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NEW TECHNIQUES FOR EFFECTIVE AND SAFE STORING OF POTATOES AT THE AMBIENT TEMPERATURE

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ABSTRACT

Several storage experiments were performed at Mansoura Experimental Farm, Agric. Res. Institute. To study the storability of different potato cvs as affected by new different storing techniques, at the ambient temperature for six months period during 2001 and 2002 years. Results could be summarized as follows:-

Exp. I , II, and III:

1. All used essential oils were effectively act as a sprout-suppressants at low concentration, they were more effective as two or three oils were mixed together. They could be directly applied (sprayed in liquid phase), or indirectly (volatilized to be act in vapour phase) within closed headspace.
2. They highly suppressad the incidence of sprouting, weight losing and damage, they also maintained higher TSS values.
3. The most effective anti-sprout treatment for each cv was:-
   - i. Ditta cv: Their tubers were sprayed twice with thyme + caraway oils (1 + 1 ml/L) within closed headspace.
   - ii. Ditta cv: Their tuber were exposure to (thyme + caraway) (5 + 5 ml) and/or (10 + 10 ml) oils to be act in vapour phase within closed headspace (60 x 10^3 cm^3).
   - iii. Spunta cv: Their tubers were sprayed with (dill + thyme + eucalyptus) oils (1 + 1 + 1 ml/L) or (dill + thyme) oils (1 + 1 ml/L) twice at opened headspace.
   - iv. Polésta cv: Their tubers were spreyed twice with limonene oil (5 ml/L) under rice straw cover at opened sites (sprouting [%] was reduced from 97.5% up to 19.8%).
   - v. Diamont cv: Their tubers were sprayed twice with thyme oil (5 ml/L) undar the same conditions, (sprouting % was reduced from 50% up to 2.3%, also eucalyptus oil up to 4.6%).
   - vi. Provento cv: Their tubers were also sprayed twice with caraway or eucalyptus and/or limonene oils (5 ml/L) under the same conditions, (sprouting % was reduced from 24.1% up to 0.0%, full suppression).

Finally, such treatments could be concluded as a new technique of great benefits for storing potatoes at the ambient temperature for six months period (without any cold or synthetic anti-sprouting application).

INTRODUCTION

Sprouting, weight loss, rotting and microbial infections represent serious problems arises during storage of potato tubers.

potato produced in Egypt often starts to sprout shortly after harvesting. Their tubers known to be stored either in nawwala (24-28°C, 65-70% RH) or in refrigerators (4°C, 90% RH) for consumption, seeds (for plantation) and at (10°C, 90% RH) for processing (Barakat, 1996).

In most cases, the use of synthetic sprout suppressants, i.e. CIPC (chloropropham) is required in nawwala and 10°C cold storage to inhibit the incidence of sprouting and other undesirable changes (El-Afry *et al*., 1986).

Cold storage facilities are rather expensive and beyond the reach of the producers. Therefore, a reliable proper technique (alternative one) to control bud development during storage must still be required.

The ideal sprout inhibitor must be effectively suppress sprouting at low levels, its inhibitional effect should be reversible (viability of buds), reduce fresh weight loss and rotting of tubers, it must be safety, available and cost-effective (Vaughn and Spencer, 1991 and Vokou *et al*., 1993).

Recently, a few volatile organic compounds, essential oils extracted from aromatic and medicinal plants, i.e., thyme, caraway, eucalyptus, mint. dill, basal, and/or their basic constituents (monoterpens), i.e., thymol carvone, 1, 8, ceniole, minthole, carveole, and etc proved to be effective for these purposes (Hartmans *et al*., 1995 and Oosterhaven *et al*., 1995).

Present work aimed to be establishing new local, potent, safety and cost-effective technique for storing potatoes by using different botanical essential oils under different storage conditions / methods.

MATERIALS AND METHODS

Several storage trials were conducted at Mansoura Research Station, Agric. Res. Inst., Cairo, during two seasons of 2001 and 2002 to study the effect of some extracted essential oils of eucalyptus, mint, dill, caraway, basal, thyme as well as limonene as a natural anti-sprout for controlling sprouting and to increasing storability of some potato cvs, i.e. Ditta, Spounta, Provento, Polesta and Diamont during 6 months storage period at the ambient temperature. Tubers of different cvs were obtained from Maba Agric. Company, El-Bihirra Governorate. Those were saved from the summer harvesting, cured and size graded to be used for this work purposes.

