International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 3383-3385

Received: 08-03-2018
Accepted: 14-04-2018

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Comparison of pasting properties of starch extracted from corn varieties

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Abstract
Maize is the third most important cereal crop and major source of energy and other nutrients for human and livestock in the world. Corn starch is a valuable ingredient in the food industry, being widely used as a thickener, gelling agent, bulking agent and water retention agent. In the present study starches extracted from corn varieties were analyzed for pasting characteristics to determine their potential applications in food system. Peak viscosity, trough viscosity, breakdown viscosity, final viscosity and setback viscosity of HQPM-1 and HQPM-7 starch were noted as 1344-1225cP, 716-779cP, 669-567cP, 1349-1326cP and 771-663cP, respectively. It is found that trough viscosity of HQPM-7 starch was significantly higher than HQPM-1 starch whereas peak viscosity, breakdown viscosity, final viscosity and setback viscosity of HQPM-1starch were higher than HQPM-7 starch.

Keywords: Comparison of pasting properties, livestock

Introduction
In the food industry, starch is utilized to produce various functionalities such as thickening, stabilizing, texturing, and gelling, encapsulation and self-life extension. It plays an important role in determining the quality and texture of many foods; controlling the acceptability and palatability of most food products. Corn is most important source of starch andin the United States, it is almost the sole industrial material for starch extraction. In the world the share of starch from corn is about 83 % (Kumar *et al.*, 2013) [5].The applications of starch in food systems are primarily governed by its gelatinization, pasting, solubility, swelling and digestibility properties. When starch granules are subjected to a certain amount of water and heat, they start to swell and this stage is called gelatinization (Hoseney, 1994) [4]. Not only, amount of the starch is the important for various functionalities in food products, but also the type of starch is critical (Biliaderis, 1991) [3] as the physicochemical properties of starches depend on the botanical source from which they are isolated (Sandhu *et al.* 2004) [10].
Thus the present investigation was carried out to compare the pasting properties of starch extracted from corn varieties HQPM-1 and HQPM-7.

Material and Methods
The experiment was conducted at Choudhary Charan Singh Haryana Agricultural University, Hisar during 2015-2016. High Quality Protein Maize varieties available at Regional Research Station, Uchani (Karnal) were procured. The grains were screened to remove defective grains and foreign matter and stored in sealed container at room temperature. Maize starch was extracted from maize grains using wet method.
Samples of HQPM starch were assessed for various pasting characteristics viz. Peak Viscosity, Peak time, Break down, Final viscosity, Set back and Pasting temperature using Rapid-Visco Analyzer, Newport Scientific Australia.
Twenty five ml of distilled water was weighed into a canister. 3.5 g sample was weighed and transferred in canister. Paddle was placed into the canister and jogged to disperse the sample. Paddle and canister was inserted into Rapid-Visco Analyzer (RVA) and wait for the command for pressing down the tower from the thermocline windows till the temperature of RVA reached50ºC. Pressed down the tower and wait till the test was run for 13 min. Canister was removed on completion of test. From Thermocline windows following observations were recorded:

Peak Viscosity
Maximum viscosity developed during or soon after the heating portion of the test.

Trough viscosity
Maximum viscosity after the peak, normally occurring around the commencement of sample cooling.

Peak time
Time taken at which peak viscosity occurred.

Pasting temperature
Temperature where viscosity first increases by at least 25 cP over a 20sec. period using the standard-1 profile.

Break down viscosities
Peak viscosity minus trough viscosity.

Final viscosity
Viscosity at the end of the test.

Set Back
Final viscosity minus trough viscosity.

Results and Discussion
The pasting curve represents changes in behaviour of paste viscosity of starch with change in temperature and mainly varies with composition and characteristics of starch. Increase in viscosity during heating may be attributed to the swelling of granules, as a result of loss of crystalline order and absorption of water (Bao and Bergman, 2004) [2].

