

Effects of Phosphate Salts on the pH Values and Rapid Visco Analyser (RVA) Pasting Parameters of Wheat Flour Suspensions

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ABSTRACT

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Changes in pH and pasting properties of instant-noodle formula dry-mix suspensions containing each of 12 phosphate salts were investigated. The pH values of solutions alone and then solution and flour suspensions decreased as the level of phosphate salts increased, except that of trisodium phosphate, which increased the pH value. The changes in the Rapid Visco Analyser (RVA) pasting parameters of instant-noodle formula suspensions were not consistent with the respective changes in pH, but the change trends of the RVA parameters for the two different wheat flours (hard red winter and soft white wheat) were similar. Five of the phosphate salts gradually increased the RVA peak viscosity (PV) as phosphate concentration increased. Seven other phosphate salts increased the PV at

0.05% and then decreased PV as the phosphate concentration increased. The change in trough viscosity owing to phosphate salt and concentration was similar to that of PV. The final viscosity (FV) gradually declined, to varying degrees, as the phosphate concentration increased for some of the phosphate salts. However, seven of the phosphate salts caused slight increases in FV as their concentrations increased. The response of starch gelatinization and pasting behavior, as measured by RVA, indicated that phosphate salts exert an influence on starch during heating in water. Because RVA parameters have been linked to instant-noodle processing and textural properties, phosphate salt identity and concentration can likely be manipulated to affect end-product quality.

Inorganic phosphates have been widely used in many food and industrial applications (Federal Register 1979; Molins 1991; Lampila and Godber 2002). Phosphate forms include ortho-, pyro-, poly-, cyclic, and miscellaneous phosphates. Depending on the form, in addition to leavening acid functionality, phosphates are used as buffering agents, sequestrants, dispersants, and water-holding agents in food and industrial applications. Phosphate is also an essential nutrient for the human body and can only be obtained from foods, because the human body cannot directly synthesize it in bioavailable form (Datta et al 1962).

As food safety becomes more of a concern, it is worth noting that the direct addition of inorganic phosphates to food, at current levels, is well below the acceptable daily intake of 70 mg/kg/day and hence is unlikely to cause adverse effects in humans in terms of acute, subchronic, and chronic toxicity, genotoxicity, teratogenicity, and reproductive toxicity (Weiner et al 2001). Phosphates are primarily utilized in cereal products as starch-phosphate ester products, leavening agents in baked goods, or quality improvers for certain types of noodles to enhance their texture, appearance, and flavor (Wu et al 2006; Tan et al 2009). Recently, Asian noodle manufacturers have become more interested in the use of phosphates as product and processing improvers, especially in instant noodles (Wang et al 2011a, 2011b). Phosphates or phosphate blends added into noodles can beneficially modify starch gelatinization during cooking or steaming, increase water retention in the noodle, function as a chelating agent in the dough system, modify the dough processing properties, and retard discoloration of fresh noodles (Fu 2008; Tan et al 2009). Further, Bean et al (1974) reported that 0.05–0.27% trisodium phosphate (TSP, flour weight basis) added to noodle formulations improved noodle dough processing properties, inhibited α -amylase activity, and reduced gluten solubility. Alkaline salts (sodium carbonate and potassium carbonate) are commonly used to alter noodle color and texture, but little is known about the influence of phosphate salts on some of these parameters, as well as on the formulation's pH.

Within the U.S. system, as codified by the Code of Federal Regulations (CFR) parts 182 and 184, food-grade phosphates fall into the generally recognized as safe (GRAS) category. Within the U.S. Department of Agriculture and the Food and Drug Administration systems in the United States, the use of phosphates in meat and poultry products is limited to 0.5% by weight of final product according to Title 9 CFR 424.21. Other than that, there is no limit on the usage level because they are identified as GRAS and are typically used according to good manufacturing practice (Federal Register 1979).

Eating quality of noodles has been related to the swelling and pasting properties of wheat starch, and the most convenient method to evaluate wheat flour for noodle quality was by using the viscoamylograph (Panozzo and McCormick 1993). More recently, the Rapid Visco Analyser (RVA, Perten Instruments, Springfield, IL) has offered an alternative to the viscoamylograph. The RVA produces information on gelatinization and retrogradation properties of flour and starch slurries, but it does so more rapidly and with a smaller sample than does the viscoamylograph. Derived from either instrument, the peak viscosity (PV) and the rate of viscosity breakdown (BD) after gelatinization can be used to predict the eating quality of Japanese white salted noodles and Chinese yellow alkaline noodles (Bhattacharya and Corke 1996). Similarly, RVA data can be used to predict the influence of phosphate salts on the end-product texture of Korean instant-fried noodles (Wang et al 2011b). It can be expected that alterations in noodle formulations, as measured by the RVA, will relate to noodle processing and textural attributes (Wang et al 2011a, 2011b).

