

IMPACT OF ENVIRONMENTAL FACTORS ON THE VISCOSITY OF STARCH SOLUTIONS

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Abstract: Use of starch in food products as a functional agent must be preceded by a precise determination of functional properties, solubility, dispersability, thermal stability, compatibility with other food components et al. Has been studied the influence of environmental factors (the mineral salts, pH, presens of sugars) on viscosity of gelatinizat starch solutions of maize, potatoes and soriz. It has been found that the presence of acids (acetic, lactic, citric, oxalic) in solutions increases degree of hydrolysis of the starch and decreases viscosity solutions. Adding salts ($NaCl$, KCl , $CaCl_2$) lead also to a gradual decrease in viscosity. This effect could be due to increase of the degree of polymerization of the starch macromolecules and the increasing mobility of the gelatinizat starch snippets. The sugars (sucrose, fructose, glucose), at relatively low concentrations (below 20 %) will behave like cosolvent plastifiant forms complex *starch-water-sugar* and, therefore, increase viscosity solutions of the gelatinizat starch.

Key words: starch, soryz, functional properties

1. Introduction

Starch is widely used in food industries and these applications depend on starch properties such as viscosity, swelling volume, solubility, clarity, etc. Starch is normally used along with other ingredients like salts, acids, sugars or other substances (surfactans, fats) and these are reported to modify the physicochemical properties of starch, and it may lead to understanding how to control the viscosity of starch products.

In present work were analyzed the effect of pH, sugars, and salt on viscosity of tree kind of starch: corn starch, potato starch and a new variety - soryz starch, on the other hand to analyze the impact of the concentration of these solutions on the gel starch. Among the different starches used by the industry, the corn and potato starch is very important in view of its easy extractability, high viscosity and paste clarity.

Sorghum *Oryzoidum* (soryz) is a variety of sorghum obtained in the Republic of Moldova that is remarkable for its high production and resistance to drought. Soryz grains are rich in starch (Dupouy et al, 2003).

2. Materials and methods

2.1 Materials

Corn starch - fine homogenous powder, white with yellow nuance, flavor specific for cereal starch, without strange smelt (GOST 7697-82).

Potato starch - white homogenous powder, cristalin, with a starch specific flavor, without strange smelt (GOST 7699-78).

Soryz starch - was extracted in the TUM laboratory from Soryz grains, Piscevoi-1 cultivar, 2011 harvest years, from Plant Protection Institut, Chisinau, Republic of Moldova.

Water distilled - GOST 6709-72, Acetic acid - GOST 19814, Citric acid - GOST 908-2004, Oxalic acid - GOST 22180-76, Lactic acid - GOST 490-2006, $CaCl_2$ - GOST

450-77, KCl - GOST 4234, NaCl - GOST 4233-77, Saccharose - GOST 21-94, Fructose - GOST 9111, Glucose - GOST 6038-79.

2.2 Methods

2.2.1 Determination of kinematic viscosity

The principle of method - determination of kinematic viscosity of transparent liquids with the aid of the glassy capillary viscometre of type OSTWALD.

Method of counting - kinematic viscosity of liquid is determined according to expression:

$$V = \frac{g}{9.807} \times T \times K, \quad (1)$$

K – viscosimetr constant, 0,03354 mm²/cm;

V – kinematic viscosity of liquid in seconds;

T – time of fall (flow) in seconds;

g – acceleration of free-fall in the place of measure, 9,8 m/s.

3. Results and discussion

Starch is used widely in the food industry in the main, to correct texture food by increasing their consistency, but in secondary mode, it also contributes to stabilize emulsions and suspensions, the control issue of flavorings, process control foaming. Added to food, starch disperse and/or dissolved in aqueous environment, by controlling its texture through the formation of viscous solutions and/or gels.

Presence of a starch in the diet reduces water mobility of that system and induces an increase in viscosity thanks to their molecular size large, specific configuration and the possibility to form ties into and intermoleculare. Viscosity of formed solution depends on several factors: characteristics of starch, temperature of the solution, the solution of any substances that may act as a opposing or greater synergies. In this work are presented results of the study influence on the starch viscosity solutions to food acids, sugars and mineral salts- characteristic components to a wide spectrum of food.

Using viscometer Ostwald has been studied reological behavior of the three samples of the starch: soriz, corn and potatoes. Measurements have been carried out in average food acids, sugars and mineral salts with the various concentrations.

