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Effect of pre-storage application of different organic and inorganic salts on stored potato quality

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Summary

The application of salts including aluminium chloride, potassium sorbate, sodium benzoate and sodium metabisulfite has been shown to control diseases of stored potato tubers. In order to integrate salt application in the disease control strategies, it is imperative to evaluate their effect on the quality of stored tubers. The effect of salt application either alone (0.05 M and 0.2 M) or in combination on quality attributes of tubers of two cultivars (Norland and Shepody) stored at 4 °C for up to 6 months was evaluated. Higher weight losses were generally observed in tubers treated with aluminium chloride and sodium metabisulfite after 6 months of storage, while the organic salts, sodium benzoate and potassium sorbate, exhibited weight losses comparable to that of the control tubers. Both organic salts at a concentration of 0.2 M decreased sprout growth on Shepody cultivar tubers. Sodium benzoate was shown to increase the sugar content of the stored tubers.

Introduction

Potato (*Solanum tuberosum* L.) tubers are subject to different post-harvest diseases causing significant storage losses. Among these diseases, silver scurf (*Helminthosporium solani* Durieu & Mont.), soft (*Erwinia carotovora* subsp. *carotovora* (Jones) Bergey et al.; *Erwinia carotovora* subsp. *atroseptica* (van Hall) Dye) and dry (*Fusarium sambucinum* Fuckel) rots are of high economic significance (Jeger et al., 1996; Olivier et al., 1998; Sharga & Lyon, 1998). Control of silver scurf and dry rot on potato tubers in Québec is accomplished primarily by postharvest application of thiabendazole, a benzimidazole fungicide. Many strains of *H. solani* and *F. sambucinum* however have become resistant to thiabendazole, resulting in increased incidence and severity of both silver scurf and dry rot (Hide et al., 1988; Holley & Kawchuk, 1996). Although appropriate sanitary and cultural practices such as crop rotation, use of disease-free seed tubers and alleviating injuries during harvesting and handling can help reduce post-harvest diseases, no alternative reliable method is currently available for Québec potato producers for effective control of potato silver scurf, soft and dry rots.

The application of organic and inorganic salts at a concentration of 0.2 M reduced the development of silver scurf (Olivier et al., 1998, 1999; Hervieux et al., 2002),

dry rot (Mecteau et al., 2002) and soft rot (Yaganza et al., 2001). Among various salts tested, aluminium chloride and sodium metabisulfite applied either as preventive or curative treatment reduced soft rot, dry rot and silver scurf development significantly (Yaganza et al., 2001; Hervieux et al., 2002; Mecteau et al., 2002). Sodium benzoate and potassium sorbate were shown to significantly reduce soft rot (Yaganza et al., 2001) or silver scurf (Hervieux et al., 2002). These studies suggest that the use of these salts to control potato diseases in either seed or warehouse potatoes for human consumption has potential. To our knowledge, however no information is available on the effect of aluminium chloride, sodium metabisulfite, sodium benzoate or potassium sorbate on potato tuber quality during storage. Thus, the objective of the present study was to evaluate the effect of these salts on tuber quality attributes including colour, firmness, weight loss, sprouting, soluble sugar contents as well as chlorogenic and citric acids.

Materials and methods

Chemicals. Aluminium chloride ($AlCl_3$), sodium benzoate ($C_7H_5O_2Na$), sodium metabisulfite ($Na_2S_2O_5$), potassium sorbate ($C_6H_7O_2K$), chlorogenic acid, citric acid, fructose, glucose and sucrose were purchased from Sigma Chemical Co. (St. Louis, MO, USA).

Potato tubers. Potato tubers of cultivars Norland (red skin) and Shepody (white skin) were purchased from Propur Inc. (St-Ambroise, Québec, Canada). Tubers were stored in the dark at 4 °C until use. Selected tubers of equal size were washed in tap water and air-dried.

Effects of salts on potato tuber quality. Tubers were dipped in different salt solutions containing either aluminium chloride, sodium metabisulfite, sodium benzoate and potassium sorbate (0.05 and 0.2 M), or a mixture of the four salts (0.05 M each) for 10 minutes. Tubers were air-dried and subsequently stored in plastic crates at 4 °C (85 to 95% relative humidity) in the dark for 6 months. After 3 days, 3 and 6 months of storage, periderm colour, firmness, soluble sugar, chlorogenic acid and citric acid contents of the tubers were determined. Tuber weight loss was evaluated after 3 and 6 months of storage. Sprouting was evaluated once after 6 months of storage.

