Muña (sp. *Minthostachis mollis*) essential oil, as a natural alternative to control potato sprouting tested under different storage conditions.

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Abstract

Preferences of modern consumers for healthy food are challenging researchers to seek natural options to control potato sprouting. Early Incas used muña plant (sp. *Minthostachis mollis*) as an insect deterrent in potato storage due to its high content of terpenoids in its essential oil. Sprout suppressing property of muña essential oil, was tested during 4 months at room temperature and cold storage conditions (8°C/HR85%) at two different concentrations (50 and 100ppm), as compared to commercial rate of CIPC and non-treated control on quick sprouting native potato variety Amarilla Tumbay. Muña oil and CIPC treatments were applied with a hand spray, oil treatments were repeated every 15 and 30 days at both storage conditions. Effectiveness of muña oil to suppress sprouting (length and weight of sprouts) was not significantly different from CIPC when applied every 15 days, either at both concentrations, and treated potatoes stored at 8°C for 4 months. It was observed that suppressing effect of muña oil was lost when potatoes were treated every 30 days and then stored at room temperature or at cold storage conditions, because sprout suppressing property of muña oil is due to burning of tender sprout tips tissue. Therefore, it appears that after 15 days the tissue development of sprouts, become thicker and more resistant to the burning effect of muña oil and or can recover quickly to resume growth. No off odors were detected by a taste panel in boiled potatoes treated with muña oil.

Keywords: sprout suppressant, essential oil, storage, postharvest.

Introduction

Sprouting control is a constant concern during potato storage (sp. *Solanum tuberosum* L.), therefore CIPC (chlorpropham) is commonly used by the potato processing industry as sprout inhibitor since 1952 (Lewis, et al. 1997). However, in recent years studies related to excess in maximal residue limits (Noël, et al. 2002; Noël, et al. 2003) and possible side effects on human health are raising public concern on the use of chemicals in the food processing industry. Although no direct toxic side effects have been detected in humans because of the use of CIPC, a number of studies have been conducted to test natural products to control potato sprouting in storage (Kleinkopf, et al. 2003; Elsadr and Waterer, 2005) that can result in new options for organic production and organic postharvest management. In this regard Frazier, et al. (2004) found that both peppermint and spearmint oils were equally effective sprout suppressants, but peppermint oil caused fewer problems with culinary and palatability concerns. As compared to CIPC effect that has a direct effect on cell division, volatile oils and hydrogen peroxide are more correctly called sprout suppressants, as they physically damage burning developing sprouts with a high concentration of the product (Frazier, et al. 2004). In Perú, muña (sp. *Minthostachis mollis*) is a wild Andean herb that grows between 2500 to 3500 m of altitude, it has been utilized mainly as a medicine plant, but also in potato storage as an insect deterrent since pre-Inka times (Fournet et al 1996; Morris, 1985) because of its high content of terpenoids (Fuertes and Munguia 2001). Its potential as sprout suppressant has been reported by Aliaga y Feldheim (1985) in lab, but no storage trials have been conducted under controlled conditions. This comparative study evaluated the performance of muña natural oil as a natural alternative to CIPC to control sprouting in treated potato tubers kept at room temperature and cold storage for 4 months.