3.1 Impact of food acids

For studies have been used next food acid: acetic acid, citric, lactic acid and oxalic in concentrations up to 0.25 mol/l.

In figures 1, 2, and 3 is shown dependence of viscosity gelatinizat starch solutions 1.0 % as a function of the concentration of acids.

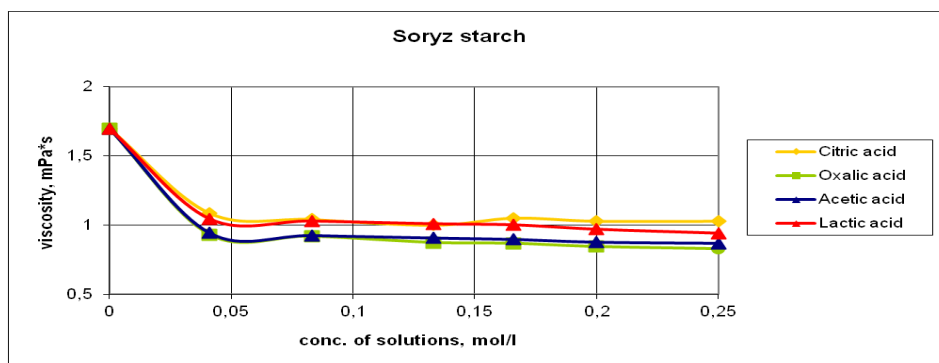


Fig. 1 Viscosity of soryz starch gels in solutions of acids

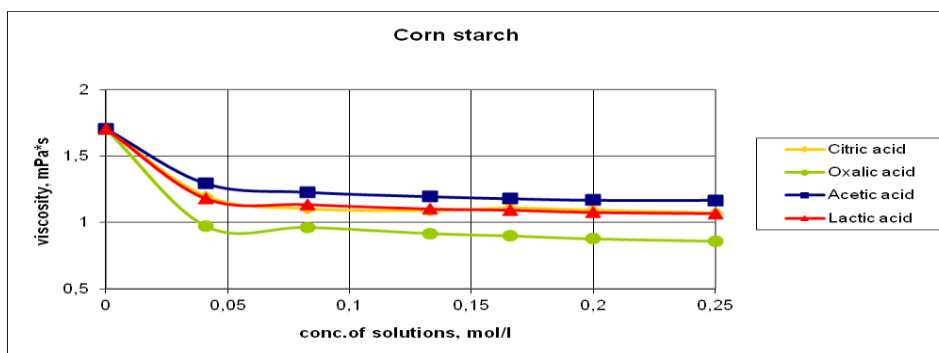


Fig. 2 Viscosity of corn starch gels in solutions of acids

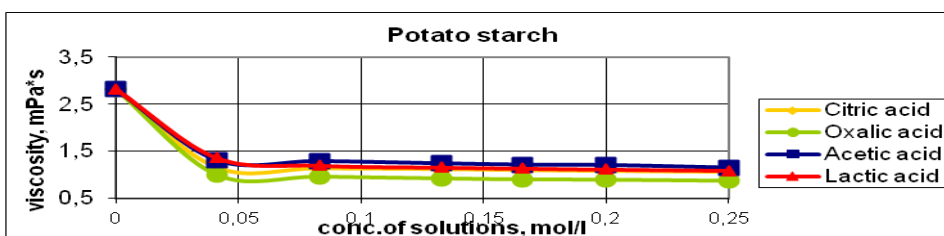


Fig. 3 Viscosity of potato starch gels in solutions of acids

It found that viscosity is a function of nature and the concentration of acid. With the increasing concentration of acids in the solution, the viscosity of solutions of starch decreases for all samples. Taking into account the fact that viscosity is a function of molecular weight of active agent, it can be assumed that the presence of acids causes further hydrolysis of the starch chains (reduced degree of polymerization) and viscosity solutions decreases. Comparing the values viscosity in different types of environments of acid shows that the decrease in viscosity is different and after viscosity fall in the value of a specific concentration of acid it form series: oxalic acid > lactic acid > acetic acid \approx citric acid. This series correspond to coefficient values of the dissociation of the acids (pK), which make up properly for each acid (25 °C): oxalic acid (is dibasic)- $pK_{A1} = 1,2$ and $pK_{A2} = 4,3$; the lactic acid- $pKa = 3,86$; acetic acid $pKa = 4,7$; citric acid $pKa = 4,8$. Therefore,

the degree of decline starch gel viscosity irrespective of the nature of starch is more pronounced for strong acids and less pronounced for weak acids.