Broadly, wheat flour and water blends are used for the manufacture of various noodle products, albeit at relatively low water content (about 33%) on a flour weight basis. To obtain desirable noodle product and processing qualities, wheat flour is often subjected to modification of endogenous pH. There is currently little information on the positive or negative influence of phosphates on RVA pasting properties of wheat flour (whether by alteration of pH or by direct action on the way in which starch gelatinizes) and, by extension, on noodle processing and eating qualities. In this study, the aim was to investigate pH and the RVA-derived pasting characteristics of flour and aqueous instant-noodle salt solution and different levels of phosphate salts.

MATERIALS AND METHODS

Untreated commercial hard red winter (HRW) and soft white (SW) wheat flour samples (one sample each; Table I) were pro-

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vided by Pendleton Flour Mills (Blackfoot, ID). Phosphate salts ($N = 12$) were provided by ICL Performance Products LP (St. Louis, MO) (Table II). These samples are representative of the basic materials likely to be used in commercial noodle production.

Flour moisture (method 44-19.01), ash (method 08-01.01), and protein content (method 46-30.01) were determined according to AACC International Approved Methods (AACCI 2010). Total starch content (% dry weight basis, dwb) was determined for each flour sample with an assay kit (Megazyme International, Bray, Ireland) based on AACCI Approved Method 76-13.01 (2010). Flour starch damage was determined following the amperometric method (AACCI Approved Method 76-33.01) with the SDmatic (Chopin, Villeneuve-La-Garenne, France).

Following a basic instant-noodle formulation described by Hou (2010), 1.5 g of NaCl, 0.1 g of K_2CO_3 , and 0.1 g of Na_2CO_3 were dissolved into 100 mL of deionized water, and the resulting solution was regarded as the base solution. Broadly, the pH values for the deionized water, the base solution, the base solution with each of the phosphate salts added, and the suspension of base solution/phosphate/flour were determined with a pH meter (Seven-Easy pH, Mettler-Toledo, Switzerland). More specifically, each of the 12 phosphate salts (0, 0.05, 0.1, 0.2, and 0.3%, based on flour weight) were respectively added to the base solution and completely mixed and dissolved. Flour (15 g, 14% mb) was added to 100 mL of the various solutions, the base solution/phosphate/flour slurry was completely mixed and settled for 10 minutes, and the pH value was determined (AACCI Approved Method 02-52.01).

Pasting properties were measured with an RVA-4 (Perten Instruments). A sample of 3.5 g of wheat flour (14% mb) was transferred into a canister, and 25 ± 0.1 mL of the base solution, with or without each phosphate salt, was respectively added (corrected to compensate for 14% mb). The slurry was then manually homogenized with the plastic paddle to avoid lump formation. A programmed heating and cooling cycle was set for 20 min (Batey et al 1997). The slurry was stirred at 960 rpm for 10 sec and then at 160 rpm for the remainder of the test. The slurry was held at 60°C for 4 min, heated to 95°C over 6 min, held at 95°C for 4 min, and finally cooled to 50°C over 6 min. PV (the maximum hot-paste viscosity), holding strength or trough viscosity (TV, the trough at the minimum hot-paste viscosity), and final viscosity

(FV, the viscosity at the end of the test after cooling to 50°C and holding at this temperature) were reported. The viscosities were expressed as Rapid Visco Units.

All measurements were performed at least in triplicate. Differences between means of data were compared by least significant difference with the Statistical Analysis System (SAS Institute, Cary, NC).

RESULTS

The protein, crude starch, moisture, and ash contents, falling number (FN), and starch damage (SD) of the two wheat flours used in the experiment are shown in Table I. The SD, protein, moisture, and ash contents of HRW were higher, and the crude starch and FN value were lower than those of SW. The greater SD in hard wheat is expected because of the greater energy used to mill the kernels into flour in response to the endosperm texture. Similarly, within the kernel, greater protein content invariably means reduced crude starch content.

