СЕКЦИЯ «НОВЫЕ МАТЕРИАЛЫ И ТЕХНОЛОГИИ ИХ ОБРАБОТКИ»

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EDIBLE FOOD PACKING FILMS: CASTING SOLUTION AND FILMS PROPERTIES

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The effect of sodium alginate addition to starch solutions on the rheological properties of casting solutions and mechanical properties of films prepared from these solutions were investigated.

Currently the food industry observes a growing interest in the usage of edible food packaging films which should solve the problem of preserving food quality and ensuring the biological security. Although the era of biodegradable films, which can be destroyed directly inside the human body has not yet begun, the idea attracts attention in many countries, Belarus and China not being an exception. The joint research project "Research and Application of Degradable and Edible Food Packing Materials (films)" of the College of Biology and Environmental Engineering of the Zhejiang Shuren University from one side and Faculty of Chemistry and Research Institute for Physical and Chemical Problems of the Belarusian State University from the other side is a real example of fruitful Belarusian-Chinese cooperation in this field. Belarusian and Chinese students are involved in this project activity.

As a strategy of research it was decided that not only such film characteristics as tensile strength, elasticity, air, oil, moisture permeability and solubility have to be taken into account, since mechanical stability, antimicrobial properties and taste of the films are equally important.

For solving this problem it is needed to modify starch (that is the main polymer for food films production) with additives like other food polymers, antioxidants, vitamins. Such additives can give the packaging material new functions for example, improve taste qualities, give the film antimicrobial properties or the additive can be of medical use to cure or prevent sickness. The latter is of special interest. Thus, black pepper can be packed using a film containing turmeric (a plant component used as a spice), which in combination with black pepper helps prevent cancer.

Presently there are many polymers and possible additives that can be regarded to as feedstock for the production of such films. In the current research the effect of sodium alginate addition on the rheological properties of casting solutions and mechanical properties of films prepared from these solutions were investigated.

Starch is a biodegradable polymer with excellent biocompatibility and non-toxicity.

Starch granules are composed of two types of alphaglucan, amylose and amylopectin, which represent approximately 98–99% of the dry weight. The ratio of the two polysaccharides varies according to the botanical origin of the starch. The 'waxy' starches contain less than 15%amylose, 'normal' 20–35% and 'high' (amylo-) amylose starches greater than about 40%. The structure of the alpha-glucans is discussed below in more detail. The moisture content of air-equilibrated starches ranges from about 10–12% (cereal) to about 14–18% (some roots and tubers)

Starch is often compounded with other polymers or used alone in food industry. Sodium alginate, widely used for food purposes, was chosen as an additive for starch. Sodium alginate is a water soluble salt of alginic acid, a naturally occurring non-toxic polysaccharide found in all species of brown algae. It contains two uronic acids, (1-4)-linked β-D-mannuronic acid (M) and (1-4)-linked α-L-guluronic acid (G). It is composed of homopolymeric blocks M-M or G-G, and blocks with an alternative sequence of M-G blocks. Sodium alginate has a unique property of cross-linking in the presence of multivalent cations, such as calcium ions in aqueous media. As a result of cross-linking of admittedly G-G blocks the insoluble calcium alginate is formed.

There were following bodies of interest in the research: influence of polymers ratio and total concentration of two polymers in solution that generates the viscosity of solution, conditions of films casting (thickness of the solution layer), treatment (solutions or films) by calcium chloride as a cross-linking agent on the mechanical and barrier properties of produced films. The following ratio of polymers were used: starch: sodium alginate = 100:0; 98:2; 95:5; 90:10; 80:20; 70:30; 60:40; 50:50; 40:60; 30:70; 0:100.

Rheological measurement was carried out on the rheometer R/S Brookfield with a regime of constant share rate with the help of coaxial cylinders CC25 at 323 till 363 K.