Cultivars characteristic (from Agrico Comp. Holand), as follows:

Ditta: Long oval to long, yellow skin, deep yellow flesh, medium size, fresh marketing, rather firm.

Provento: Oval to round, light yellow flesh, rather firm, processing and fresh marketing.

Polesta: Round oval, yellow flesh, rather firm to mealy, fresh marketing and processing.

Diamont: Oval, light yellow flesh, rather firm to mealy, fresh marketing and processing.

Spounta: Long, yellow skin, yellow flesh, larg size, rather firm to mealy, fresh marketing (notice Fig. 1, 2 and 3).

Essential oil extraction:

Essential oils were extracted by hydro-distillation method (Charles and Simon, 1990). From 50 gm of dill, caraway, basal seeds, mint and thyme dried herp through 2 hrs period, extraction was repeated as required. Also, commercial limonene essential oil was included.

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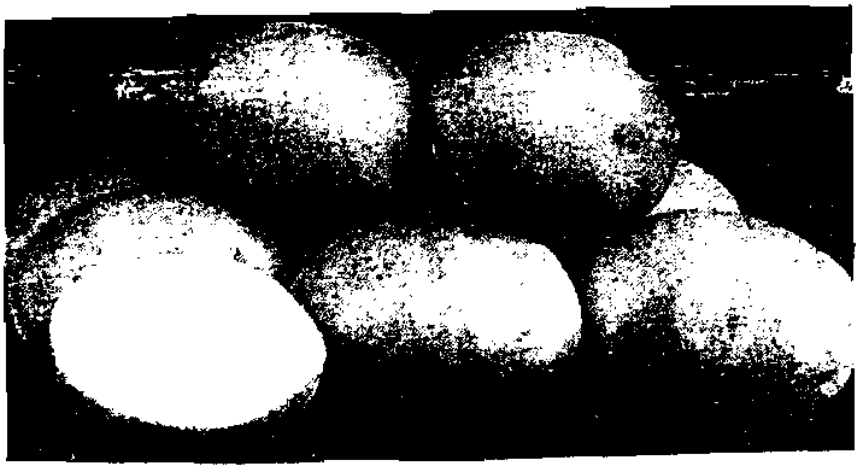

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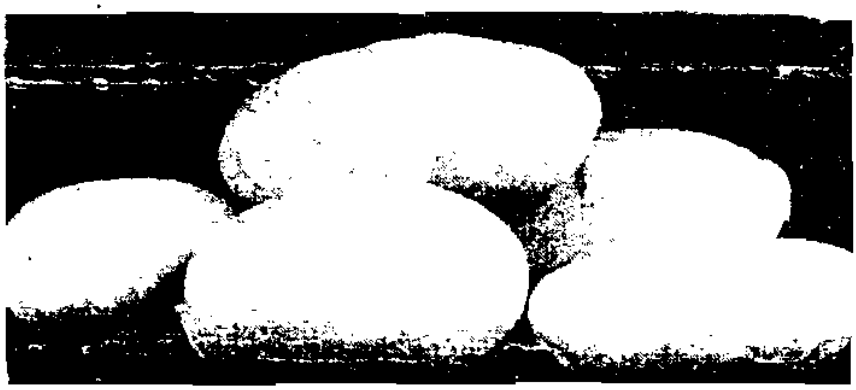

Fig. 1. Characteristics of some potato cv. (tubers)
A. *Ditta* B. *Poliesta*

Experiment Ia:

This experiment was conducted for storing tubers of Ditta cv for 6 months period at the ambient temperature by spraying (direct application) tubers with some essential oils in closed headspace (60 x 10^3 cm^3).

Tubers were taken into cardboard boxes of 60 x 10^3 cm^3 internal space, each one contained 50 kg of tubers. Boxes were arranged in 3 vertic rows (replicates), each row included11 boxes (treatments).

Randomized complete blocks design (RCB) of 11 treatments and 3 replicates was adopted.

Essential oils were emulsified by Tween-80 (1m/L) and sprayed twice at the beginning and again after 3 months. Just after spraying boxes were tightly sealed.