Materials and methods

This study was conducted in the storage facilities at the International Potato Center headquarters in Lima. A commercial concentrated emulsion formulation product of sprout inhibitor CIPC 300 g/L was utilized at the recommended rate (60cc/ton) and two concentrations of muña essential oil (50 y 100 ppm) were applied to two lots of 150 kg of quick sprouting native variety Amarilla Tumbay (*Solanum goniocalyx*). Then each lot was grouped following a RCB design with 3 reps in 42 carton boxes, each containing 8 net-bags with 5 tuber samples. Both lots were placed under two different conditions, one lot was placed for 4 months at cold storage at 8°C/HR85% and the other lot was kept at room temperature (21°C/ HR78%) for the same period of time, in each lot there was an untreated control. The muña essential oil was applied prior to sprout development in two ways (spray and wick application) and two application frequencies were tested (every 15 and 30 days). The application schedule of all sprouting control treatments started on Nov 5th 2007 and finished on March 2008, considering a 10 days elapse to apply sequentially the treatments and to avoid sample congestion at the evaluation time. The evaluation of samples consisted in randomly sampling a net-bag from the box and registering tuber data: initial weight, weight loss, specific gravity, as well as length and weight of sprouts. Analysis of variance and mean comparison tests were used, as well as the area under the curve technique (Shaner and Finney, 1977) was used to calculate and estimate the sprout growth development. Statistical computation of data was done utilizing Proc GLM (SAS Institute Inc. 1989). Treated potato tubers were boiled and tested for odd odors by a taste panel.

Results and discussion

Analysis of variance conducted for specific gravity, as well as length and weight of sprouts showed significant differences ($p<0.001$) in response to the tested treatments. The muña essential oil was an efficient sprout suppressant as observed when evaluating length and weight of sprouts, its effect was not significantly different from CIPC (Table 1). The suppressant effect was observed during 4 months with both tested oil concentrations, but only when the oil application was carried out every 15 days and the treated potato tubers were stored at cold storage conditions (Figure 1). A similar result was obtained by Elsadr and Waterer (2005) who found that purified plant extracts (diallyl disulphide and carvone) completely suppressed sprouting for 14 days. When muña oil was applied at both concentrations using a saturated wick (MuñaW_50ppm and MuñaW_100ppm) to mimic a fumigation application, the sprout development continued during the same cold storage period at a rate not significantly different from the untreated control, even though the treated tubers were kept at low temperature.

Table 1. Sprout length (cm) in cold room storage at 8°C by product applied every 15 days for 4 months

	Frequency of application (15 days)																
	0	15		30		45		60		75		90		105		120	
CIPC	0	0	c	0	b	0	b	0	c	0	c	0	d	0	c	0	C
MuñaS_50ppm	0	0	c	0	b	0	b	0	c	0	c	0	d	0	c	0	C
MuñaS_100ppm	0	0	c	0	b	0	b	0	c	0	c	0	d	0	c	0	C
MuñaW_50ppm	0	1,2	b	1,9	a	2,4	a	3	a	3,4	a	3,5	ab	4,3	a	4,4	ab
MuñaW_100ppm	0	1,7	a	2,1	a	2,4	a	3,6	a	3,8	a	3	bc	4,7	a	4,8	a
Control	0	1,7	ab	1,9	a	2,4	a	2,7	ab	2,8	b	2,8	c	3,3	b	3,8	b
DMS	n.s.	0,49		0,3		0,28		0,6		0,56		0,59		0,56		0,61	

Common values followed by common letters don not differ significantly

The progression of the sprout growth on treated tubers with muña oil at 50 ppm sprayed every 15 days during 120 days and maintained under cold room conditions as compared to CIPC and the untreated control is shown in Figure 1. The effect of muña oil at 100 ppm was also successful under the same conditions of application and storage, although the application of muña at both concentrations with wick failed to control sprout development. CIPC was applied once at the beginning of the storage period.