Experiments were performed using a completely randomized experimental design with 10 replicates (tuber weight loss, colour), 5 replicates (sprouting) and 3 replicates (firmness), one tuber being an experimental unit. For soluble sugars, chlorogenic acid and citric acid contents, a completely randomized experimental design with two replicates was used, the experimental unit being a group of five tubers. Control tubers were dipped in double-distilled water. Experiments were repeated twice.

Periderm colour. Periderm colour of the tubers was measured using a colorimeter

(Model CR200; Minolta, Japan) according to the CIELAB scale (L* a* b*) (L*= Luminosity; a* = scale of green; b* = scale of blue). Four measurements were carried out on each tuber. The colour intensity and the colour were expressed by the chroma ($C = [a^{*2} + b^{*2}]^{1/2}$) and the hue angle ($H = \tan^{-1} b^*/a^*$) values, respectively.

Tuber firmness. Tuber firmness was evaluated by simple penetration, according to the method of Anzaldua-Morales & Bourne (1992) with slight modification using a TA-XT2 Texturometer (Stable Microsystems, Scarsdale, NY, USA) equipped with a computer (XTRAD V3.7H software) and a cylindrical punch (3 mm tip diameter). Each tuber was longitudinally cut in halves, and each half punctured twice (7 mm penetration depth) from the skin surface, at the stolon and bud end regions. For each puncture, the elasticity modulus (E) was calculated from the force-deformation curve.

Soluble sugars (fructose, glucose and sucrose). Freeze-dried longitudinal tuber slices were ground with a coffee grinder. Soluble sugars were extracted from the dry powder, according to the method of Viola & Davies (1992) with slight modification. The powder (100 mg) was transferred in a flask containing 5 ml of ethanol:water (80:20, v:v). The flask was then placed in a water bath maintained at 70 °C for 10 minutes. The slurry was centrifuged (2500 rpm, 10 minutes) and the extraction was repeated once more with the pellet. The supernatants were pooled, evaporated with air to dryness, suspended in water and filtered through a 0.45 µm particle size filter. Concentrations of fructose, glucose, and sucrose were determined using HPLC equipped with a differential refractometer detector (LKB Bromma 2142, Berlin, Germany), a 600E system controller, and an autosampler 717 Plus (Waters, Milford, MA, USA). Chromatographic separation was performed on a sugar pack column 4.6×150 mm (Waters) with Ca-EDTA solution (50 ppm) as mobile phase, at a flow rate of 0.5 ml $minute^{-1}$. Mobile phase and column were maintained at 90 °C. Calibration curves were obtained using different concentrations of fructose, glucose and sucrose standards. Sugar concentrations were expressed in mg g^{-1} fresh weight.

Chlorogenic and citric acids. Chlorogenic and citric acids were extracted from tuber epidermic tissue (2 mm thick) according to the method of Reddy et al. (1999) with slight modification. Freeze-dried and ground epidermic tissue (0.5 g) was placed in 50 ml tube containing 25 ml of methanol:water (80:20, v:v) under agitation overnight. The slurry was centrifuged (2500 rpm, 10 minutes) and the extraction was repeated once more with the pellet. The supernatants were pooled and methanol was evaporated under nitrogen. The aqueous phase was adjusted to 5 ml with hot water (80 °C), and digested with an equal volume of acetate buffer (0.2 M, pH 5.0) containing 0.1 mg ml^{-1} of β-glucosidase (Sigma Chemical) during 16 hours at 37 °C under nitrogen. Samples were then adjusted to pH 2.0 using HCl, diluted with an equal volume of methanol, and filtered through a 0.45 µm particle size filter. Concentrations of chlorogenic and citric acids were determined using HPLC equipped with a 717 Plus autosampler (Waters), a photo diode array UV-visible

detector with a variable wavelength (Model 996, Waters), and a system controller (Model 600MS, Waters). Chlorogenic acid was separated on a C_{18} column (Aqua 5 µm; 4.6×150 mm; Phenomenex, Torrance, CA, USA), using a continuous gradient of three mobile phases: A) 50 mM $NH_4H_2PO_4$ (pH 2.6), B) 0.2 M H_3PO_4 and C) mobile phase A:acetonitrile (20:80, v:v) (Häkkinen et al., 1998), at a flow rate of 0.5 ml minute^{-1}. Citric acid was eluted through a C_{18}/ODS column (Aqua 5 µm; 4.6×250 mm; Phenomenex), using KH_2PO_4 (50 mM, pH 2.9) at 0.7 ml minute^{-1} as mobile phase. The column was maintained at 35 °C. Calibration curves were obtained using different concentrations of chlorogenic acid and citric acid standards. Chromatographic peaks were identified by comparing retention times and UV-absorption spectrum (220 nm) with those of their standards.

