Effect of amino acids under various pH conditions on the pasting properties of rice starch

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A B S T R A C T

Previous studies have shown that amino acids can change functional properties of starches. This study was conducted to determine the effects of different pH treatments in combination with amino acids on rice starch pasting properties. Starch samples were prepared by adding amino acids (aspartic acid, leucine, lysine and tyrosine) at 6% starch dry weight basis to rice starch in buffers of pH 4, 7 and 10 (starch:buffer 1:2.5) and mixing for 1 min. Samples were then dried in an oven at 40ºC for 4 hr. Pasting properties were measured using an RVA. pH and amino acid treatments all decreased the paste viscosities compared to untreated control. For lysine-treated rice starch, peak, minimum and final viscosities decreased as the pH increased. At pH 10 the peak viscosity was 302+/-7 cP, while at pH 4 peak viscosity was 1554+/-50 cP for lysine-treated rice starch. Without amino acid, the peak viscosity for pH 4 treatment was 766+/-16 cP, but by adding amino acid some of the viscosity could be recovered. For all other samples, all paste viscosities were greater at pH 7 than pH 4 or 10. The three different pH treatments resulted in better cooking stability of rice starch even without amino acids, with the lowest breakdown at 78.5+/-3.5 cP for pH 7. This study showed that different pH treatments and the addition of amino acids in rice starch can be used to alter starch properties and stabilize the starch to retrogradation and cooking.

Introduction

- Starches are modified to improve shear and thermal stability, and control retrogradation potential (1).
- Charged amino acids can alter pasting of sweet potato (2) and rice starches (3).
- Lysine added to sweet potato starch made it more shear stable. Aspartic acid made sweet potato starch less shear stable but more stable to retrogradation (2).
- Lysine decreased viscosity and PTime of rice starch ozonated and native starch (4).
- Gelatinization of starch is influenced by pH, net charge and concentration of amino acids (5).

Objective

- To determine pasting properties of rice starch with added amino acids at various pHs.

Materials and Methods

Samples and Treatments

- Commercial rice starch (Sigma® S7260) was used as native starch control.
- Amino acids used were DL-aspartic acid (negative), DL-leucine (neutral), DL-lysine (positive) and DL-tyrosine (with hydroxyl group).
- Three pHs used were: pH 4 (potassium acid phthalate), 7 (phosphate) and 10 (carbonate).
- Treatment protocol included untreated native rice starch, starch treated with buffers without amino acid (NoAA), and starch treated with buffers and amino acid additives.

Sample Preparation

- Starch (15g) and amino acids (6% dwb) were dispersed in buffers at 1:2.5 wt/vol ratio, with mixing under magnetic stirrer.
- Suspension was dried in oven at 40ºC for ~4hr.

