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Effect of Sodium Lauryl Sulphate on the Solubility and Viscosity Properties of Cassava Starch

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Surfactants and lipids are known to modify the swelling and rheological properties of starches. The action is due to complexation of the amylose fraction of the starch with the surfactant. The effect of 9 different concentrations of sodium lauryl sulphate (SLS) on the swelling, solubility and viscosity properties of cassava starch was studied. The peaks in swelling volume were found to be between 0.005 and 0.1 % of the surfactant. No breakdown effect was observed even when the complex was subjected to steam pressure treatments of 5, 10 and 15 psi, showing the stability of the complex. The solubility of starch was found to be influenced by different factors like concentration of surfactant, concentration of starch and temperature. The peak viscosity of starch remained almost same upto 0.05 % surfactant and then showed a noticeable increase upto 0.5 % and then declined to the control value. A second peak was observed during cooling.

Key Words: Sodium lauryl sulphate, Solubility, Viscosity, Cassava starch.

INTRODUCTION

The rheological properties of starch are influenced to a great extent by surfactants and lipids[1-4]. The swelling and solubility are found to increase when starch is treated with ionic surfactants as they destabilise the starch granules. The increased swelling and solubility could be attributed to the amylose extraction effect of the ionic surfactants because of the charged and highly hydrophilic head group[5,6]. The complex on the surface of the starch granules reduces stickiness by decreasing the available hydrogen bonds. The complex forming ability of amylose with monoglycerides and related monoacyl lipids are made use to increase the shelf life of bread and in extruded starch containing products to control texture[7,8]. Similarly, the stickiness of potato mash could be reduced by adding glyceryl mono stearate. Earlier study on the effect of different surfactants on cassava starch has shown that the different surfactants affect the rheological properties of starch differently. The present study was undertaken to examine the effect of the surfactant sodium lauryl sulphate (SLS) on the swelling, solubility and viscosity properties of cassava starch.

EXPERIMENTAL

Cassava starch for the experiment was extracted from H-1687 variety. The different concentrations of SLS (SISCO Laboratories) used are 0.0025, 0.005, 0.01, 0.025, 0.05, 0.1, 0.25, 0.5 and 1 %. For the swelling and solubility studies 0.5, 0.75, 1.0, 1.25, 1.5, 1.75 and 2 % starch suspensions in SLS solutions were examined at 65, 75, 85 and 95°C, 5 psi, 10 psi and 15 psi using standard methods.

A Brabender Viscometer was used for the viscosity studies. 5, 6 and 7 % starch suspensions in SLS solutions were taken in the sample cup and the viscometer adjusted for heating at the rate of 1.5º/min and the speed of rotation at 75 rpm. The peak viscosity (PV), viscosity at 95ºC (V95), viscosity during holding (Vhold), viscosity during cooling (Vcool) and Pasting Temperature (PT) were obtained from the Fig. 1.