Tuber weight loss. Tuber weights were determined prior to storage, and after 3 and 6 months of storage. Weight loss was expressed as percentage: [(tuber weight prior to storage – tuber weight after 3 or 6 months of storage) / tuber weight prior to storage] × 100.

Tuber sprouting. Six month-stored tubers were placed for 5 weeks at 15 °C and 95% relative humidity under diffuse light to stimulate sprouting. The sprouts were then removed from each tuber and weighed. The total mass of the sprouts was measured for each tuber and expressed as mass (g) of sprouts per tuber.

Statistical analysis. Analyses of variance were carried out with the GLM procedure of SAS (SAS Institute, Cary, NC, USA). When significant ($P<0.05$), treatment means were compared using Fisher's protected LSD.

Results

Weight loss. The effect of salt application on tuber weight loss after 3 and 6 months of storage is shown in Fig. 1. Generally, the weight loss of Norland cultivar tubers was higher than that of Shepody cultivar. The weight loss of Shepody cultivar was significantly higher than the control with aluminium chloride and salt mixture after 3 and 6 months of storage. After 6 months of storage, sodium metabisulfite, sodium benzoate and potassium sorbate caused weight losses in Shepody tubers comparable to that of the control tubers of about 4.0%. Whatever was the salt treatment, the weight loss of Shepody tubers after 6 months of storage was less than 7.0%.

Aluminium chloride at 0.05 and 0.2 M and sodium metabisulfite at 0.2 M increased the weight loss of Norland tubers significantly, compared with the control tubers, after 3 and 6 months of storage. Salt mixture also increased the weight loss of Norland tubers significantly after 6 months of storage. In particular, aluminium chloride (0.05 and 0.2 M), sodium metabisulfite (0.2 M) and salt mixture caused a weight loss more than 7.0% after 6 months of storage, with sodium metabisulfite causing a weight loss of about 9.5%. Sodium benzoate and potassium sorbate however caused weight losses comparable to that of the control Norland tubers after 6 months of storage.

