

INFLUENCE OF HIGH VOLTAGE ELECTRICAL DISCHARGE AND PULSED ELECTRIC FIELD ON THE ACETYLATION OF ANNEALED POTATO STARCH

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Introduction

Starch is one of the most abundantly available, inexpensive, and biodegradable polymers, commonly used in the food, pharmaceutical, textile, biomass energy, and chemical industries. In order to achieve its optimal functional properties, it has to be modified, mainly by chemical processes. These processes are time-consuming and often requiring heating. The aim of this study was to investigate the effect of the application of high voltage electric discharge and pulsed electric field for the acetylation of annealed potato starch.

Materials and Methods

The annealed potato starch was acetylated with the addition of acetic anhydride (4, 6 and 8 % w/w starch), and modification without and in combination with high electric discharge or pulsed electric field was examined. Percent of acetylation and degree of substitution, swelling power and solubility index, the texture of starch gels and thermophysical properties were determined.

Results

Table 1. Percent of acetylation and degree of substitution of acetylated annealed potato starches

Sample	% Acetylation	Degree of substitution
Annealed potato starch + 4% AC	1.06 ± 0.05	0.040 ± 0.002
Annealed potato starch + 6% AC	1.53 ± 0.02	0.058 ± 0.001
Annealed potato starch + 8% AC	1.88 ± 0.02	0.071 ± 0.001
Annealed potato starch + 4% AC + HVED	0.94 ± 0.00	0.036 ± 0.000
Annealed potato starch + 6% AC + HVED	1.45 ± 0.04	0.055 ± 0.002
Annealed potato starch + 8% AC + HVED	1.76 ± 0.02	0.067 ± 0.001
Annealed potato starch + 4% AC + PEP	0.91 ± 0.02	0.034 ± 0.001
Annealed potato starch + 6% AC + PEP	1.26 ± 0.00	0.048 ± 0.000
Annealed potato starch + 8% AC + PEP	1.78 ± 0.05	0.067 ± 0.002