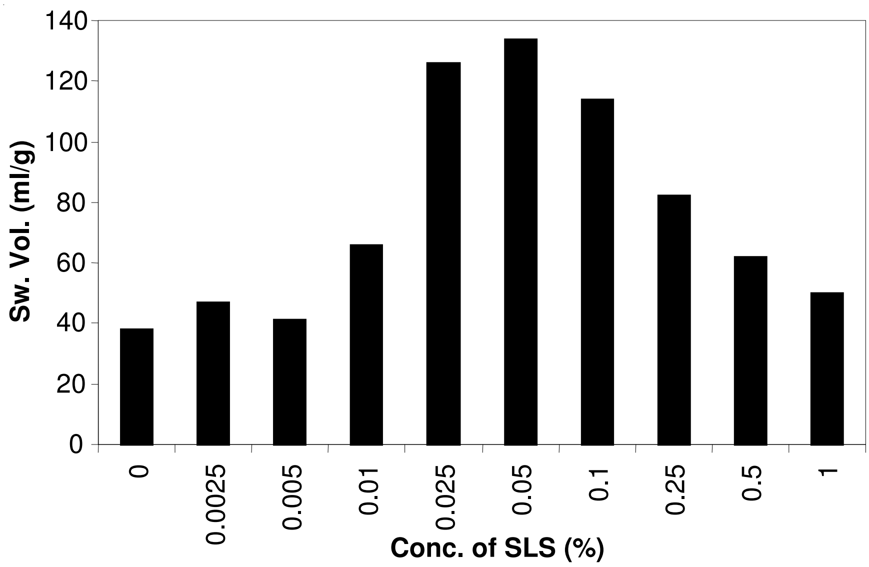

Fig. 1. Effect of SLS on the swelling volume of 0.5 % starch at 15 psi

RESULTS AND DISCUSSION

With increase in SLS concentration, an increase in swelling and solubility was observed upto a certain concentration and then declined (Tables 1 and 2). The most significant increase in swelling volume occurred at the lowest starch concentration used. The peak in swelling volume lay between 0.005 and 0.1 % of the surfactant (Fig. 1). As the temperature increased, there was a progressive increase in the swelling volume and solubility upto 95ºC and thereafter the increase was much less pronounced. Starch forms strong complexes with surfactants. There was no breakdown effect even when heated at 5, 10 and 15 psi showing the stability of the complex.

TABLE-1
SWELLING VOLUME (mL/g) OF STARCH TREATED WITH SLS AT 95ºC

SLS (%)	0.50st	0.75st	1.00st	1.25st	1.50st	1.75st	2.00st	Mean
0.0000	36.00	30.66	40.00	35.20	35.96	37.11	35.50	36.35
0.0025	50.00	43.32	41.50	39.20	38.63	36.26	36.75	40.81
0.0050	53.00	46.66	39.50	40.80	39.29	36.83	39.50	42.30
0.0100	66.00	51.99	47.00	40.80	40.63	37.97	38.65	46.72
0.0250	112.00	79.31	58.00	47.20	41.62	40.26	39.50	59.70
0.0500	103.00	96.64	81.00	64.00	51.95	44.54	39.00	68.60
0.1000	102.00	105.97	86.00	68.80	53.95	44.82	39.50	71.59
0.2500	76.00	78.65	77.00	68.80	56.94	50.82	44.25	64.64
0.5000	54.00	58.65	59.00	57.60	58.28	50.82	41.00	54.20
1.0000	44.00	44.66	53.00	56.80	53.28	47.96	42.50	48.90
Mean	69.66	64.05	58.21	51.93	47.45	42.74	39.62	–

TABLE-2
SOLUBILITY (%) OF STARCH TREATED WITH SLS AT 85ºC

SLS (%)	0.50st	0.75st	1.00st	1.25st	1.50st	1.75st	2.00st	Mean
0.0000	16.80	18.40	26.80	23.60	19.40	15.86	8.000	18.41
0.0025	19.50	22.00	20.47	38.16	32.00	15.43	9.800	22.48
0.0050	21.75	26.80	27.00	22.88	18.33	12.81	12.000	20.23
0.0100	15.64	19.68	33.34	15.76	12.55	8.47	4.450	15.70
0.0250	23.00	16.03	15.80	15.20	12.78	10.89	6.520	14.32
0.0500	15.40	10.60	8.05	6.12	4.80	3.73	4.025	7.54
0.1000	24.00	11.60	10.80	7.60	5.31	5.26	1.950	9.51
0.2500	30.75	8.13	1.60	6.08	7.00	0.68	0.875	9.93
0.5000	32.40	22.40	16.57	9.36	5.00	3.70	2.370	13.11
1.0000	31.20	24.93	19.60	8.32	11.00	1.54	3.540	14.31
Mean	23.05	18.05	19.44	15.31	12.82	7.84	5.360	–

The peak viscosity of starch remained almost same upto 0.05 % surfactant concentration and showed a noticeable increase upto 0.5 % and then declined. A second peak was observed during cooling and the gelatinization temperature increased with increase in SLS concentration (Fig. 2).