Treatments were as follows:

1.Thyme oil (T) 1ml/L.
2. Caraway oil (C) 1 ml/L.
3. T + C oils (1 + 1 ml/L).
4. T oil 1.5 ml/L.
5. C oil 1.5 ml/L.
6. T + C oils (1.5 + 1.5 ml/L).
7. T oil 2 ml/L.
8. C oil 2 ml/L.
9. T + C oils (2 + 2 ml/L).
10. Control-1 (closed boxes).
11. Control-2 (Opened boxes).

Six months later, experiment was terminated, sprouting (%) was calculated based on number of sprouted eyes relative to total number of eyes of each tuber (10 tuber / box).

Sprout length (cm) and weight (g) were also determined.

Experiment Ib:

Ditta tubers were also indirectly treated by allowing oils to be volatilized (act in vapour phase) within closed headspace (60 x 10^3 cm^3). Oils were put in Petri dishes at the bottom of each box nearly the stored tubers, then boxes were closely sealed.

Treatments were as follows:

1. T oil 5 ml/headspace (60 x 10^3 m^3).
2. C oil 5 ml/headspace (60 x 10^3 m^3).
3. T + C 5 + 5 ml/headspace (60 x 10^3 m^3).
4. T oil 10 ml/headspace (60 x 10^3 m^3).
5. C oil 10 ml/headspace (60 x 10^3 m^3).
6. T + C 10 + 10 ml/headspace (60 x 10^3 m^3).
7. Control-1 (closed boxes).
8. Control (opened boxes).

After 6 months, experiment was terminated, sprouting (%), sprout length (cm) and weight (g) was determined.

Experiment II:

Spunta tubers were directly sprayed (twice) with other essential oils in opened space (box) at the ambient temperature. Treatments were as follows:

1. Mint (M) oil. 2. Caraway (C) oil 3. Eucalyptus (E) oil.
4. Thyme (T) oil 5. Dill (D) oil. 6. Basal (B) oil, each one (2ml / L).

7. D + T oils (1 + 1 ml/L) 8. E + D + T oils (1 + 1 + 1 ml/L)
9. Control (sprayed with water).

At the end, sprouting (%), sprout length (cm) and weight (gm) were determined. Also, weight loss (%), based on wt (gm) of 10 tuber at the beginning and the end, damage (%) based on recording the number of rotted and decayed tubers and excluded them all over the period and TSS %, all were determined.

Experiment III:

Tubers of Polesta, Provento and Diamont cvs were sprayed with essential oils, i.e. C, T, E, L all 5 ml/L, C + T + E + L 1.25 ml/L from each one. They were sprayed twice at the storage onset and again 90 days later. Just after spraying, tubers were covered with rice straw (0.6 m depth).

Factorial experiment of 3 cvs x 6 treatments, replicated 3 times and RCB design were adopted.

Treatments were three cvs, each one received 6 treatments:

1. C oil 2. T oil 3. E oil 4. L oil each one (5 ml/L).
5. C + T + E + L oils (1.25 ml/L) from each one 7. Control.

At the end of experiment, sprouting (%) of each treatment was determined. Also, data of monthly temperatures and relative humidity during two storage seasons of 2001 and 2002 were presented in Table (1).

Table 1. Monthly means of temperature degrees and relative humidity (%) (RH) during 2001 and 2002 seasons.

Months	2001 season		2002 season	
	Temperature (°C)	Relative humidity (%)	Temperature (°C)	Relative humidity (%)
May	24.6	62.2	23.9	64.9
June	25.9	64.9	27.1	68.1
July	26.9	64.0	30.5	70.8
August	28.0	70.7	28.9	71.0
September	29.8	67.5	27.4	67.7
October	23.8	67.8	25.5	72.0

RESULTS AND DISCUSSION

Experiment Ia:

Data in Table (2) and Fig. (2) indicated that all oil treatments were significantly suppressed sprouting and reduced sprout length (cm) compared with the two controls. At all used concentrations, thyme oil was the best one relative to caraway oil in most cases. Thyme oil gave its great suppressive effect at low concentration (1 ml/L), while caraway oil did at medium concentration (1.5 ml/L).

It was evident from the same data that combination of more one oil was greatly enhanced their anti-sprouting effect due to the involvement of more basic component (monoterpenes). The most effective treatment was T oil combined with C oil at the lowest concentration (1 + 1 ml/L).