pH Change in Solutions and Suspensions

The pH of deionized water determined was 6.40 ± 0.05 , but deionized water has no buffering capacity and so will change markedly with addition of any buffering agent. Thus, the addition of the base solution (sodium and potassium carbonates) resulted in a pH of 11.1. There were significant differences among the pH values of the base solutions or suspensions after different levels of phosphate salts were added (Fig. 1). Figure 1A shows that the pH value of solution containing TSP gradually increased with concentration. However, the pH of solutions containing sodium acid pyrophosphate (SAPP), monosodium phosphate (MSP), calcium acid pyrophosphate (CAPP), sodium potassium hexametaphosphate (SKMP), sodium trimetaphosphate anhydrous (STMP), sodium hexametaphosphate (SHMP), and sodium tripolyphosphate anhydrous (STPP) gradually decreased as their concentrations increased (Fig. 1). The order of pH decrease of solutions is $SAPP > MSP > CAPP > SKMP > STMP > SHMP > STPP$. The pH of solutions containing disodium phosphate (DSP), tetrasodium pyrophosphate (TSPP), dipotassium phosphate anhydrous (DKP), and tricalcium phosphate (TCP) all slightly decreased when compared

TABLE I
Compositional Characteristics of Two Wheat Flours^a

Sample	Protein (14% mb)	Crude Starch (% total flour, dwb)	Falling Number (14% mb)	Starch Damage (14% mb)	Moisture (%)	Ash (14% mb)
HRW	11.20 ± 0.12	77.48 ± 1.20	422 ± 15	4.40 ± 0.05	13.50 ± 0.12	0.57 ± 0.03
SW	9.49 ± 0.14	79.01 ± 1.51	433 ± 19	2.90 ± 0.05	11.81 ± 0.15	0.50 ± 0.02

^a HRW = hard red winter, and SW = soft white.

TABLE II
Composition of Phosphate Salts^a

Sample Name	Abbr.	Formula	1% Soln. pH	20% Slurry pH	P (%)	P ₂ O ₅ (%)	Na (%)	Solubility ^b	Grade ^c
Monosodium phosphate anhydrous	MSP	NaH ₂ PO ₄	4.4	4.8	25.8	59.2	19.1	48	FCC
Disodium phosphate anhydrous	DSP	Na ₂ HPO ₄	8.7	9.6	21.8	50	32.3	11	Food
Trisodium phosphate anhydrous	TSP	Na ₃ PO ₄	12.0	...	18.9	43.3	42.1	13	FCC
Sodium acid pyrophosphate	SAPP	Na ₂ H ₂ P ₂ O ₇	4.0	4.5	27.9	64	20.7	13	FCC
Tetrasodium pyrophosphate	TSPP	Na ₄ P ₂ O ₇	9.9	10.6	23.3	53.4	34.5	6	FCC
Sodium tripolyphosphate anhydrous	STPP	Na ₃ P ₃ O ₁₀	9.3	10.1	25.3	57.9	31.3	13	Food
Sodium trimetaphosphate anhydrous	STMP	(NaPO ₃) ₃	6.7	...	30.4	69.6	22.5	20	FCC
Sodium hexametaphosphate	SHMP	Na ₆ P ₆ O ₁₉	7.3	8.2	28	64.3	26.8	>60	FCC
Dipotassium phosphate anhydrous	DKP	K ₂ HPO ₄	9.0	9.5	17.8	40.7	0	62.9	FCC
Sodium potassium hexametaphosphate	SKMP	Na ₈ K ₈ P ₆ O ₁₉	5.0	8.0	26.2–27.1	60–62	5.0–8.0	30–50	Food
Tricalcium phosphate	TCP	Ca ₁₀ (OH) ₂ (PO ₄) ₆	7.3	...	18.5	42.5	0	Insoluble	FCC
Calcium acid pyrophosphate	CAPP	CaH ₂ P ₂ O ₇	3.5	...	28	64.1	0	Slight	Food

^a Provided by ICL Performance Products LP.

^b As g/100 g of saturated solution at 25°C.

^c FCC = Food Chemical Codex grade, and Food = components of product meet FCC grade.

with the control (base solution). These results weren't completely in agreement with the pH of phosphates at 1% solution or 20% slurry shown in Table II. The change in solution pH might be caused, under otherwise the same conditions, by the content of phosphorous, P_2O_5 , sodium in phosphates, and the differences of their solubility (Table II).