The interaction of starch with surfactants is a complex phenomenon in which a number of factors are playing important roles. The type of surfactant and the temperature influence the swelling of starch. The surfactants

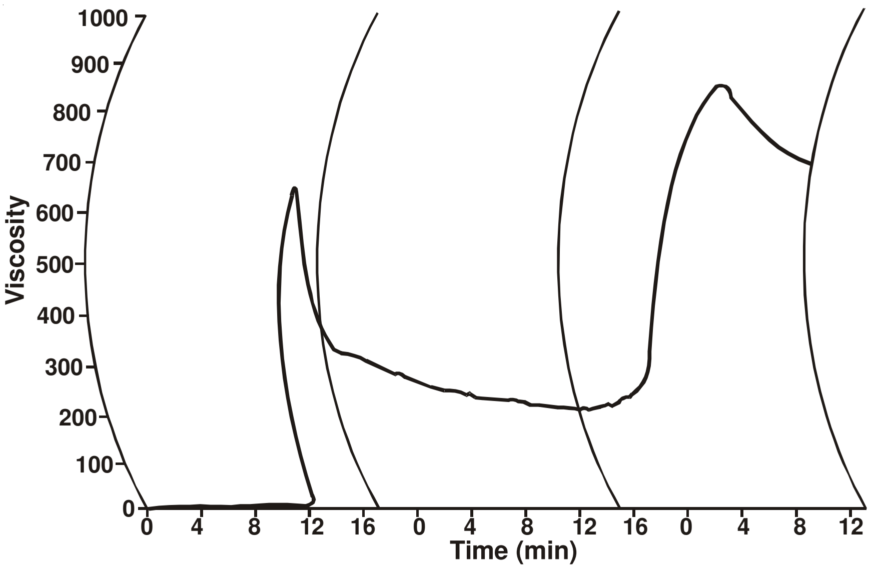

Fig. 2. Viscographic pattern of starch (6 %) in presence of sodium lauryl sulphate (1.0 %)

act by complexing either with the amylose portion or with the outer chains of the amylopectin molecules. It can also get adsorbed on the surface of the granule. It was reported that non-ionic surfactants like glyceryl monostearate, poly oxyethylene stearate, *etc.* inhibit the swelling of starch molecules[9-12]. The effect has been attributed to the formation of a fatty layer around the granules which hinders the penetration of water into the granules. The hydrophobic portion of the surfactant which fits into the helical portion of the starch granule restricts the easy entry of water molecules into the starch granules. This restricts the extent of swelling and delays gelatinization[13]. Gray and Schoch[14] showed that SLS suppressed the sediment weight and solubility of corn and potato starches below 85°C and the effect was reversed at higher temperatures. Collison and Elton[15] reported that SLS and CTAB drastically increased the swelling volume of wheat starch at 85°C.

The result in the present study show that in cassava starch, the effect of concentration of SLS was very significant. At lower concentrations, the increase in swelling volume may be attributed to the complexation of the surfactant with the more easily accessible outer chains of the amylopectin molecules. Since the swollen grains may be repelling each other due to electrostatic repulsion and also due to the bulky hydrophilic sulphate group an increase in swelling volume occurs. However as the concentration increases, most of the surfactants complex with the outer amylopectin chains as well as the amylose chains imparting restriction to the penetration of water leading to a decline in swelling volume. As the concentration of the starch increased, the above effect became less prominent because of the possible competition among the starch granule for the surfactant. Since the inter-molecular bonding is weakened during swelling, some of the molecules undergo fragmentation and leach out into the solvent medium, increasing the solubility. At 10 and 15 psi, the solubility were almost nil at high starch and surfactant concentrations due to strong complexation. Roach and Hoseney[16] studied the effect of surfactants on starch and found that surfactants affect starch properties differently depending on the nature of the surfactant. Moorthy[17] also found variability in the effect of surfactants on cassava starch. Evans[1] reported that surfactants modified the starch viscosity by complexing with the amylopectin in addition to the amylose and variation existed among different surfactants. The results show that starch properties can be modified conveniently to any desired levels by using surfactants at different concentrations. This property can be made use of in improving the functional properties of foods in which cassava starch has been incorporated.

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