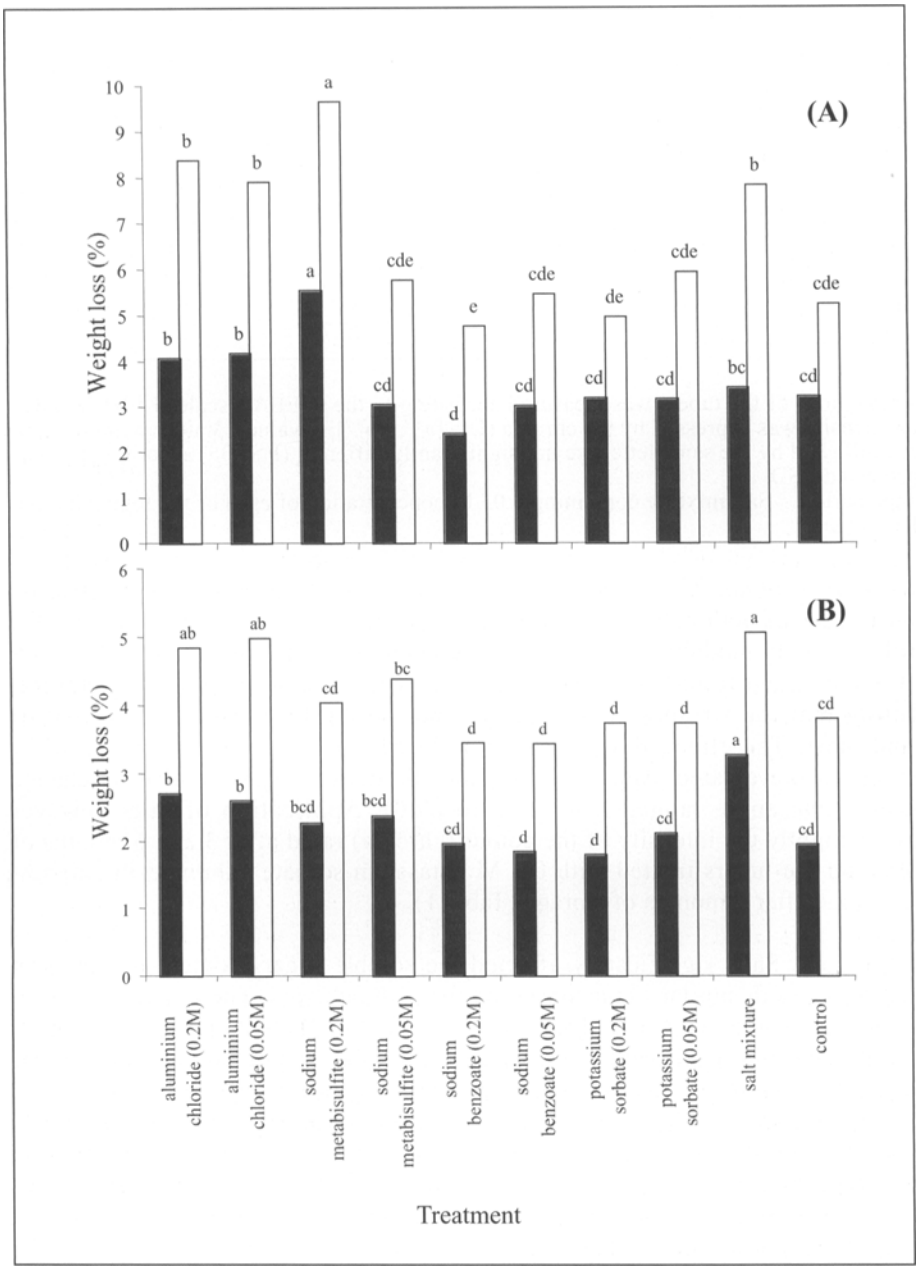

Fig. 1. Effect of salts on weight loss of Norland (A) and Shepody (B) cultivar tubers after 3 (■) and 6 (□) months of storage. Weight loss was expressed as percentage: [(tuber weight prior to storage - tuber weight after 3 or 6 months of storage) / tuber weight prior to storage] × 100. For a same storage period, values followed by the same letter are not significantly different (P>0.05) according to Fisher's protected LSD.

Table 1. Effect of salts on the intensity of periderm colour of Norland tubers during storage.

Treatment		3 months[a]	6 months
Aluminium chloride	0.05 M	25.1 b	29.4 abc
	0.2 M	25.3 b	27.4 cd
Sodium metabisulfite	0.05 M	24.7 bc	30.0 ab
	0.2 M	23.2 bc	29.7 ab
Sodium benzoate	0.05 M	24.3 bc	28.1 bc
	0.2 M	23.5 bc	28.5 bc
Potassium sorbate	0.05 M	24.0 bc	29.2 abc
	0.2 M	30.9 a	31.0 a
Salt mixture[b]		ND	25.6 d
Control		22.7 c	25.5 d

Periderm colour of the tubers was measured according to the CIELAB scale (L* a* b*). The colour intensity was expressed by the chroma ($C = [a^{*2} + b^{*2}]^{1/2}$) values. Values within a same column followed by the same letter are not significantly different (P>0.05) according to Fisher's protected LSD.
[a] Storage period; [b] Salt mixture containing 0.05 M concentration of each of the four salts; ND not determined.

Firmness and colour. The application of different salt solutions had no effect on tuber firmness of both cultivars during the entire storage period compared with the control. Elasticity modulus of Norland and Shepody cultivar tubers ranged from 4.9 to 6.3 N mm^{-1}, and from 6.0 to 9.9 N mm^{-1}, respectively after 6 months of storage, indicating that the firmness of Shepody tuber periderm is greater than that of Norland tuber. The effect of salts on the periderm colour of the Norland cultivar tubers was also evaluated. Application of salts did not cause any significant change of colour (hue angle ranged from 20.3 to 29.0). Application of salts however increased slightly the intensity of the colour (chroma) rated after 3 and 6 months of storage, and the tubers treated with 0.2 M potassium sorbate exhibited the highest chroma value after 6 months of storage (Table 1).