3.2. 3.2. Impact of sugars.

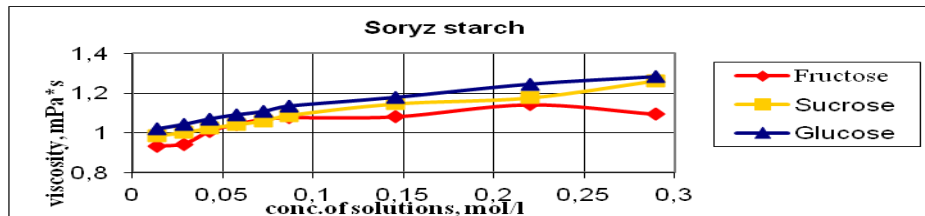


Fig. 4 Viscosity of soryz starch gels in solutions of sugars

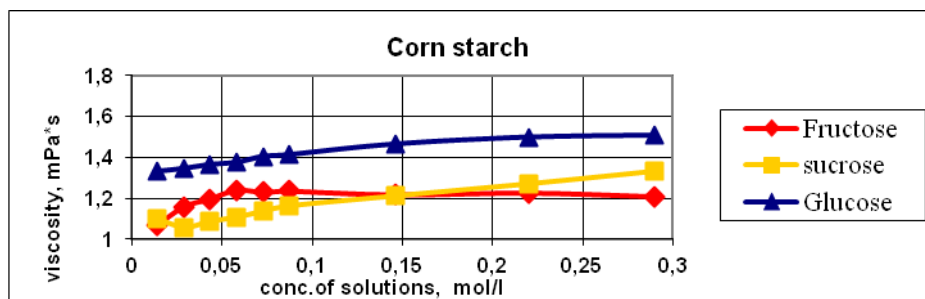


Fig. 5 Viscosity of corn starch gels in solutions of sugars

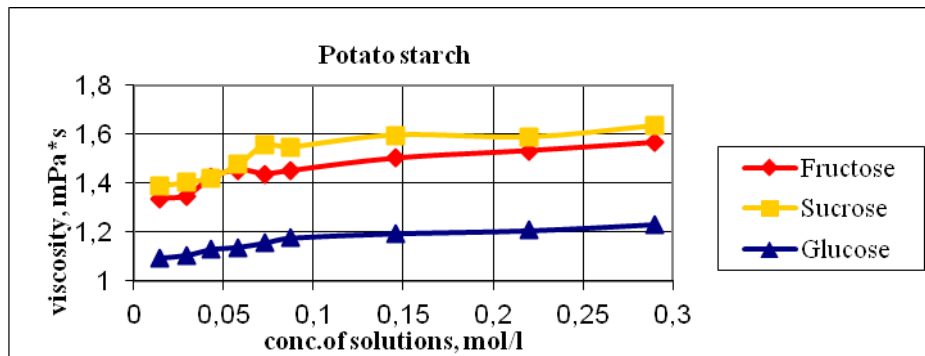


Fig. 6 Viscosity of potato starch gels in solutions of sugars

In figures 4,5,6 it is presented dependence of viscosity of gelatinizat starch solutions of 1.0 % as a function of the concentration sugars: sucrose, fructose and glucose. Results indicate that the presens of sugars increased viscosity of starch solutions.

Increase in viscosity of solutions of starch in the presence of sugars (up to 20 %) can be explained in the first place through the formation of leached between gelatinizat starch, sugars and water. The sugars (sucrose, fructose, glucose), at relatively low concentrations (below 20 %) will behave like cosolvent plastifiant forms complex starch-water-sugar and, therefore, increase viscosity solutions of the gelatinizat starch. At the higher concentrations

of sugars, they have a effect dehidratant, inhibit the process of hydration of the starch chains and thus reduced viscosity solutions.

3.3. Impact of salts.

Dependences of viscosity of gelatinizat starch solutions 1.0 % as a function of the concentration salts ($NaCl$, KCl , $CaCl_2$) is shown in figurile7,8,9.

