IMMOBILIZATION OF BIOACTIVE COMPOUNDS IN AMPHOTERIC STARCH DERIVATIVES

M. Babelyte, R. Rutkaite
Department of Polymer Chemistry and Technology, Kaunas University of Technology, Radvilenu Rd. 19, Kaunas 50254, Lithuania
E-mail: migle.babelyte@ktu.edu

Introduction. Amphoteric starch contains both cationic and anionic groups in the same molecule. Cationic starch derivatives are starch ethers prepared by using tertiary amino or quaternary ammonium groups containing reagents. Meanwhile, anionic starches can be synthesized by introducing phosphate, phosphonate, sulfate, sulfonate or carboxyl groups into starch molecules. The introduction of both positively and negatively charged groups into starch may be realized by using several approaches: firstly anionization and thereafter cationization or firstly cationization and after that anionization (Fig. 1.).
Bioactive compounds such as caffeic acid and natural green coffee bean extract possess good antimicrobial and antioxidant properties. However, these compounds are unstable and quickly lose their beneficial properties. The biological activity of phenolic compounds could be preserved by the immobilization in amphoteric starch derivatives. Amphoteric starch derivatives have both positive and negative charge groups and could form complexes with negatively and positively charged compounds.
The aim of the present work was to prepare amphoteric hydroxyethyl starches (CHES/AHES) of different composition and investigate their interaction with caffeic acid (CA) and natural green coffee bean extract (GCBE).

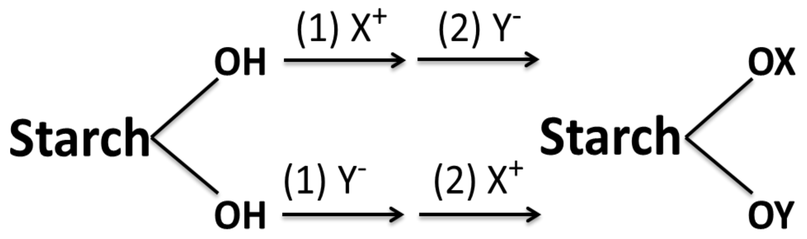

Fig. 1. Two–step mode for preparation of amphoteric starches*

Experimental results. Preparation of CHES/AHES has been achieved by using cationic and anionic modifying reagents by two - step reaction as demonstrated in the synthesis scheme in Fig. 2.

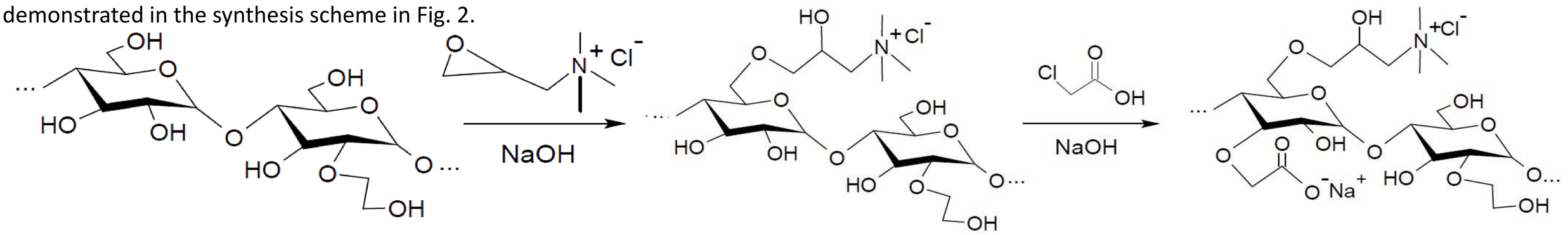

Fig. 2. Two–step synthesis scheme for preparation of amphoteric hydroxyethyl starch

Water soluble amphoteric hydroxyethyl starch derivatives ($CHES_{DS=0.29}/AHES_{DS=0.27}$ and $CHES_{DS=.,29}/AHES_{DS=0.55}$) can form polyelectrolyte complexes with cationic or anionic compounds due to the presence of anionic and cationic groups in the same molecule. The polyelectrolyte complex formation in water between water soluble amphoteric hydroxyethyl starches and components of GCBE have been investigated (Fig. 3). By changing concentration of amphoteric hydroxyethyl starch and GCBE in water the complex particles were obtained (Table 1) and characterized thereinafter.