The pH change trends of two wheat flour-phosphate suspensions (Fig. 1B and 1C) were similar to those of base solution and

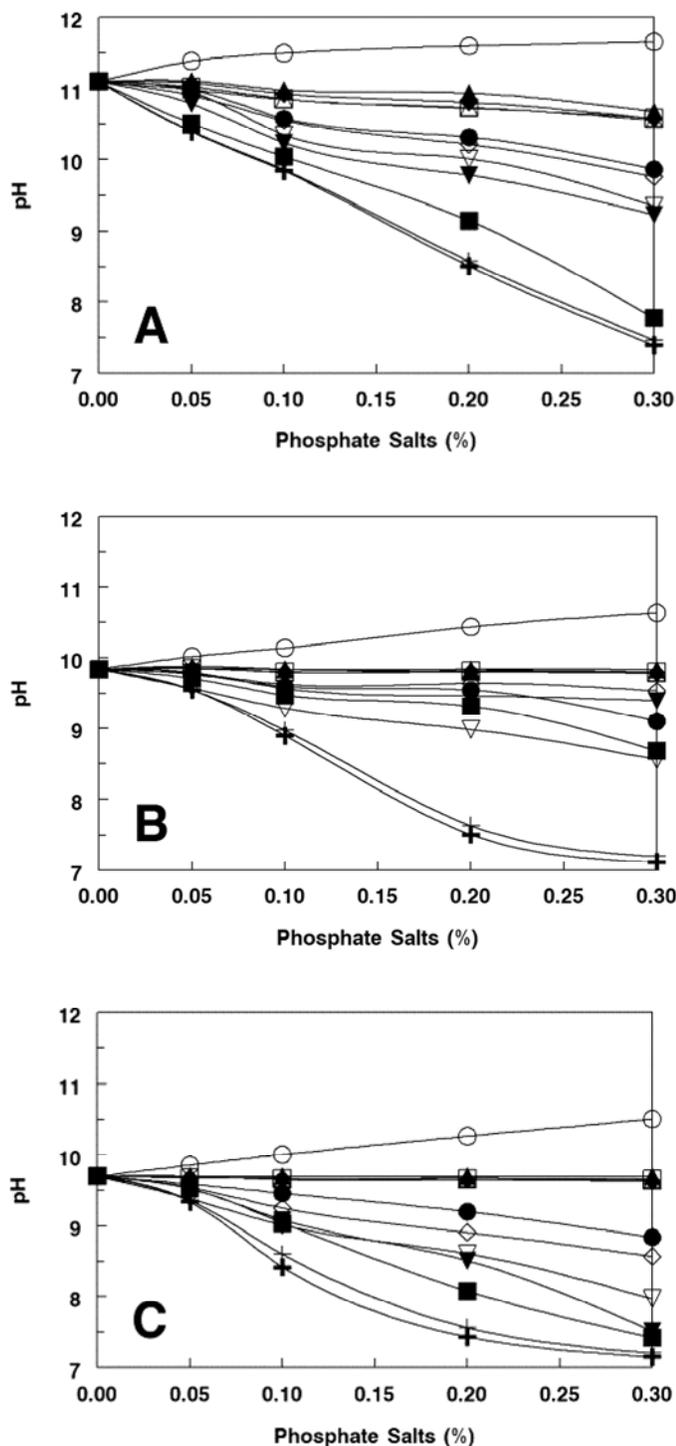


Fig. 1. Effect of phosphates on pH. Phosphate salts in (A) base solution, (B) hard wheat flour suspension, and (C) soft wheat flour suspension. + = MSP; \triangle = DSP; \circ = TSP; + = SAPP; \blacktriangle = TSPP; \bullet = STPP; ∇ = STMP; \diamond = SHMP; \square = DKP; \blacktriangledown = SKMP; \blacklozenge = TCP; and \blacksquare = CAPP. Full chemical names are listed in Table II.

exhibited a better linear relationship ($R^2 > 0.98$), except that the linear relationship of the samples with MSP and SAPP was R^2 of 0.95 and 0.96 in Figure 1B and R^2 of 0.93 and 0.96 in Figure 1C. The pH-versus-concentration curves for MSP and SAPP appeared more suited to sigmoidal curve analysis than to linear analysis; thus, the R^2 values are underreported through strictly linear analysis.

Compared with the pH of the base solutions with phosphate salts, the pH values of the corresponding wheat flour suspensions with phosphates were lower. It is probable that the solution was diluted, and phosphates were to some extent absorbed or sequestered by starch granules or polymers in wheat flour, which then caused the pH value to be reduced. Further, wheat flour had its own intrinsic buffering capacity, so the resulting slurry had a reported pH value somewhere between those of the base solution and the flour alone. In addition, the pH values of samples with DSP, TSPP, DKP, and TCP observed were hardly changed after HRW and SW were supplemented. However, among the 12 phosphates tested, TSP continued to demonstrate not only the highest pH but also a pH that again rose slowly across the concentration increase of the TSP. As with the base solution alone, MSP and SAPP had the lowest and declining pH levels as their respective concentrations increased. Bean et al (1974) found that TSP gradually increased the pH of noodle dough as concentrations increased from 0.05 to 0.27%, but no other investigations have reported pH change of wheat flour suspension involving other sources of phosphates.

