In the present study, we modified the same three starches along with the five others: maize, wheat, tapioca, shoti, and rice starches in methanol and ethanol at 20 °C with 0.36% (w/v) HCl and their water solubilities were determined. The modifications were limited to these two alcohols to give the higher molecular sizes. The starches were solubilized by taking different amounts, 110, 220, 330, and 550 mg of starch, and autoclaving them in 10 mL of water.

Tables 3 and 4 show that the solubilities for the eight acid–alcohol treated starches are greatly increased over the solubilities of their native granules. Also increasing the amount of starting material gives significant increases from ~9 mg/mL, using 110 mg, to ~40 mg/mL, using 550 mg.

An unusual phenomenon was observed for the acid–methanol treated potato and shoti starches. At all amounts (110–550 mg) of these two modified starches, the amount of starch precipitated by the 4 vol of ethanol left a substantial amount (35% for 220 mg potato starch and 31.3% for 550 mg of shoti starch) that was not precipitated (see Table 3). Only these two starches showed this phenomenon and only for the acid–methanol treated starches. The two starches are known to be high in covalently linked phosphate.[16,17] Analysis for phosphate showed that it was primarily found in the starch that was not precipitated, 70.58% for potato starch and 77.93% for the shoti starch. Analysis of the supernatants from all of the other starches, both native starches and acid–alcohol treated starches, found only very low

**Table 3.** Solubilities of eight acid–methanol treated starches

| Starches[a] | Ppted[b] (mg/10 mL) | Supern[c] (mg/10 mL) | Totals[d] (mg/10 mL) | Insoluble[e] (mg) |
|---|---|---|---|---|
| *110 mg of starch in 10 mL solubilized by autoclaving* | | | | |
| Potato | 70.2 | 22.9 | 93.1 | 16.9 |
| Shoti | 65.0 | 27.1 | 92.1 | 17.9 |
| Tapioca | 87.5 | 1.5 | 89.0 | 21.0 |
| Waxy maize | 88.5 | 0.9 | 89.4 | 20.6 |
| Maize | 87.8 | 1.4 | 89.2 | 20.8 |
| Wheat | 80.8 | 0.6 | 81.4 | 28.6 |
| Amylomaize-7 | 41.8 | 1.1 | 42.9 | 67.1 |
| Rice | 92.3 | 1.0 | 93.3 | 16.7 |
| *220 mg of starch in 10 mL solubilized by autoclaving* | | | | |
| Potato | 117.4 | 62.0 | 179.4 | 40.6 |
| Shoti | 132.9 | 53.6 | 186.5 | 33.5 |
| Tapioca | 176.3 | 1.7 | 178.0 | 42.0 |
| Waxy maize | 190.5 | 1.7 | 192.2 | 27.8 |
| Maize | 149.6 | 1.0 | 150.6 | 69.4 |
| Wheat | 175.4 | 1.0 | 176.4 | 43.6 |
| Amylomaize-7 | 95.8 | 1.2 | 97.0 | 123.0 |
| Rice | 144.4 | 0.9 | 145.3 | 74.4 |
| *330 mg of starch in 10 mL solubilized by autoclaving* | | | | |
| Potato | 238.3 | 43.7 | 282.0 | 48.0 |
| Shoti | 206.1 | 72.1 | 278.2 | 51.8 |
| Tapioca | 272.0 | 1.0 | 273.0 | 57.0 |
| Waxy maize | 280.0 | 1.9 | 281.9 | 48.1 |
| Maize | 217.2 | 2.6 | 219.8 | 110.2 |
| Wheat | 216.3 | 1.3 | 219.6 | 112.4 |
| Amylomaize-7 | 130.0 | 0.9 | 130.9 | 199.1 |
| Rice | 257.8 | 2.3 | 260.1 | 69.9 |
| *550 mg of starch in 10 mL solubilized by autoclaving* | | | | |
| Potato | 401.2 | 74.4 | 475.6 | 74.4 |
| Shoti | 309.5 | 141.0 | 450.5 | 99.5 |
| Tapioca | 424.2 | 2.8 | 427.0 | 123.0 |
| Waxy maize | 472.6 | 2.1 | 474.7 | 75.3 |
| Maize | 376.0 | 2.3 | 478.3 | 171.7 |
| Wheat | 357.3 | 7.3 | 364.6 | 185.4 |
| Amylomaize-7 | 171.6 | 1.0 | 172.6 | 377.4 |
| Rice | 419.7 | 5.4 | 425.1 | 124.9 |

[a] Starches were suspended in 7 mL of water, autoclaved, diluted to 10 mL and centrifuged.
[b] After removing the starch by centrifugation that did not go into solution, the solubilized starch was precipitated with 4 vol of ethanol.
[c] The supernatants were concentrated to dryness and the solids were dried and weighed.
[d] mg/10 mL of solubilized starch.
[e] Amount of starch that did not dissolve after autoclaving.