Caraway oil at the highest concentration (2 ml/L) induced great stimulatory effect on sprouting (25%) (means of two seasons). At the same concentration (2 ml/L) thyme oil had no similar stimulatory effects.

On the other hand, the same data (Table 2) illustrated that the two controls (closed space 1 and opened space 2) were greatly differed among them. Control (1) raised sprouting (%) to 27% and the sprout length (cm) 75% over control (2), there was no differences in sprout weight. This might be due to the differences in their micro climate conditions, i.e. temperatures, RH and light (within storage boxes).

Table 2. Sprouting characters of Ditta cv. as affected by essential oils spraying during 6 months storage at the ambient temperature during two seasons.

Treatments	2001 season			2002 season		
	Sprouting (%)	Sprout length (cm)	Sprout Average FW (gm)	Sprouting (%)	Sprout length (cm)	Sprout Average FW (gm)
T (1 m/L)	8.10 f	1.63 efg	3.60 f	7.63 ef	1.43 def	3.07 e
C (1 m/L)	12.03 d	1.87 d	4.97 d	11.98 d	1.63 de	4.23 d
T+C (1 + 1 m/L)	6.97 g	1.47 gh	6.10 c	6.10 f	1.27 ef	5.50 c
T (1.5 m/L)	8.13 f	2.10 c	7.30 b	7.63 f	1.80 cd	6.43 a
C (1.5 m/L)	7.47 fg	2.43 b	7.67 a	6.40 f	2.03 bc	6.30 ab
T+C (1.5 + 1.5 m/L)	7.03 g	1.37 h	6.37 c	6.93 f	1.17 f	5.67 bc
T (2 m/L)	10.20 e	1.73 def	4.33 e	9.30 e	1.57 de	4.23 d
C (2 m/L)	26.00 c	2.07 c	6.30 c	23.83 c	2.27 b	6.47 a
T+C (2 + 2 m/L)	12.47 d	1.80 df	7.47 ab	11.60 d	1.60 de	7.00 a
Control closed (1)	78.53 a	7.83 a	3.33 fg	71.40 a	7.33 a	3.17 e
Control opened (2)	54.73 b	1.57 fg	3.03 g	50.33 b	2.20 b	3.33 e

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test at 5% probability..

Such suggested storage technique of applying essential oils in the tightly sealed boxes, based on the idea of such oils volatility nature as they act in vapoure phase. This to avoid vapour leakage, to ensure sufficient and current suppressive effect within store headspace and within tuber tissues for a possible long time.

It was known that monoterpenes, the basic components of these oils, i.e. thymole of T oil and carvone of C oil, their lipohilicty and volatility nature and their functional groups, all found to be the main factors controlled their suppressive effect on sprouting, weight losing, rotting and decaying of potato tubers (Asplund, 1968 and Reynolds, 1987).

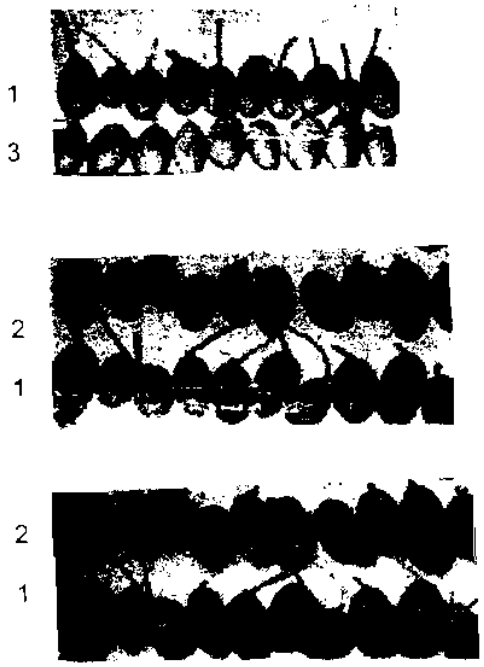

Fig.2. Tubers of Ditta cv.