Pasting Properties of Hard Wheat Flour with Phosphate Salts

Figure 2 shows the PV, TV, and FV of HRW at 0–0.3% phosphates in suspensions. The PV values of pasting with DSP, TSPP, STMP, DKP, and TCP increased slightly as their concentrations increased (Fig. 2A). Most of the increase in PV occurred with the first 0.1% addition of phosphate salts and then leveled off. The PV values with MSP, TSP, and CAPP initially increased with phosphate salt addition from 0 to 0.1% but then decreased back to about the PV of the system without phosphate salts. The maximum PV values with SAPP, STPP, SHMP, and SKMP occurred at about 0.05% and then decreased as concentrations increased. Ragaee and Abdel-Aal (2006) found that high PV was related to the degree of swelling of the starch granules during heating. It implies that there was an optimal level of phosphates that promoted the swelling of starch granules in wheat flour during initial heating.

During the hold period of the test, TV (the rate and extent of the reduction from PV) depends on temperature, the degree of mixing, mechanical shear stress, and the characteristics of the solution. Essentially, low TV values demonstrate resistance to breakdown (Morris et al 1997; Newport Scientific 1998). Figure 2B shows that TV values for MSP, DSP, TSP, SAPP, TSPP, STMP, SHMP, DKP, SKMP, and TCP exhibited similar behavior to that of their respective PVs. The maximum TV was at 0.1% for MSP and at 0.2% for SAPP. The TV with CAPP initially increased at 0.05% and then gradually decreased as the concentration of the CAPP salt increased.

BD is regarded as paste stability, as it is caused by the degree of disintegration of starch granules. It is calculated following the equation $BD = PV - TV$ (previous data shown in Fig. 2A and 2B). At breakdown, the swollen granules are further disrupted, and amylose molecules leach from the granules into the solution (Newport Scientific 1998). The BD value observed was directly negatively correlated with the TV for the same sample. Because the BD value was calculated as $PV - TV$, this finding made mathematical sense. The maximum BD value of HRW with phosphates was found for DSP, STMP, DKP, and TCP at 0.05%; for TSP, TSPP, STPP, SHMP, and SKMP at 0.1%; and for MSP, SAPP, and CAPP at 0.3% (data not shown but can be calculated from existing data if needed).

FV indicates the ability of wheat flour to form a viscous paste or gel after heating and cooling. FV values are shown in Figure

2C. FV of HRW with TSPP, STPP, and SHMP decreased as the phosphate salt concentration increased. The FV value of HRW with DSP, DKP, TSP, and SAPP increased with increasing phosphate salt concentration beyond 0.10%. At low levels, some phosphate salts led to mild increase or decrease in FV values. The FV value of HRW with MSP increased from 0 to 0.1% and then significantly decreased. Conversely, the FV value for HRW with SKMP decreased until 0.20%, after which concentration it increased significantly.

Zaidul et al (2003) reported that setback values (SB) reflect the retrogradation tendency and reordering of starch molecules, which are reflected in increased minimum viscosity upon cooling. SB is calculated following the equation $SB = FV - PV$. TSP gradually increased the SB value as the phosphate salt concentration increased, but the SB values of HRW supplemented with DSP, TSPP, STPP, STMP, SHMP, SKMP, and TCP gradually decreased as their concentrations increased. Pasting with MSP and SAPP showed that SB value was decreased at 0–0.05% and then was