RESULTS

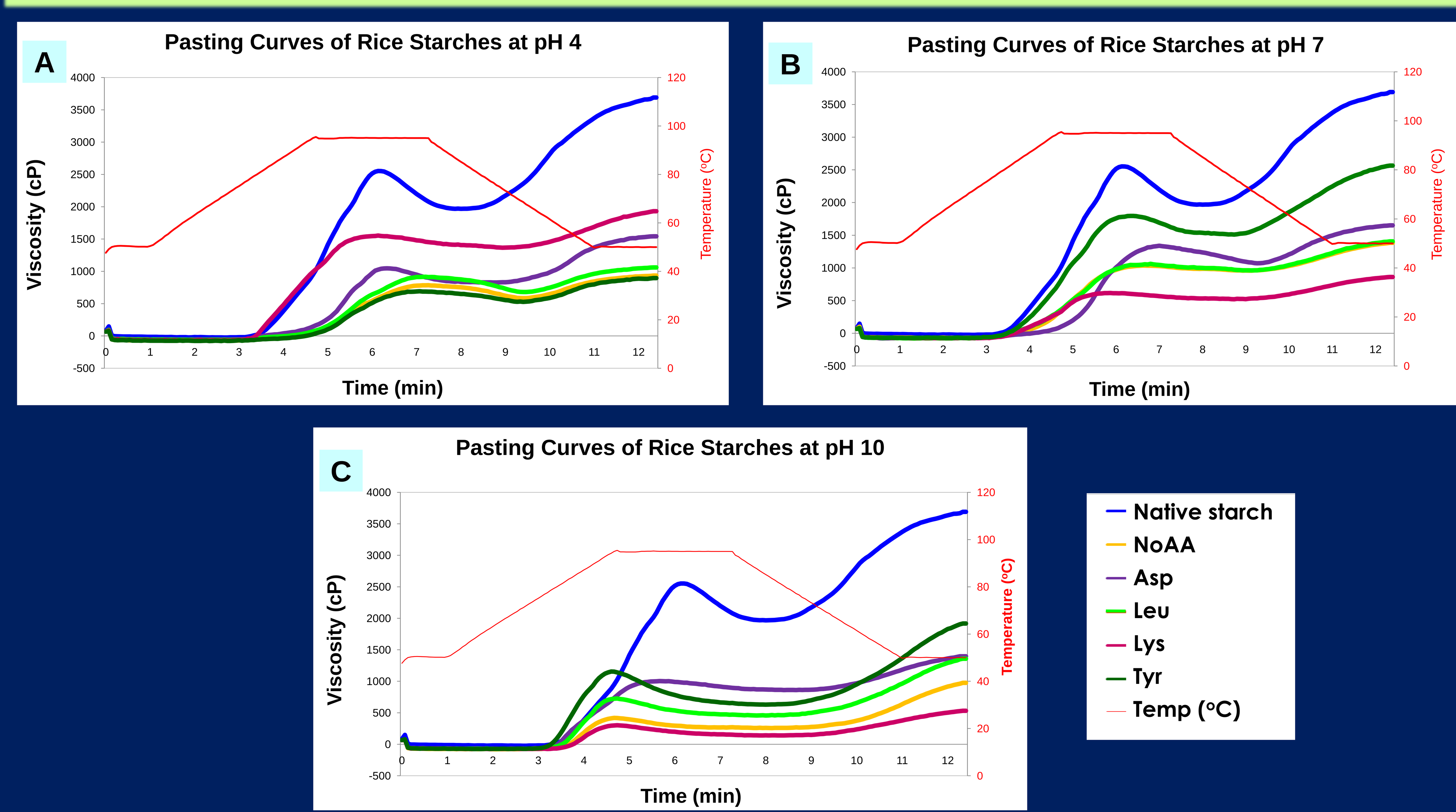

Table 1. Pasting parameters of rice starches with amino acid additives at different pH levels.

