscopies were performed for the structural elucidation of the modified inulin derivatives. The thermal studies were carried out by TGA and DSC which showed increased thermal stability for the inulin derivatives and the complex. Morphological studies of the inulin, modified inulin and complex were carried out by SEM. Release of folic acid from conjugates was performed in three mediums comprising of water, SGF and SIF. The amount of folic acid released was higher at higher pH i.e. the release was highest in water followed by simulated intestinal fluid and simulated gastric fluid. The present system could be considered as a good vehicle for the sustained release of an important nutrient, folic acid.

Chapter VI

Tosyl and amine derivatives of inulin and niacin-modified inulin conjugates were successfully synthesized. Inulin was first modified by tosylation and amination reactions and then niacin was conjugated to the aminated inulin derivative. FTIR and ^{1}H-NMR spectroscopies were performed for the structural elucidation of the modified inulin derivatives and the conjugates. The thermal studies were carried out by TGA and DSC which showed increased thermal stability for the inulin derivatives and the vitamin conjugate. Morphological studies of the inulin, modified inulin and conjugate were carried out by SEM. The release of niacin from the conjugate was studied by using UV-Visible spectroscopy. The release of niacin, from the matrices, at different pH was studied. The release was observed to be pH dependent, showing a greater release of the vitamin from the conjugate in water than in SIF and SGF. Natural polymer-based approach was used for the preparation of stable niacin-inulin conjugates with controllable and prolonged release of niacin. These types of conjugates may be useful as vitamin delivery systems for vitamin deficiency disorders.