Soluble sugars. Salts significantly affected the soluble sugars content of tubers in both cultivars, with similar trends observed for both cultivars. The effect of salts on soluble sugars content of Norland tubers is presented in Table 2. The application of aluminium chloride significantly decreased the soluble sugars content of Norland tubers after 3 months of storage compared with the control. The application of 0.2 M sodium metabisulfite decreased after 3 months the levels of glucose and fructose, while treatment with sodium benzoate increased significantly the levels of glucose and fructose after 3 and 6 months of storage. The salt mixture significantly increased tuber sucrose content after 3 months. There was no significant salt effect on soluble sugar levels after 3 days of storage.

Chlorogenic and citric acids. Salts significantly influenced chlorogenic acid content of Norland epidermic tuber tissue (Table 3). Significantly lower chlorogenic acid levels occurred after 3 months of storage in tubers treated with sodium benzoate,

Table 2. Effect of salts on the soluble sugars contents (mg g^{-1} fresh weight) of Norland tubers during storage.

Treatment		3 days[a] (G + F)[b]	S[c]	3 months (G + F)	S	6 months (G + F)	S
Aluminium chloride	0.05 M	10.8 a	4.1 a	18.5 ef	4.1 de	19.6 bc	3.4 c
	0.2 M	11.6 a	3.7 a	17.7 f	3.9 e	18.8 bc	3.4 c
Sodium metabisulfite	0.05 M	9.8 a	4.2 a	21.5 c	4.9 bc	20.1 bc	4.4 b
	0.2 M	11.7 a	3.9 a	19.4 def	4.5 cd	18.7 bc	3.7 bc
Sodium benzoate	0.05 M	11.2 a	4.3 a	26.1 b	5.2 b	20.7 b	4.3 bc
	0.2 M	11.7 a	4.5 a	27.5 a	5.9 a	26.2 a	7.3 a
Potassium sorbate	0.05 M	11.5 a	3.7 a	19.8 cde	5.1 b	18.9 bc	3.8 bc
	0.2 M	10.0 a	4.4 a	19.9 cde	5.3 b	19.9 bc	4.7 b
Salt mixture[d]		9.9 a	3.7 a	20.7 cd	5.9 a	19.4 bc	4.5 b
Control		10.5 a	4.0 a	21.6 c	4.9 bc	17.8 c	4.1 bc

Values within a same column followed by the same letter are not significantly different (P>0.05) according to Fisher's protected LSD.
[a] Storage period; [b] G: glucose, F: fructose; [c] Sucrose; [d] Salt mixture containing 0.05 M concentration of each of the four salts.

Table 3. Effect of salts on chlorogenic acid contents (mg g^{-1}epidermic tissue dry weight) of Norland tubers during storage.

Treatment		3 days[a]	3 months	6 months
Aluminium chloride	0.05 M	0.14 bc	0.14 abc	0.12 cd
	0.2 M	0.13 c	0.15 ab	0.13 cd
Sodium metabisulfite	0.05 M	0.14 bc	0.14 abc	0.14 c
	0.2 M	0.21 ab	0.16 ab	0.13 cd
Sodium benzoate	0.05 M	0.17 abc	0.12 c	0.20 a
	0.2 M	0.19 abc	0.12 c	0.18 b
Potassium sorbate	0.05 M	0.24 a	0.13 bc	0.12 de
	0.2 M	0.21 ab	0.12 c	0.11 e
Salt mixture[b]		0.13 c	0.12 c	0.13 cd
Control		0.18 abc	0.15 ab	0.13 cd

Values within a same column followed by the same letter are not significantly different (P>0.05) according to Fisher's protected LSD.
[a] Storage period; [b] Salt mixture containing 0.05 M concentration of each of the four salts.

0.2 M potassium sorbate and salt mixture. While sodium benzoate treated tubers showed significantly higher chlorogenic acid levels after 6 months of storage. Chlorogenic acid contents of Shepody cultivar tubers rated after 3 days, 3 and 6 months of storage were not significantly higher than that of the control (data not shown). Citric acid content of the epidermic tissue increased throughout the storage period in salt-treated as well as control tubers of both Norland (Table 4) and Shepody (data not shown) cultivars. Citric acid levels were not affected by salts except for 0.2 M sodium benzoate after 3 days of storage, where the citric acid level was markedly higher than that of the control (Table 4).

Table 4. Effect of salts on citric acid contents (mg g^{-1} epidermic tissue dry weight) of Norland tubers during storage.