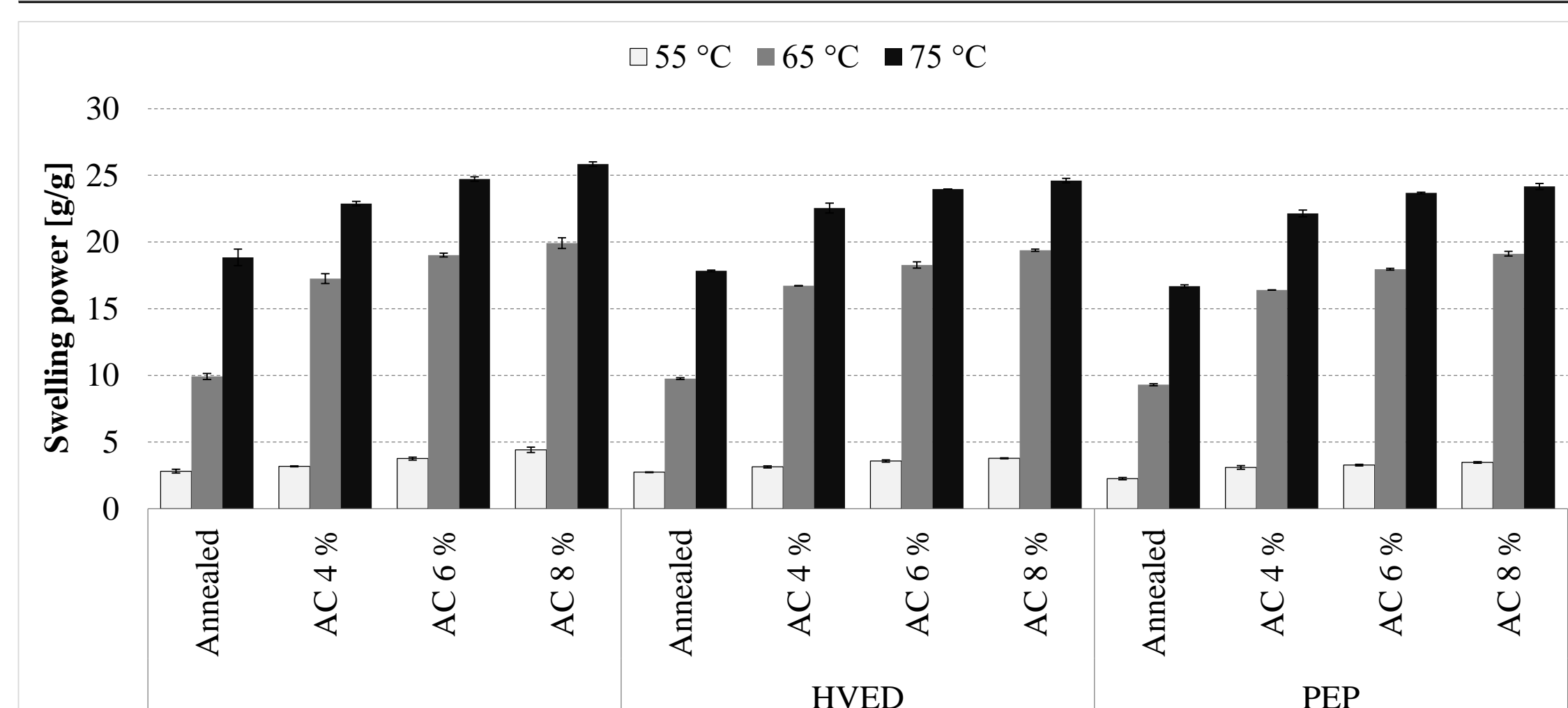


Figure 1. Swelling power of annealed and modified potato starches at different temperatures

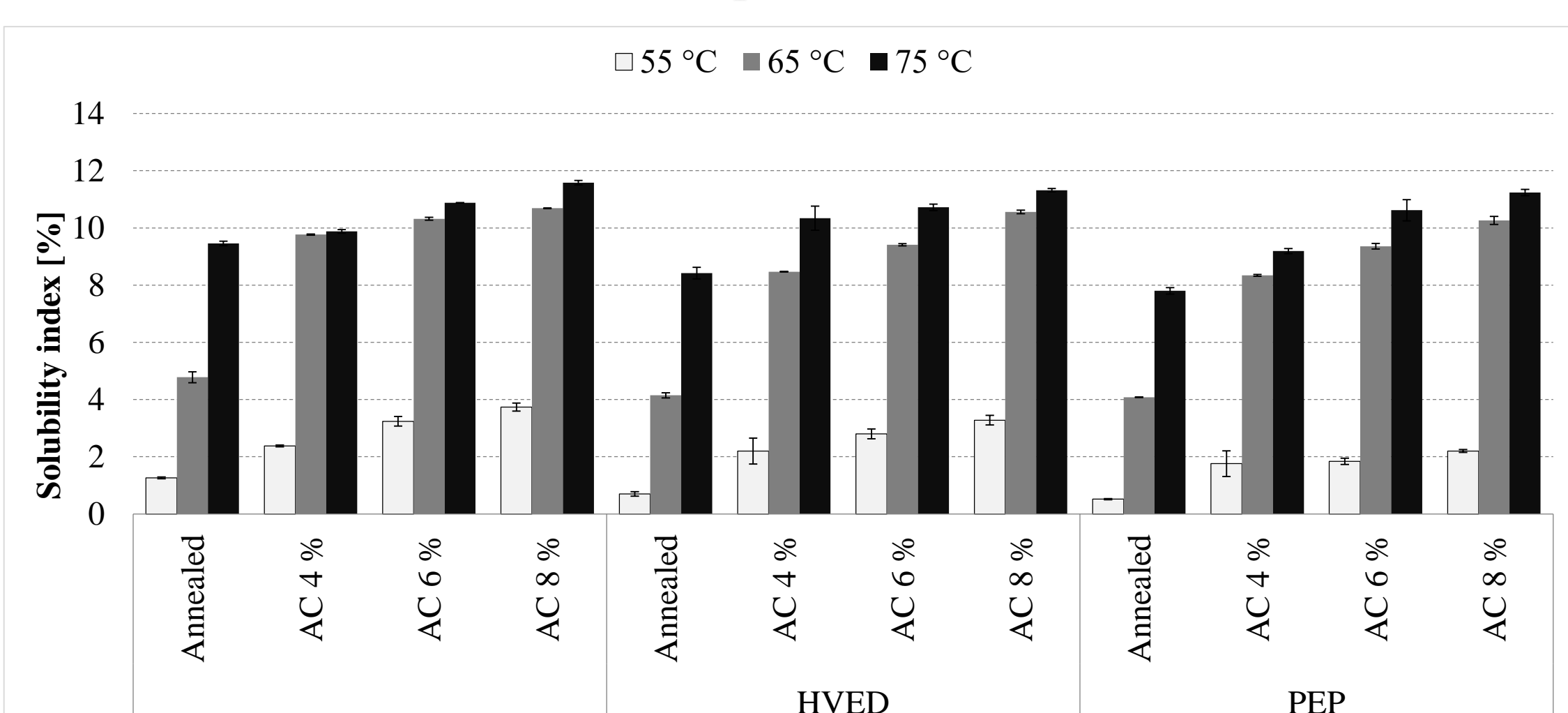


Figure 2. Solubility index of annealed and modified potato starches at different temperatures