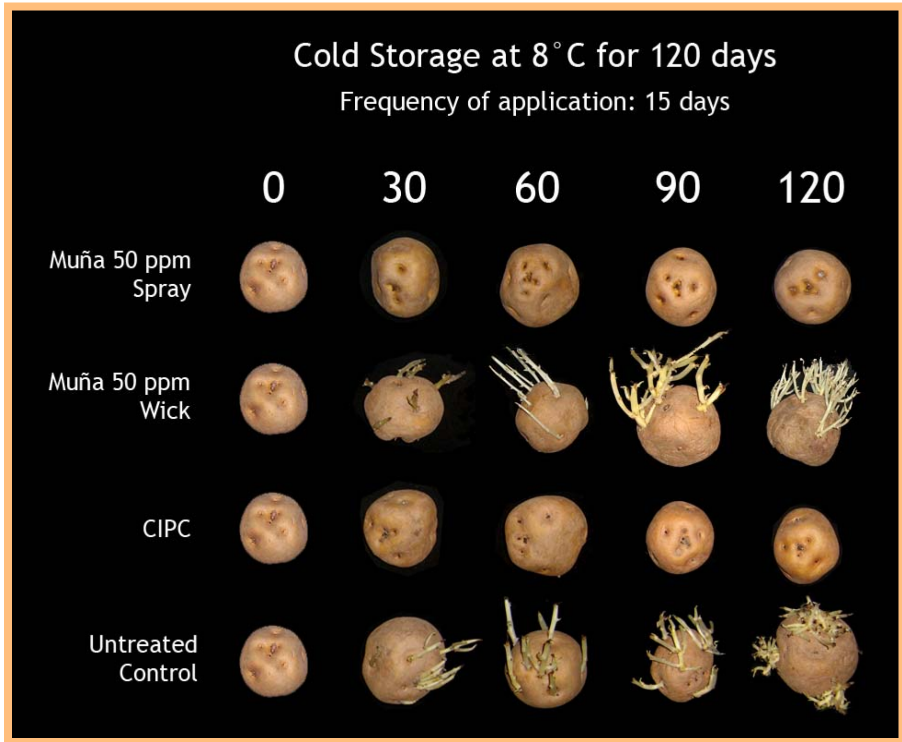

Figure 1. Sprout growth on treated tubers with muña oil at 50ppm every 15 days as compared to CIPC and the untreated control, stored under cold room conditions. (8°C/HR85%) for 120 days

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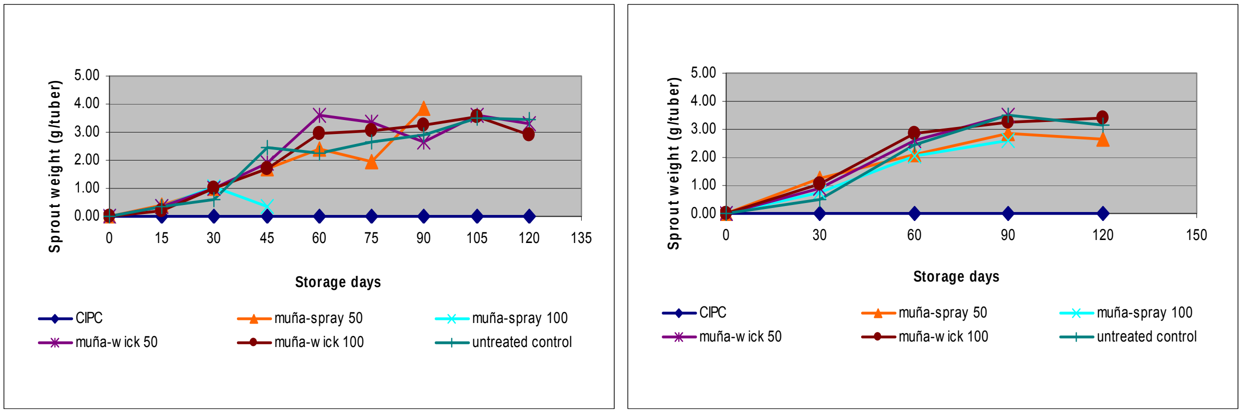
It was observed that the suppressant effect was lost when the frequency of application was every 30 days and the storage of treated potato tubers was done either in cold room (Table 2) or at room temperature (Figure 2).