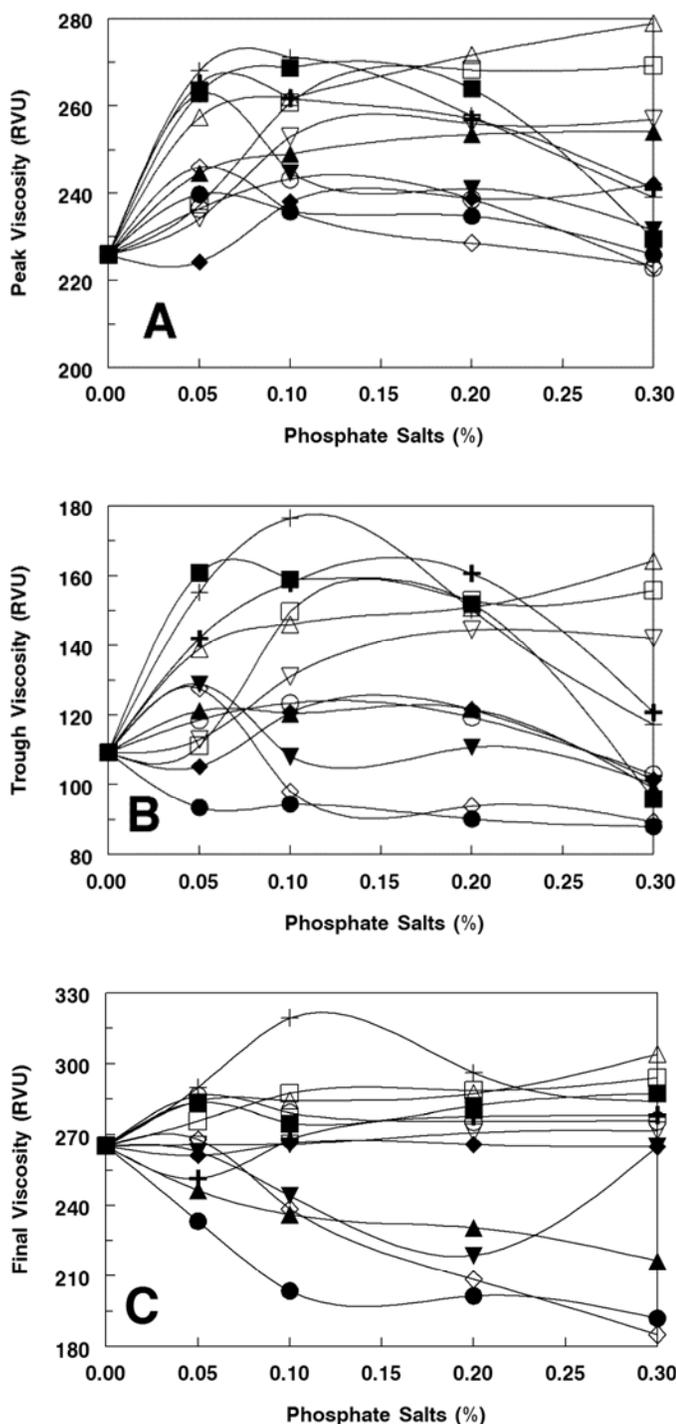


Fig. 2. Rapid Visco Analyser pasting curve results for hard wheat flour with inclusion of different phosphate salts at different concentrations. **A**, Peak viscosity. **B**, Trough viscosity. **C**, Final viscosity. + = MSP; Δ = DSP; ○ = TSP; + = SAPP; ▲ = TSPP; ● = STPP; ▽ = STMP; ◇ = SHMP; □ = DKP; ▼ = SKMP; ◆ = TCP; and ■ = CAPP. Full chemical names are listed in Table II.