Following conclusions have been made:

1. As follows from the rheological curves of 6% starch solution they can be describe by non-Newtonian behavior at all investigated temperatures. The calculation of the viscosity demonstrated the higher the temperature the lower the viscosity. The dependence of the viscosity from the reverse temperature is linear in the investigated temperature interval (figure 1). It allowed calculating the activation energy of viscous flow (enthalpy of activation of the viscous flow) (figure 2). The viscosity of the solutions contained starch and alginate grows with the increase of the sodium alginate content in the solution at all investigated temperature (figure 3).

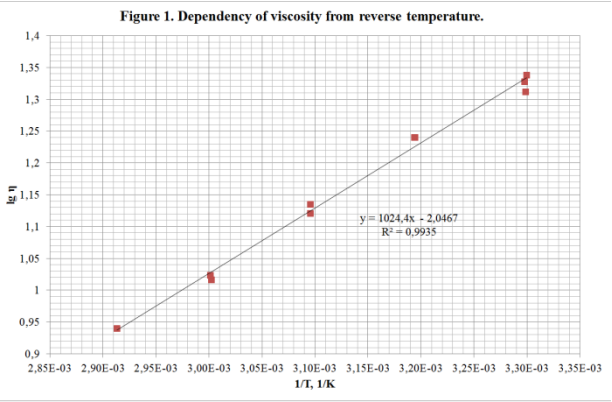

Fig. 1

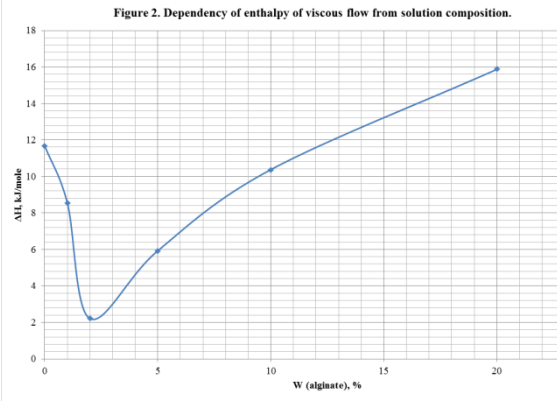

Fig. 2

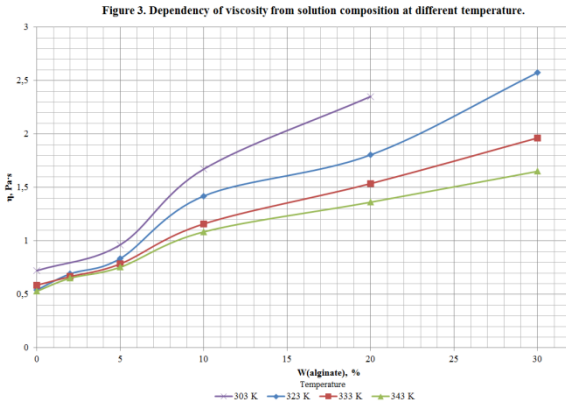

Fig. 3

2. Rheological properties of the solutions correlate with the mechanical properties of the films. For example, the increasing of the enthalpy of activation of the viscous flow characterizes the degree of the intensity of the intermolecular contacts in the solutions, in other words, the strength of the solution structure, namely, supermolecular structure. It has been found that the highest value of enthalpy of activation of the viscous flow at 50% sodium alginate content at the solution corresponds to the highest value of tensile strength (TS) of the film with the same ratio of polymers. The estimation of the rheological properties is important on the reason of their influence on casting ability of the solutions.

3. The utilization of calcium chloride solution as a precipitating bath at the wet-dry method resulted in the increasing of TS (in 50 and more percentages) and stability of the mechanical properties in the conditions at the increased temperature and humidity at storage. For example, TS for the film starch:sodium alginate =50:50 increased in 1,5 times after such treatment. The reason is the cross-linking of the admittedly G-G blocks (1-4)-linked α-L-guluronic acid when the insoluble calcium alginate is formed. The elasticity of the films meanwhile conserved. The cross-linking was approved by IR spectroscopy.