1. **Untreated tubers stored within closed space**
2. **Untreated tubers storsd within opened space**
3. **Tubers sprayed with T + C (1 + 1 ml/L).**

They inhibited respiration due to their role as an uncoupling agents in mitochondria (Douce *et al.*, 1978). Thereby reduced the carbohydrate degradation and sugars changes (Daniels *et al.*, 1996). Meanwhile, during sprouting carbohydrate reserves known to be degraded into sugars to provided energy and structural components for the rapidly developing sprout tissues. Thus, sprouts act as a powerful sink to the mobilized sugars (Vans and Hartmans, 1987). Besides, caraway and dill oils found to be fully inhibited HMGR-enzyme system, the main key enzyme of mevalonate pathway in potato tubers (Oosterhaven *et al.*, 1993). Mevalonate known as the main pathway of gibberellin biosynthesis, this which closely related with the sprouting and dormancy case. Such results and interpretations were also coincided by the findings of Hartmans *et al.*, (1990), Vaughn and Spencer (1991), Vouko *et al.* (1993), Daniels *et al.* (1996) and Carlo *et al.* (1997)

Experiment Ib:

Data in Table (3 and Fig. (3) indicated that caraway and thyme oils (singly or combined) were significantly and highly reduced sprouting (%) and sprout length (cm) in all cases and sprout weight in some cases compared with the two controls. Thyme oil (singly) at all concentrations was more effective than caraway one.

Table 3. Sprouting characters of Ditta cv. as affected by essential oils vapour exposure during 6 months storage at the ambient temperature during two seasons.

Treatments	2001 season			2002 season		
	Sprouting (%)	Sprout length (cm)	Sprout Average FW (gm)	Sprouting (%)	Sprout length (cm)	Sprout Average FW (gm)
T 5 ml/headspace 60 x 10^3 cm^3	7.33de	1.50 d	4.00 c	7.00 c	1.40 d	3.63 c
C 5 ml/headspace 60 x 10^3 cm^3	8.03 d	0.76 ef	2.90 d	7.63 c	0.70 f	2.73 d
T+C 5+5 ml/H.S. 60 x 10^3 cm^3	6.20 f	0.82 ef	2.50 e	6.00 c	0.81 ef	2.30 e
T 10 ml/headspace 60 x 10^3 cm^3	6.60 ef	0.56 f	1.87 f	6.33 c	0.47 g	1.73 f
C 10 ml/headspace 60 x 10^3 cm^3	9.03 c	2.27 b	5.90 a	8.77 c	2.03 b	4.80 a
T+C 10+10 ml/H.S. 60 x 10^3 cm^3	7.23 e	0.90 e	4.73 b	6.39 c	0.86 e	4.43 b
Control closed headspace 60 x 10^3 cm^3	76.73a	8.37 a	4.23 c	73.77a	8.53 a	3.73 c
Control opened headspace 60 x 10^3 cm^3	55.0 b	1.83 c	4.53 b	54.00b	1.87 c	4.30 b

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test at 5% probability.

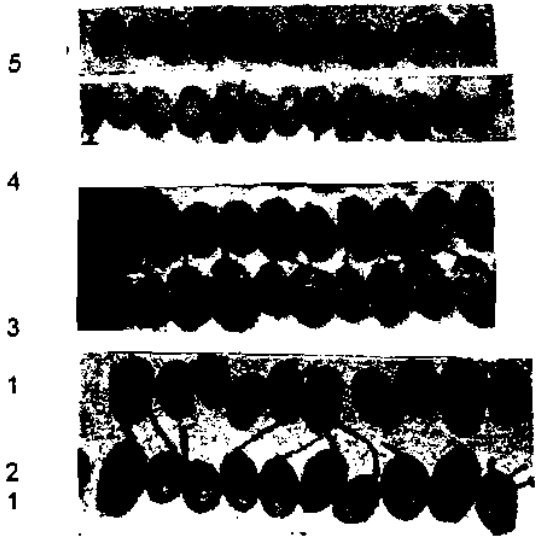

Fig.3. Tuber of Ditta cv.

1. **Control 1 (closed).**
2. **Control 2 (opened) sp.**
3. **Tubers subjected to oil vapour T + C (5 + 5 ml/sp.).**
4. **Tubers subjected to oil vapour T (10 ml/sp.)**
5. **Tubere subjected to oil vapour C (10 ml/space).**

The same data revealed that both raising oil concentration and combining of two oils were induced an sustainable suppressive effect on sprouting. This could be logically true under this experiment conditions due to the need for current oil vapour (suppressive action) to be contact sufficiently and penetrate into the internal tissues of all the stored tubers. Also to be ensure sufficient and current suppressive effect for long time.