Table 1: Pasting properties of starch extracted from HQPM-1 and HQPM-7

Sample	Peak Viscosity (cP)	Trough Viscosity (cP)	Breakdown Viscosity (cP)	Final Viscosity (cP)	Setback Viscosity (cP)	Peak time (min.)	Past. Temp. (ºC)	Gelatinization temp. (ºC)
HQPM varieties								
HQPM-1 starch	1344±16.38	716.3±3.75	669±10.11	1349±17.03	771.6±6.56	5.23±0.04	76.35±0.17	95.18±0.02
HQPM-7starch	1225±7.05	779.6±8.35	567.6±9.82	1326±5.81	663.6±4.90	6.04±0.02	75.11±0.04	95.16±0.03

Peak viscosity of starch extracted from HQPM-1 and 7 varieties was 1344 and 1225 cP, respectively (Table 1) which was comparable with the peak viscosity observed by Sandhu and Singh (2007) [11] for starch extracted from African Tall corn variety. Ali *et al.* (2016) [1] observed higher value (2849-2997 cP) of peak viscosity of starch extracted from different corn varieties than the peak viscosity observed in present study.The differences observed in the peak viscosities of the starch extracted from HQPM varieties may be attributed to different rates of water absorption and swelling of starch granules during heating (Ragaee and Abdel-Aal, 2006) [9].

Trough viscosity of starch extracted from HQPM-1 and 7 varieties was 716.33 and 779.66 cP, respectively (Table 1) which was comparable with the value (727 cP) of trough viscosity observed by Sandhu and Singh (2007) [11] for starch extracted from corn variety (Parbhat). Ali *et al.* (2016) [1] observed higher value (1286-1528 cP) of trough viscosity of starch of corn varieties than the viscosity observed in present study.

The degree of viscosity reduction during heating process is termed as breakdown viscosity and can be used as an indicator for pasting stability during heating and stirring (Oke*et al.* 2012 [7] and Zaidul*et al.* 2007) [13]. Breakdown viscosity of starch extracted from HQPM-1 and 7 varieties was 669 and 567.66 cP, respectively (Table 1) which was comparable with the value (590 cP) of breakdown viscosity of starch extracted from African Tall corn variety (Sandhu and Singh, 2007) [11]. Ali *et al.* (2016) [1] observed higher breakdown viscosity (1321-1711.5 cP) of starch extracted from corn varieties than the breakdown viscosity observed in present study.

Final viscosity of starch extracted from HQPM-1 and 7 varieties was 1349.66 and 1323.66 cP, respectively (Table 1) which was in the range of final viscosity (824-1388 cP) observed by Sandhu and Singh (2007) [11] for starch extracted from corn varieties. Ali *et al.,* (2016) [1] observed higher final viscosity (2434.5-2820.5 cP) of starch of corn varieties than the final viscosity observed in present study. The variations in the final viscosity may be due to the simple kinetic effect on cooling on viscosity and the association of starch molecules.

The stability of paste during cooling and storage is indicated by setback viscosity; *i.e.* the differences between final viscosity and trough viscosity. The higher setback viscosity indicates the higher tendency of amylose to retrograde (Zaidul *et al.* 2007) [13]. Setback viscosity of starch extracted from HQPM varieties ranged from 663.66-771.66 cP (Table 1) which was comparable with the setback viscosity (659 and 726 cP) observed by Sandhu and Singh (2007) [11] for Arican Tall and Vijay corn varieties, respectively. Radosavljevic (2006) [8] and Ali *et al.,* (2016) [1] observed higher value (750 BU and 1148.5-1292 cP) whereas, Li *et al.* (2014) [6] observed lower value (394 m-Pa-sec.) of setback viscosity of starch of corn varieties than the setback viscosity observed in present study.

Pasting temperature of starch extracted from HQPM varieties ranged from 75.11-76.35 ^{0}C, (Table 1) which was comparable with the pasting temperature (75.9-77.5 ^{0}C) observed by Sandhu and Singh (2007) [11] for different corn varieties. Li *et al.,* (2014) [6] and Ali *et al.* (2016) [1] observed lower pasting temperature (70.85 and 71.0-74.3 ^{0}C, respectively) of corn varieties than the values found in present study.High pasting temperature might be due to internal starch granule is tightly packed, swelling slows during heating, which, in turn, increases the pasting temperature (Yoon *et al.* 2009) [12].

Conclusion
Peak viscosity, trough viscosity, breakdown viscosity, final viscosity and setback viscosity of HQPM-1 and HQPM-7 starch were noted as 1344-1225cP, 716-779cP, 669-567cP, 1349-1326cP and 771-663cP, respectively. It is found that trough viscosity of HQPM-7 starch was significantly higher than HQPM-1 starch whereas peak viscosity, breakdown viscosity, final viscosity and setback viscosity of HQPM-1starch were higher than HQPM-7 starch.

Acknowledgement
The author is thankful to the Department of Food Science and

Technology for their support and courage during research work.

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