Table 2. Sprout length (cm) in cold room at 8°C by product applied every 30 days for 4 months

	Frequency of application (30 days)								
	0	30		60		90		120	
CIPC	0	0	c	0	c	0	d	0	d
MuñaS_50ppm	0	1,9	b	1	b	2,2	c	3,2	b
MuñaS_100ppm	0	2,1	ab	0,1	c	0,5	d	2,1	c
MuñaW_50ppm	0	2,4	a	2,9	a	3,1	b	4,2	a
MuñaW_100ppm	0	2,1	ab	2,8	a	3,6	ab	3,5	ab
Control	0	2	ab	2,5	a	2,9	bc	3,7	ab
DMS	n.s.	0,43		0,72		0,8		0,8	

Common values followed by common letters don not differ significantly



15 days 30 days

Figure 2. Variation in sprout weight (g/tuber) when tubers were treated with CIPC every 15 and 30 days with muña essential oil at two concentrations (50 and 100ppm) and in two ways (spray and wick application) and kept at room temperature, as compared to the untreated control.

These results indicate that a longer period between oil applications allowed sprouts tissues to grow stronger and become less sensitive, or to recover after being sprayed with oil. At the end it appears that more mature tissues of sprouts are less sensitive to the burning effect of the essential oil, as compared to tender tissues of sprouts that were impaired to grow because of the burning effect when muña oil was sprayed at a higher frequency of 15 days. This finding is coincident with Frazier et al. (2004) who mention that alternative natural sprout suppressants are most effective when applied at "peeping" (initial status of sprout growth) or before sprouts are one-eighth of an inch long, otherwise application may result in sprout suppression failure. In a comparative prospective study run at the University of Idaho (N. Olsen, pers.comm.), to evaluate the effects of muña oil, clove oil and CIPC on potato sprout growth, the obtained results suggest that muña oil can become an effective replacement of clove oil to control potato sprouting in storage.

Although the evaluation of storage diseases was not part of the study, it was observed that treated tubers kept in cold room did not show any development of dry rot (*spp. Fusarium*) or decay, further studies are needed to determine how, when and how much of these 'natural' products should be used to control sprouting, and determine its effect on dry and soft rot.

It was observed in the potato lot stored at room temperature condition that the performance of muña essential oil as sprouting suppressant was negatively affected, may be because of the volatilization of the terpenoids components due to the higher temperature. The inhibitory effect of CIPC was also effective at room temperature during the storage period of the trial.

In the same lot at room temperature it was necessary to eliminate a number of treated tuber samples that decayed due to bacterial soft rot and water rot. The application of muña essential oil as fumigant (wick application) was ineffective as sprouting suppressant with both concentrations and under both storage conditions, since in all cases it was detected sprout development as well as weight loss. The taste panel that evaluated boiled samples of potato tubers treated with muña essential oil did not reported any odd odors.

Conclusions

This storage trial shows that muña essential oil has an effective potential as potato sprouting suppressant, but it has to be repeatedly sprayed every 15 days, and the treated potato tubers has to be stored under cold storage conditions. Although commercial feasibility of a sprouting control agent derived from muña essential oil are still to be developed, it is necessary further studies to investigate new ways to extend the sprouting suppressant effect of muña oil in potato tubers for fresh consumption, as well as other application treatments to optimize the efficiency such as fumigant. Therefore, another trial need to be carried out to mimic a commercial context to test if the suppressant effect of 15 days is enough to control sprouting when native potato tubers treated with muña oil are marketed for fresh consumption in quality demanding markets. Improved and native potato cultivars need to be assessed on an individual basis for proper timing and frequency of application of muña oil, since response and sprouting differ by variety. These results suggest also that muña oil treatments could be used to suppress the sprouting of seed potatoes, without compromising the subsequent field performance of the seed. It is expected that the sprout suppression effect provided by the muña oil method does not stress the potatoes and thereby cause negative effects on internal processing quality of the tubers. However, further studies may need to be carried out to demonstrate that this method does not cause the potatoes to respond with increased sugar levels or cause the processed product to darken in color and become unacceptable for marketing.

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