Treatment		3 days[a]	3 months	6 months
Aluminium chloride	0.05 M	5.2 bc	12.2 ab	12.9 c
	0.2 M	6.8 ab	12.2 ab	14.1 bc
Sodium metabisulfite	0.05 M	6.7 ab	13.5 a	16.2 abc
	0.2 M	5.8 abc	12.0 ab	19.4 a
Sodium benzoate	0.05 M	5.0 bc	11.4 ab	15.7 abc
	0.2 M	7.5 a	11.3 ab	14.4 bc
Potassium sorbate	0.05 M	5.8 abc	9.9 b	15.6 abc
	0.2 M	5.6 abc	11.1 ab	12.8 c
Salt mixture[b]		4.2 c	11.8 ab	18.3 ab
Control		4.8 bc	11.5 ab	16.8 abc

Values within a same column followed by the same letter are not significantly different (P>0.05) according to Fisher's protected LSD.
[a] Storage period; [b] Salt mixture containing 0.05 M concentration of each of the four salts.

Table 5. Effect of salts on potato sprout growth.

Treatment		Total sprout mass (g) / tuber	
		Norland	Shepody
Aluminium chloride	0.05 M	4.2 abc	3.1 b
	0.2 M	4.9 a	4.3 a
Sodium metabisulfite	0.05 M	4.7 ab	3.3 b
	0.2 M	3.3 c	3.0 b
Sodium benzoate	0.05 M	4.3 abc	3.2 b
	0.2 M	3.5 c	2.1 cd
Potassium sorbate	0.05 M	4.1 abc	2.9 bc
	0.2 M	3.7 bc	2.0 d
Salt mixture[a]		3.3 c	3.5 ab
Control		4.2 abc	3.8 ab

Values within a same column followed by the same letter are not significantly different (P>0.05) according to Fisher's protected LSD.
[a] Salt mixture containing 0.05 M concentration of each of the four salts.

Tuber sprouting. Sprout growth was generally higher in Norland cultivar tubers than that of Shepody (Table 5). Application of salts affected the sprout growth of both Shepody and Norland tubers significantly. Compared to control tubers, application of aluminium chloride and sodium metabisulfite did not significantly influence sprout growth in both cultivars. Potassium sorbate and sodium benzoate at 0.2 M concentration significantly reduced sprout growth in Shepody cultivar tubers.

Discussion

The application of sodium benzoate, sodium metabisulfite, potassium sorbate and aluminium chloride at 0.2 M concentration was shown to reduce the development of potato soft rot (Yaganza et al., 2001), dry rot (Mecteau et al., 2002), or silver scurf (Olivier et al., 1999; Hervieux et al., 2002). This study investigated the effect of these salts on tuber quality.

Tuber weight loss during storage is an important quality parameter for the potato industry. It results from physiological processes like evaporation, respiration and sprouting. Evaporative loss largely depends on the permeability of water through periderm, and thus also on the degree of suberization of the tubers, which plays a part in reducing moisture loss during storage. However evaporation is noticeably increased by mechanical damage and sprout growth (Rastovski, 1987; van Es & Hartmans, 1987; Burton, 1989). Weight loss due to respiration involves the loss of starch, the ultimate source of respiratory substrates, thus it can influence the cooking quality of potatoes.

The results show that tubers with thinner periderm (Norland cultivar) exhibited higher weight loss during storage than tubers of the Shepody cultivar which have a thicker periderm. Higher weight losses were observed for both cultivars after 6 months of storage in tubers treated with aluminium chloride and salt mixture. But sodium metabisulfite (0.2 M) caused a markedly higher weight loss in Norland tubers only. On the other hand, organic salts, sodium benzoate and potassium sorbate, caused weight losses either comparable to or moderately lower than that of the control tubers of both cultivars after 6 months of storage. This suggests that salt-tuber periderm interactions are different between inorganic and organic salts.

Although the weight loss of Shepody tubers treated with salts was less than 7.0% after 6 months of storage, the application of aluminium chloride, salt mixture and sodium metabisulfite (0.2 M) caused weight losses higher than 7.0%, the weight loss considered threshold at which potato tubers are considered unmarketable (Burton, 1989), during the same storage period in Norland tubers. Yet these salts did not cause any measurable adverse effect on the firmness of the Norland tubers. It appears that the tubers had not sustained moisture loss severe enough to affect tissue turgor. However, as the weight loss reaches about 10%, tubers become increasingly flaccid and unsuitable for human consumption, because of difficulty of peeling flaccid tubers and high peeling losses (Burton, 1989).