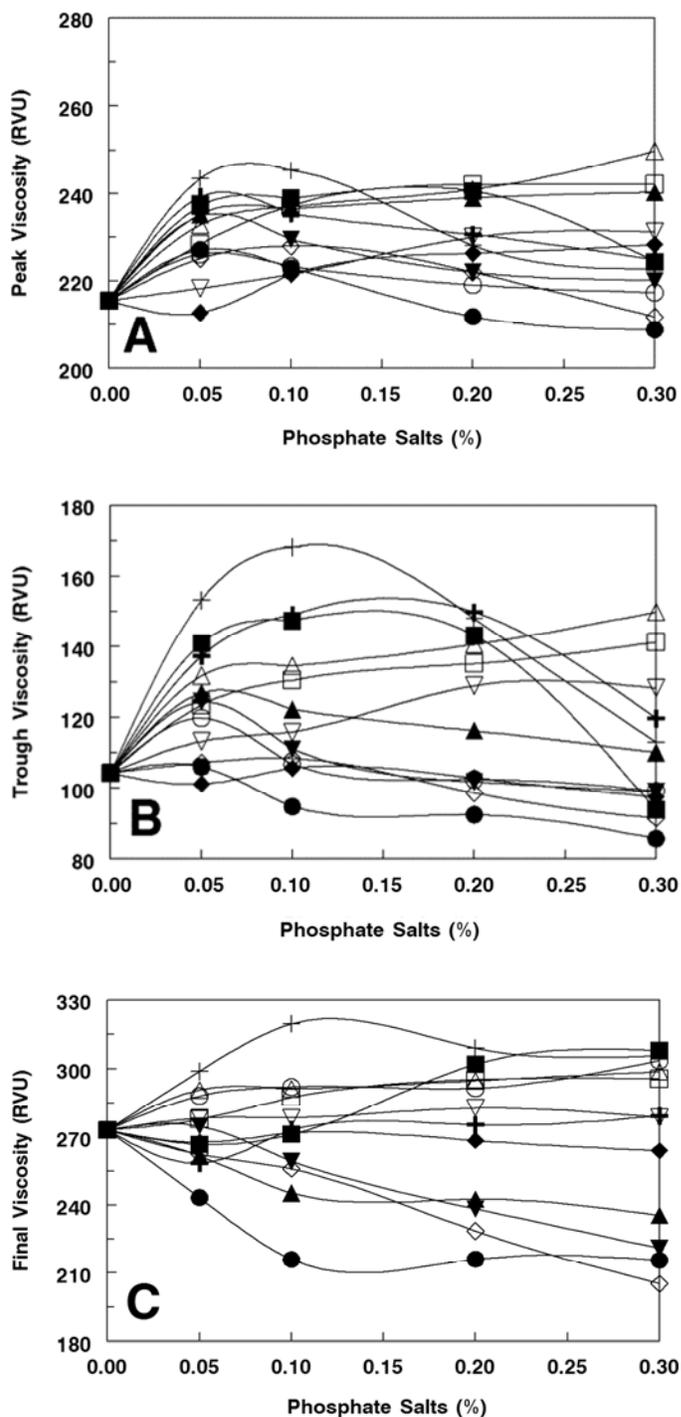


Fig. 3. Rapid Visco Analyser pasting curve results for soft wheat flour with inclusion of different phosphate salts at different concentrations. **A**, Peak viscosity. **B**, Trough viscosity. **C**, Final viscosity. + = MSP; Δ = DSP; ○ = TSP; + = SAPP; ▲ = TSPP; ● = STPP; ▽ = STMP; ◇ = SHMP; □ = DKP; ▼ = SKMP; ◆ = TCP; and ■ = CAPP. Full chemical names are listed in Table II.

increased at 0.1–0.3%. SB value for DKP increased as its concentration increased from 0 to 0.05% and then subsequently decreased. In the case of CAPP, SB value decreased at 0–0.1% and then dramatically increased as concentrations increased from 0.2 to 0.3% (data not shown but can be calculated from existing data if needed).

The changes in peak time (data not shown) were similar to those of PV and were directly positively correlated with PV for the same sample. These results suggest that the property differences among phosphates ought to be considered when phosphates are applied in wheat flour products.

Pasting Properties of Soft Wheat Flour with Phosphates

Under the same conditions, the RVA parameters of SW as a function of phosphate salts are shown in Figure 3. The respective curve shapes for PV, TV, and FV of SW were similar to those of HRW with the corresponding phosphates. This result indicated that the phosphates added to different wheat flour suspensions had similar influences on RVA values. However, PV, TV, and BD values for SW with phosphates were lower than those of the corresponding values for HRW with phosphates. Conversely, FV and SB values were higher when compared with the corresponding values of HRW. Multiple potential causes for the differences between the RVA parameters of the two wheat flours exist. It has been reported that lower amylose content is associated with higher PV (Zaidul et al 2007). Additionally, differences in the protein composition in wheat flours could also affect pasting viscosity and properties (Batey and Curtin 2000). Zaidul et al (2003, 2004, 2007) found that a higher protein content significantly increased PV and BD values. Lin and Czuchajowska (1998) observed that although several soft wheat starches had similar amylose and amylopectin fine structure, they differed significantly in PV, BD, FV, and SB values. However, Ragaee and Abdel-Aal (2006) reported that hard wheat flour exhibited much higher values of PV, TV, and FV than did soft wheat flour. This result is not consistent with this investigation. It is probable that the RVA parameters are also influenced by enzymatic and mechanical starch damage, protein content, and the solution used as a medium, in addition to the content and properties of starch in wheat flour.

DISCUSSION

Addition of 12 phosphate salts affected differently the RVA parameters of instant-noodle formula suspensions. Further, the changes in the patterns of RVA parameters when flour was added to the mixtures were not consistent with those of pH in base solutions. Compared with the base solution control, DSP, TSPP, STMP, DKP, and TCP enhanced the PV value as the phosphate concentrations increased. The maximum PV of the suspensions occurred at 0.05% for TSP, SAPP, STPP, and SKMP, at 0.1% for MSP and SHMP, and at 0.2% for CAPP. The change in TV was similar to that of PV. During heating at 95°C, STPP exhibited the greatest effect on the BD value, and MSP, SAPP, and CAPP caused dramatic changes in the BD value as the phosphate salt concentration changed, whereas other phosphate salts did not cause significant changes in BD value. The FV of suspensions containing each of DSP, TSP, STMP, SAPP, DKP, and CAPP gradually increased as their concentrations increased, and the FV of suspensions containing each of STPP, TSPP, SHMP, and SKMP decreased with added phosphate salt concentration, but the effect of TCP on FV value was less than that of the other salts. The maximum FV for MSP occurred at 0.1%.