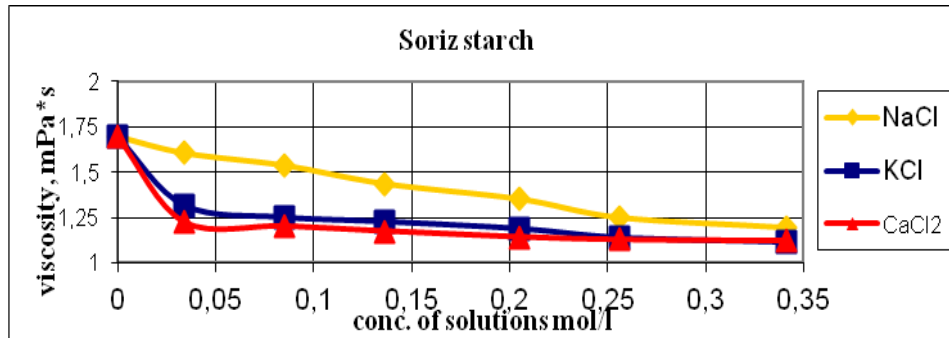


Fig. 7 Viscosity of soryz starch gels in solutions of salts

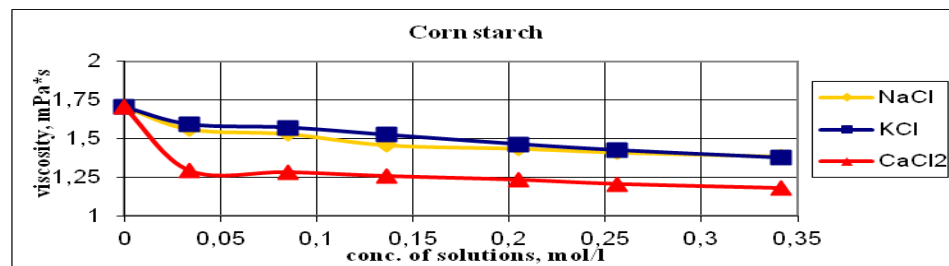


Fig. 8 Viscosity of corn starch gels in solutions of salts

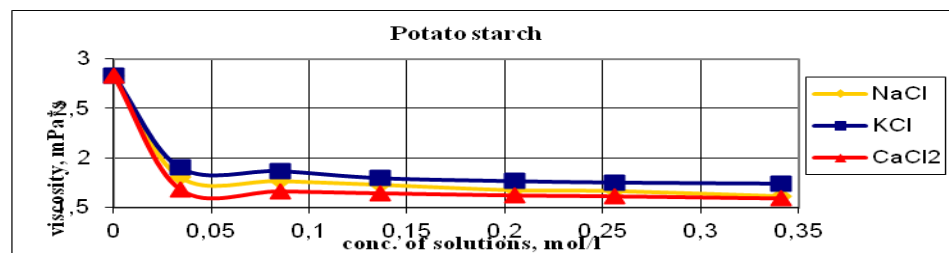


Fig. 9 Viscosity of potato starch gels in solutions of salts

Adding salts ($NaCl$, KCl , $CaCl_2$) runs, as well as in the case of acids, the gradual decrease in viscosity. This effect could be due to interaction salts with the chains of the gelatinizat starch and, therefore, the increase in mobility of the gelatinizat starch fragments (Bircan and Barringer) [2] and the decrease in viscosity of solutions. Comparing the values of the viscosity of gelatinizat starch solutions with salts show that the effect of salts is different and form following series: $CaCl_2 > NaCl > KCl$.

Conclusions

It has studied rheological behavior of the gelatinized starch solutions of soriz, corn and potatoes as a function of various concentrations of alimentary acids, salts and sugars. It has been found that the presence of acids (acetic, lactic, citric, oxalic) in solutions increases degree of hydrolysis of the starch and decreases viscosity solutions.

The addition of salts (*NaCl*, *KCl*, *CaCl₂*) lead to a gradual reduction of viscosity. This effect will be able because of the increase of the polymerization degree of the starch macromolecules and the increasing mobility of the gelatinized starch fragments.

Sugars (sucrose, fructose and glucose), in concentration relative reduced (up to 20 %) act as cosolvent plastifiant, by forming complexes starch-eau-sugar and it lead to increasing of the viscosity of the gel starch.

References

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