Application of salts slightly increased the periderm colour intensity of Norland tubers, especially potassium sorbate. Olivier et al. (1999) also observed that the application of potassium sorbate (0.2 M) caused a pronounced increase in the red skin colour of Chieftain cultivar tubers after 4 to 6 months of storage. Periderm colour intensity continued to increase from 3 to 6 months of storage for both the treated and control tubers. It is not clear however whether the enhanced colour intensity is due to increased synthesis of anthocyanins or altered light reflectance characteristics of the potato skin attributable to the formation of cork tissue with maturation or desiccation of the tuber surface with storage. In any event, application

of sodium metabisulfite did not result in the bleaching of the red skin colour, as expected.

Soluble sugar content has an impact on the taste, texture and colour of cooked or processed potatoes. High soluble sugars impart a sweet taste often associated with soggy texture (Burton, 1989). Among the soluble sugars, the reducing sugars undergo Maillard reaction with amino acids during frying, imparting undesirable brown coloration (Rodriguez-Saona & Wrolstad, 1997). Since sucrose serves as a sink and provides reducing sugars for such a reaction, high sucrose content is also undesirable (Zrenner et al., 1996). The results obtained showed that application of salts influenced tuber soluble sugar content. Aluminium chloride decreased soluble sugar content in tubers stored for 3 months, while sodium benzoate clearly increased it in tubers stored for 3 or 6 months, more so at higher concentration. Changes in the enzymatic pathways of starch-sugar conversion in tubers treated with aluminium chloride and sodium benzoate could explain the results obtained.

Pre-storage treatment with salts affected sprout growth. Organic salts (sodium benzoate and potassium sorbate) at a 0.2 M concentration reduced sprout growth in tubers of both cultivars, but the reduction observed was significant only in Shepody cultivar tubers. This suggests that organic salts affected the mechanisms involved in sprout growth. On the other hand, the increase in sucrose content in tubers treated with 0.2 M sodium benzoate may be a result of sprout growth suppression since sucrose is translocated to the top region of the tuber but not hydrolysed into glucose and fructose to the same extent as in tubers with developing sprouts.

The susceptibility of potato tubers to darken after cooking is of concern to potato processors. This discolouration, referred to as after-cooking-darkness (ACD), is a result of non-enzymatic oxidation of iron-chlorogenic acid complex in the presence of oxygen (Griffiths & Bain, 1997). Darkening intensity, to a large extent, is affected by organic acids, especially citric acid which competes with chlorogenic acid, forming colourless complexes (Silva et al., 1991). Potato tubers with chlorogenic acid concentration greater than the critical value of 0.53 mg g^{-1} dry weight or low in citric acid are highly susceptible to ACD (Vertregt, 1968). Salt application did not have any major impact on either chlorogenic acid or citric acid content. None of the salt-treated tubers displayed a chlorogenic acid content higher than the critical concentration, suggesting that salt application would not alter tuber susceptibility to ACD.

Our results show that the application of salts has an impact on specific quality attributes of stored potatoes. All the salts tested in this study did not have any significant effect on texture or on the potential susceptibility to ACD measured as chlorogenic acid. However, salt effects were evident with respect to weight loss, sugar accumulation and sprout growth. In addition, our results do not suggest the existence of any salt interaction in their effects on various quality attributes. The effects of salt mixture on various tuber quality factors can be related to non-interacting mixture of the constituent salts.

Given that the four salts tested in this work have potential to control dry rot, soft rot or silver scurf and that these salts may exert either beneficial or negative

influence on specific quality attributes of stored potatoes, formulation of an effective salt mixture from the standpoints of disease control and tuber quality and longevity can be envisaged. Use of such a formulation can eventually be integrated into disease control strategies for potatoes.

The two inorganic salts, aluminium and sulfite, which have been shown to be effective disease control agents for stored potatoes, are also suspects in certain health concerns. It would be prudent then to assess the depth of penetration and residues of aluminium and sulfites in stored tubers as well as potato products fabricated from salt-treated tubers from the standpoint of food safety. Further work is necessary to determine the salt effects on cooking and sensory qualities of cooked products. It is also necessary to test the effect of salts on other cultivars, since this study does show, at least with respect to weight loss, that cultivars may respond to salt treatment differently.

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