Oils combination provided more and different monoterpenes, i.e. T + C treatment provided thymole and carvone, this provided more suppressive effect.

It was evident from this d77ata that the most effective treatments of the considerable lowest sprouting (%), sprout length and weight were T + C oils (5 + 5 ml) / 60 x $10^3 cm^3$ headspace followed by T + C oils (10 + 10 ml) / the same headspace size.

Some data revealed that two controls were behave as they did in experiment Ia.

All results were at the same trend in two seasons. Herein, it could be suggested that such technique must be used to store potato in closed stores with only oil treatment without the need for cold treatment or the unfavourable synthetic anti-sprouts.

Once again it should be sure that the important results of (Exper. Ia and b) could practically be utilized, when potato stored at ambient temperature in closed stores or in refrigerators (10°C). Based on the effect of their direct contact with tubers (spraying) or on volatility mature and the spreading or diffusion of oil vapour into the store space and to potato tubers.

Accordingly and practically, it is possible to be stored potato at large scale using thyme and caraway oils by spraying, fogging, fumigation and air drafting (loaded with oil vapour) within large closed stores.

Such results and suggestions were confirmed by the findings of (Hartmanns *et al.*, 1990 [fogging of oils]; Vaughn and Spencer, 1991 [spraying) and Bang, 1995 [exposure to oil vapour]).

Experiment II:

About storing of potato, spunta cv for 6 months at ambient temperatures by spraying other essential oils within open headspace. Data in Table (4) and Fig. (4) revealed that all the sprayed essential oils, i.e. mint (M), caraway (C), eucalyptus (E), thyme (T), dill (D) and basal (B) added to the two combined oils treatments were considerably improved the storability of spunta tubers. They were greatly reduced the percentage of sprouting, the sprout length and weight, weight loss and damage percentage. At the same time, they were considerably maintained higher TSS content, all compared with the control at both seasons.

The same data indicated that thyme (T) and/or dill (D) oils were the most superior among all the singly applied oils.

The most potent anti-sprout treatments were those of combined oils (D + T + E) (1 + 1 + 1 ml/L from each one) followed by D + T (1 + 1 ml/L). Similar results were obtained by Vokou *et al.* (1993), Bang (1995), Bouwmester *et al.* (1995) and Singh *et al.* (1997).

Table 4. Storability of Spunta tubers as affected by essential oils spraying during 6 months storage at the ambient temperature during two seasons.

Treatments	2201 season					2002 season				
	Sprouting (%)	Sprout length (cm)	Weight loss (%)	Damage (%)	TSS (%)	Sprouting (%)	Sprout length (cm)	Weight loss (%)	Damage (%)	TSS (%)
M (2 m/L)	17.83 b	1.07 b	5.03 b	13.27 b	6.00 d	19.00 b	1.30 b	5.57 b	14.20 b	6.10 d
C (2 m/L)	12.00 c	0.83 cd	4.17 c	8.20 c	6.07 d	12.50 d	0.90 d	4.40 c	8.87 c	6.20 cd
E (2 m/L)	10.07 d	0.73 d	3.30 d	7.07 d	7.00 b	11.67 d	0.75 de	3.27 d	7.23 d	7.00 b
T (2 m/L)	8.00 e	0.61 e	3.07 d	5.87 e	6.37 c	8.20 e	0.63 ef	3.27 d	5.37 e	6.13 d
D (2 m/L)	7.73 e	0.83 cd	2.90 d	5.70 e	7.07 b	8.37 e	0.87 d	3.00 d	6.00 e	6.93 b
B (2 m/L)	13.23 c	0.95 c	4.33 c	8.57 c	6.00 d	14.20 c	1.07 c	4.70 c	9.73 c	6.00 d
D + T (1 + 1 m/L)	0.80 f	0.54 e	1.10 e	3.00 f	6.53 c	1.08 f	0.60 ef	1.40 e	3.57 f	6.53 c
E + D + T (1+1+1 m/L)	0.71 f	0.50 e	1.33 e	3.47 f	7.79 a	0.80 f	0.54 f	1.23 e	4.23 f	7.73 a
Control	73.67 a	2.53 a	19.00 a	51.00 a	5.00 e	76.33 a	2.87 a	21.67 a	50.33 a	5.23 e

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test at 5% probability.