Additive	PV (cP)	MV (cP)	BD (cP)	FV (cP)	TSB (cP)	PTime (min)	PT (ºC)
Native starch	2,552.5 ± 19.1^{a}	1,967.5 ± 9.2^{a}	585.0 ± 9.9^{a}	3,690.0 ± 21.2^{a}	1,722.5 ± 12.0^{a}	6.3 ± 0.0^{def}	80.8 ± 0.0^{cde}
pH 4							
NoAA	766.5 ± 16.3^{fghi}	583.0 ± 14.1^{ef}	183.5 ± 2.1^{cdefg}	933.5 ± 17.7^{fghi}	350.5 ± 3.5^{h}	7.0 ± 0.0^{a}	94.8 ± 0.1^{a}
Asp	1,048.5 ± 43.1^{defg}	826.0 ± 38.2^{cde}	222.5 ± 4.9^{bcde}	1,542.5 ± 34.6^{cde}	716.5 ± 3.5^{de}	6.5 ± 0.0^{cde}	94.8 ± 0.2^{a}
Leu	949.5 ± 78.5^{efgh}	725.5 ± 43.1^{def}	224.0 ± 35.4^{bcde}	1,118.5 ± 95.5^{efgh}	941.0 ± 52.3^{fgh}	7.0 ± 0.0^{a}	94.9 ± 0.1^{a}
Lys	1,554.5 ± 50.2^{bc}	1,364.0 ± 42.4^{b}	190.5 ± 7.8^{bcdef}	1,930.5 ± 84.1^{c}	566.5 ± 41.7^{efg}	6.2 ± 0.1^{ef}	79.2 ± 0.0^{de}
Tyr	685.0 ± 31.1^{ghi}	524.5 ± 13.4^{fg}	160.5 ± 17.7^{defg}	894.5 ± 33.2^{ghi}	370.0 ± 19.8^{gh}	6.9 ± 0.0^{ab}	94.9 ± 0.0^{a}
pH 7							
NoAA	1,035.5 ± 2.1^{defg}	957.0 ± 1.4^{cd}	78.5 ± 3.5^{a}	1,383.5 ± 4.9^{def}	426.5 ± 3.5^{fgh}	6.8 ± 0.0^{abc}	91.5 ± 0.1^{ab}
Asp	1,327.5 ± 113.8^{cd}	1,070.0 ± 77.8^{c}	257.5 ± 36.1^{bcd}	1,651.0 ± 48.1^{cd}	581.0 ± 30.0^{de}	7.0 ± 0.0^{a}	94.9 ± 0.1^{a}
Leu	1114.5 ± 259.5^{def}	1,012.5 ± 224.2^{cd}	102.0 ± 35.4^{fg}	1,519.0 ± 336.6^{cde}	506.5 ± 112.4^{fgh}	6.6 ± 0.1^{bcd}	88.0 ± 7.8^{abcd}
Lys	619.5 ± 85.6^{hij}	519.5 ± 53.0^{fg}	100.0 ± 32.5^{fg}	862.0 ± 121.6^{hi}	342.5 ± 68.6^{h}	6.1 ± 0.2^{fg}	89.2 ± 5.0^{abc}
Tyr	1,796.5 ± 62.9^{b}	1,510.0 ± 56.6^{b}	286.5 ± 6.4^{bc}	2,564.0 ± 55.2^{b}	1,054.0 ± 1.4^{c}	6.6 ± 0.0^{cd}	81.6 ± 1.2^{cde}
pH 10							
NoAA	420.5 ± 2.1^{ij}	257.0 ± 2.8g^{h}	163.5 ± 0.7^{defg}	976.0 ± 24.0^{fghi}	719.0 ± 21.2^{de}	4.8 ± 0.0^{h}	83.6 ± 0.6^{bcde}
Asp	1,004.5 ± 101.1^{defg}	860.0 ± 86.3^{cde}	144.5 ± 14.8^{efg}	1,397.0 ± 111.7^{def}	537.0 ± 25.5^{efgh}	5.8 ± 0.0^{g}	80.0 ± 0.1^{cde}
Leu	756.0 ± 83.4^{fghi}	460.0 ± 48.1^{fg}	296.0 ± 35.4^{b}	1,353.5 ± 140.7^{defg}	893.5 ± 92.6^{cd}	4.8 ± 0.0^{h}	81.7 ± 0.1^{cde}
Lys	302.0 ± 7.1^{j}	138.5 ± 26.2^{h}	163.5 ± 19.1^{defg}	531.5 ± 46.0^{i}	393.0 ± 19.8^{fgh}	4.8 ± 0.0^{h}	84.3 ± 0.6^{bcde}
Tyr	1,155.0 ± 138.6^{de}	628.5 ± 72.8^{ef}	526.5 ± 65.8^{a}	1,916.5 ± 167.6^{c}	1,288.0 ± 94.8^{b}	4.8 ± 0.0^{h}	78.0 ± 0.5^{e}

Means with same letters in columns are not significantly different at $p \leq 0.05$.

RVA Method

- Pasting Properties Determination using the Rapid Visco Analyzer (RVA) (Newport Scientific Method 10 Version 4, December 1997)
- About 25ml of dH_2O was weighed and ~3.0g of starch sample was suspended into it.
- Starch suspension was held at 50ºC at a spindle speed of 960 rpm for 10sec, then speed was reduced to 160 rpm.
- Temperature was increased at 12ºC/min to 95ºC and held there for 2.5min. It was finally cooled to 50ºC.
- Pasting temperature (PT), peak viscosity (PV), minimum viscosity (MV), final viscosity (FV), and peak time (PTime) were determined. Breakdown (BD) was calculated as the difference between PV and MV, while total setback (TSB) was determined as the FV minus MV. Analysis was carried out in duplicates.

Findings and Conclusion

- Rice starch samples with amino acid at all pHs had higher resistance to swelling as shown by the decreased paste viscosities compared to control (Figures A-C).
- At pH 7 (Fig. B), lysine treated starch had the lowest PV with 17% of the BD of native sample. Tyrosine maintained the greatest viscosity with BD and TSB at 50 to 60% of the native starch at pH 7.
- One of the lowest TSB values was recorded for starch with added lysine at pH 7 (Table 1). This indicates that it may be the most stable to retrogradation among all samples.
- The pH treatments resulted in rice starch with better cooking stability with and without amino acids, as shown by the lower BD values than the native starch (Table 1).
- Alkaline conditions yielded faster cooking starch, as indicated by their PTime values (Table 1).
- Different pH treatments and addition of amino acids in rice starch can be used to alter starch properties and stabilize the starch to retrogradation and cooking.

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