The SB values of instant-noodle formula suspensions containing added phosphates were smaller than that of the control as the addition level increased, except that TSP increased the SB value at all concentrations, and the SB values of suspensions with 0.3% MSP, SAPP, and CAPP were higher than that of the control. These

results implied that phosphates may inhibit the starch retrogradation for most phosphate salts, except for TSP.

Phosphates including ortho- and pyrophosphate are used as acidifying agents in many food processes. DeMan and Melnychyn (1970) indicated that all phosphates exhibit chemical structures in which each phosphorus atom is more-or-less tetrahedrally surrounded by four oxygen atoms, and when they are used in the food industry, the rate of hydrolysis of the polyphosphates is very slow in neutral and alkaline solution. In addition, the ortho- and pyrophosphate anions are good buffering agents for three pH ranges of 2–3, 5.5–7.5, and 10–12. This buffering propensity was a reason why the change in pH of base solutions and suspensions including DSP, TSPP, STPP, and SHMP was not large as the concentration of the phosphate salts increased. For TCP and CAPP, Crutchfield and Irani (1965) found that the precipitate formed in the presence of carbonate was not calcium carbonate but a more-soluble mixed carbonate–polyphosphate. Sand and Sodano (1971) investigated the effects of 1 and 5% SHMP, TSPP, STPP, and MSP on the viscosity of aqueous solutions of guar gum, Arabic gum, xanthan gum, carboxymethylcellulose, and κ -carrageenan, and they observed that 5% phosphate was not effective and that 1% phosphate caused an increase in viscosity. Similar tests with sodium alginate solutions indicated that 1% SHMP reduced viscosity.

Whistler and Daniel (1985) thought that phosphates could be used to increase the charge of linear and branched polysaccharides to promote extension and expansion of molecules, respectively, and hence to increase the viscosity of solutions. Apparently, the effect of phosphates on polysaccharides depends on the type of phosphate and the concentrations used in direct or indirect modification of carbohydrate characteristics and behavior. Hirashima et al (2005) reported that the viscosity of cornstarch paste was increased by lowering the pH from 5.5 to 3.6, whereas the viscosity of samples with pH below 3.5 decreased.

The proteins in wheat flour suspension were denatured and the protein polymers extended during the RVA heating process. Molins (1991) reported that phosphates studied, such as meta-, pyro-, tripoly-, trimeta-, tetrameta-, and hexametaphosphates at concentrations between 0.1 and 5%, were used to precipitate proteins by binding to positively charged groups within polypeptides at acidic pH values. Molins determined that SKMP and STMP were the most effective at effecting the precipitation of denatured proteins. The addition of phosphates promoted or hindered protein gel formation depending on the type and concentration of phosphates used. Long-chain phosphates were strong chelators of divalent cations, such as calcium. Short-chain phosphates, like ortho- and pyrophosphates, were only weak chelators, and they enhanced polypeptide cross-linking, or protein gelation, if the pH value was appropriate. In particular, isoelectric points may also represent an important factor in suspension viscosity.

Recent research (Wang et al 2011a, 2011b) has shown that some phosphate salts have an effect on instant-noodle formulations and that RVA parameters of instant-noodle formula dry mix and its finished noodle products are successful indicators of noodle texture after processing. It is therefore useful to study the impact of individual phosphate salts on pasting properties of flour starch, knowing that selected concentrations and types of phosphate salts will translate directly to modification in end-use attributes of instant-noodle formulations.

CONCLUSIONS

The changes in pH of base solution and two wheat flour suspensions (HRW and SW wheat flour) were similar and exhibited linear relationships as phosphate levels increased. Two wheat flour suspensions exhibited similar pasting properties after the addition of phosphates. It is probable that the reactions among the endogenous components of wheat flour and the different phos-

phate salts were a combination of complex interactions during heating and cooling. These results provide important information for the selection of phosphates and their level in the course of instant-noodle processing. Careful selection of the appropriate phosphate salt and concentration depending on the process and type of noodle could allow manipulation of textural attributes of the finished product.

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