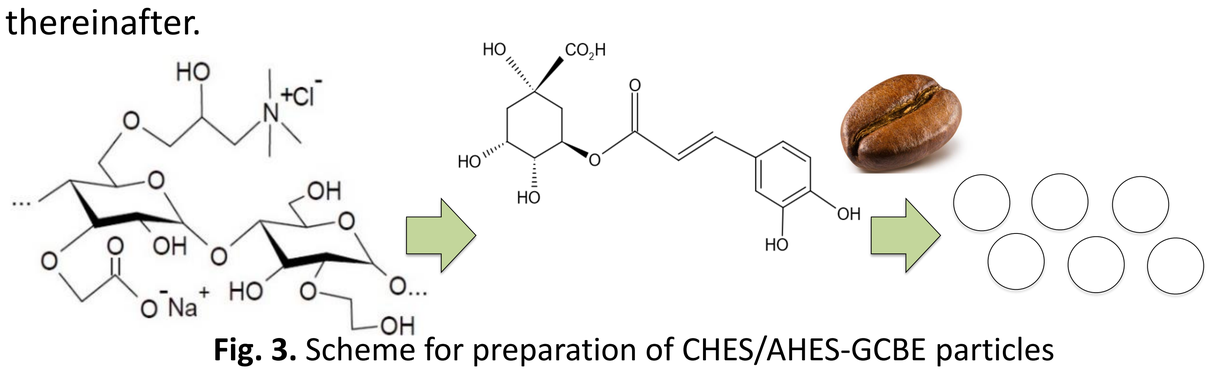

Fig. 3. Scheme for preparation of CHES/AHES-GCBE particles

Table 1. Preparation conditions, particle size and zeta potential characteristics of CHES/AHES-GCBE complex particles at pH=7

Sample	CHES/AHES g/L	GCBE g/L	Particle yield, %	Average particle diameter, nm	Zeta potential, mV
$CHES_{DS=0.29}/AHES_{DS=0.27}$-GCBE					
1	0.5	0.5	22.37	522.1±12.53	8.06±0.32
2	0.5	1	13.55	450.3±19.73	-2.21±0.21
3	0.5	2	12.44	225.3±7.20	-1.67±0.33
$CHES_{DS=0.29}/AHES_{DS=0.55}$-GCBE					
1	0.5	0.5	27.12	560.3±73.46	5.08±0.29
2	0.5	1	19.24	378.7±36.24	-3.82±0.23
3	0.5	2	14.65	358.1±12.99	-1.95±0.40

Water insoluble amphoteric hydroxyethyl starch derivatives ($CHES_{DS=0.58}/AHES_{DS=0.25}$ and $CHES_{DS=0.58}/AHES_{DS=0.57}$) were used for interaction with CA in adsorption processes. CA adsorption on amphoteric starch derivatives dependending on time demonstrated in Fig. 4.

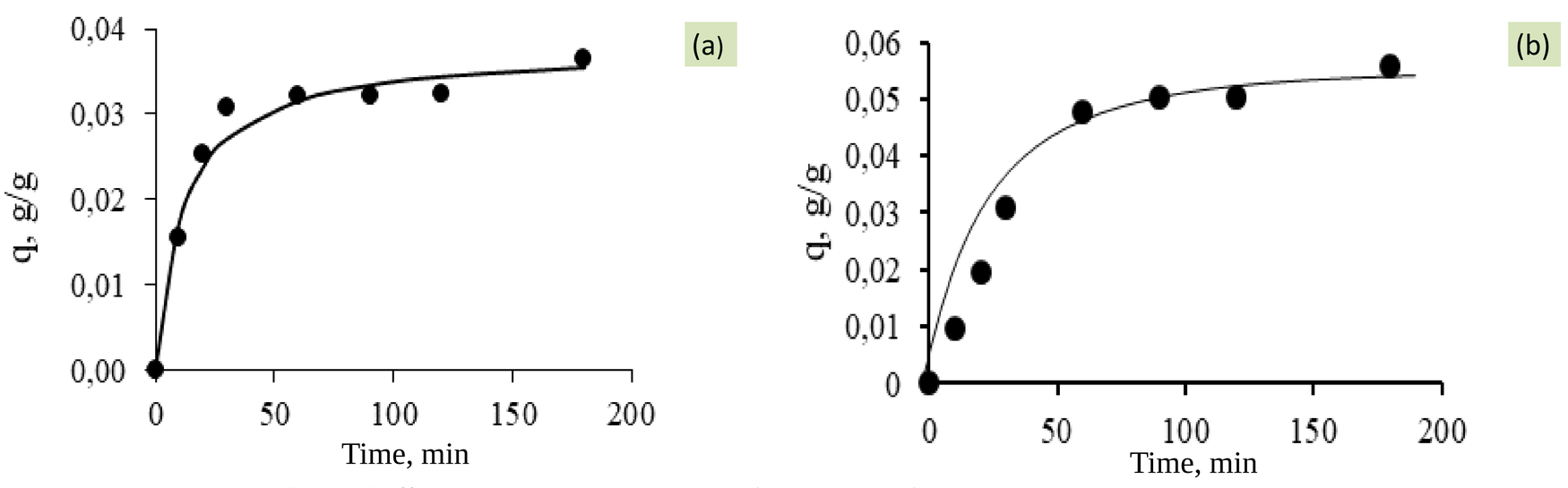

Fig. 4. Caffeic acid adsorption on amphoteric starch depending on time:
(a) - $CHES_{DS=0.58}/AHES_{DS=0.25}$; (b) - $CHES_{DS=0,58}/AHES_{DS=0.57}$.

*Zhang Min et al. A Review of Amphoteric Starches in Preparation and Applications.