Table 2. Gelatinization parameters of suspensions of annealed and acetylated potato starches

Sample	T ₀ (°C)	T _p (°C)	T _e (°C)	ΔH (J/g)
Annealed potato starch	70.60 ± 0.18	73.05 ± 0.10	77.87 ± 0.08	4.82 ± 0.25
Annealed potato starch + 4% AC	66.75 ± 0.03	70.39 ± 0.04	75.61 ± 0.39	4.43 ± 0.05
Annealed potato starch + 6% AC	65.32 ± 0.12	69.42 ± 0.18	75.21 ± 0.01	4.36 ± 0.40
Annealed potato starch + 8% AC	64.70 ± 0.46	68.84 ± 0.38	74.75 ± 0.53	4.24 ± 0.04
Annealed potato starch + HVED	69.78 ± 0.08	72.40 ± 0.11	77.41 ± 0.34	5.01 ± 0.08
Annealed potato starch + 4% AC + HVED	67.01 ± 0.11	70.47 ± 0.03	75.56 ± 0.11	4.66 ± 0.01
Annealed potato starch + 6% AC + HVED	65.27 ± 0.21	69.29 ± 0.17	74.74 ± 0.30	4.66 ± 0.43
Annealed potato starch + 8% AC + HVED	64.93 ± 0.54	69.13 ± 0.42	74.83 ± 0.52	4.46 ± 0.01
Annealed potato starch + PEP	69.75 ± 0.04	72.32 ± 0.09	77.27 ± 0.23	4.99 ± 0.13
Annealed potato starch + 4% AC + PEP	67.01 ± 0.23	70.36 ± 0.11	75.61 ± 0.20	4.72 ± 0.12
Annealed potato starch + 6% AC + PEP	66.19 ± 0.35	69.90 ± 0.23	75.01 ± 0.40	4.50 ± 0.06
Annealed potato starch + 8% AC + PEP	64.78 ± 0.02	69.04 ± 0.06	74.65 ± 0.05	4.26 ± 0.01

*Gelatinization parameters: T₀ - onset temperature; T_p - peak temperature; T_e - endset temperature; ΔH - gelatinization enthalpy

Table 3. Texture of starch gels of annealed and acetylated potato starches

Sample	Hardness [g]	Fracturability [g]	Adhesiveness [g sec]
Annealed potato starch	5.61 ± 0.11	584.88 ± 5.25	-204.28 ± 3.61
Annealed potato starch + 4% AC	4.64 ± 0.02	125.05 ± 2.33	-116.62 ± 2.66
Annealed potato starch + 6% AC	3.47 ± 0.04	105.23 ± 0.93	-100.85 ± 0.50
Annealed potato starch + 8% AC	2.93 ± 0.03	91.97 ± 0.08	-93.15 ± 4.47
Annealed potato starch + HVED	5.12 ± 0.10	532.83 ± 11.63	-196.29 ± 5.11
Annealed potato starch + 4% AC + HVED	4.30 ± 0.01	117.62 ± 6.46	-106.02 ± 1.11
Annealed potato starch + 6% AC + HVED	3.18 ± 0.09	107.27 ± 5.99	-95.30 ± 0.73
Annealed potato starch + 8% AC + HVED	2.67 ± 0.03	88.60 ± 2.16	-87.08 ± 0.55
Annealed potato starch + PEP	4.89 ± 0.05	516.77 ± 9.57	-187.18 ± 3.99
Annealed potato starch + 4% AC + PEP	3.81 ± 0.07	112.28 ± 7.78	-101.61 ± 2.70
Annealed potato starch + 6% AC + PEP	3.07 ± 0.01	94.78 ± 2.65	-92.74 ± 1.79
Annealed potato starch + 8% AC + PEP	2.57 ± 0.04	83.71 ± 4.28	-83.44 ± 0.64

Conclusion

The obtained results showed that in all modified annealed potato starches, percent of acetylation and degree of substitution increased proportionally to the concentration of acetic anhydride. With acetylation, the gelatinization temperature decreased, while swelling capacity and solubility index increased. The hardness, fracturability and adhesiveness of annealed starch gels were reduced by acetylation, and the effect was more pronounced when acetylation was combined with high voltage electric discharge or pulsed electric field compared to the classical acetylation procedure.