Fig.4. Tubers of Spounta *cv.*

Cont.1. Untreated tubers within closed site.

Cont.2. Untreated tubers within opened site.

T + D. Tubers sprayed with T + D oils (1 + 1 ml/L).

T + D + E. Tubers sprayed with T + D + E oils (1 + 1 + 1 ml/L).

$C_2 + T_2 + D_2$. Tubers sprayed with C + T + D oils each one (2 ml/L).

Herein, the anti-sprout effect of such treatments could be explained at the previously mentioned bases and discussion. Additionally, those might be reduced respiration and thereby reduced degradation and changes of carbohydrate and sugars and depletion of other tuber reserves.

Also, it was obvious that tubers of such treatments were maintained higher total soluble solids (TSS) content relative to control one. Control tubers depleted more reserves in respiration (due to storage condition) and in sprouting activities. (Notice the previously presented air temperature and relative humidity during the storage period.

This also could be extended to explain the weight losing case of oil treatments and control. On the other hand, the suppressive effect of the oils treatments on the incidence of rotting and decaying of tubers might be due to their anti-fungal function (Bang, 1995).

Experiment III:

Research was extended to investigate sprouting case of other potato cvs, i.e. Polesta, Diamont and Provento during their storage at the ambient temperatures, when their tubers were sprayed with different essential oils (caraway, thyme, eucalyptus, limonene each one (5 ml/L) and all combined oils (1.25 ml/L) from each one, under rice straw cover at open site.

Data in Table (5) illustrated the effect of different potato cvs. Provento was of the least sprouting percentage followed by Diamont and at least Polesta cv. with significant differences among them. This might be due to their differences in firmness, Provento rather firm, Diamont and Polesta were rather firm to mealy reflected. Tuber firmness reflected the internal case and associated with tuber storability.

Table 5. Sprouting (%) of different potato cvs during 6 months storage at the ambient temperatures.

Cvs	2001 season	2002 season
Polesta	51.11 a	49.72 a
Provento	5.00 c	4.79 c
Diamonte	15.89 b	16.61 b

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test at 5% probability.

Data in Table (6) illustrated the effect of oil treatments. Limonene oil followed by thyme oil were the most effective anti-sprout, they were suppressed the sprouting % to 9.0 and 13.3, respectively compared with control (57.3%). Caraway oil relatively gave some stimulatory effect (29.7% sprouting) as it previously did not higher concentration.

Data in Table (7) illustrated the effect of interaction of cvs x oil treatments. Such data indicated that different potato cvs were significantly differed among them in their response to the applied oil.

Also, same data cleared that with Polesta cv, limonene oil was the most effective treatment, it was reduced sprouting (%) from 97.5 to 19.8% . Thyme or eucalyptus oil were the most effective with Diamont, thyme oil reduced sprouting (%) from 50% to 2.3% and to 4.6% by eucalyptus one.

Table 6. Sprouting (%) as affected by essential oils spraying during 6 months storage at the ambient temperatures.

Treatments	2001 season	2002 season
C 5 ml/L	28.89 b	30.55 b
T 5 ml/L	13.22 cd	13.55 cd
E 5 ml/L	14.67 cd	15.00 cd
L 5 ml/L	9.00 d	9.22 d
C+T+E+L (1.25 ml/L of each one	19.55 c	17.66 c
Untreated	58.66 a	56.11 a

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test at 5% probability..

Table 7. Sprouting (%) as affected by interaction of potato cvs x essential oils during 6 months storage at the ambient temperatures.

Treatments		2001 season	2002 season
Polesta	C 5 ml/L	75.67 b	79.00 b
	T 5 ml/L	32.00 def	33.33 de
	E 5 ml/L	41.00 cd	38.67 cd
	L 5 ml/L	20.33 fgh	19.33 fg
	C+T+E+L (1.25 ml/L of each one)	37.67 cde	33.00 de
	Control	100.00 a	95.00 a
Proventa	C 5 ml/L	0.0i 0.0	0.0 h
	T 5 ml/L	5.00 i	4.33 h
	E 5 ml/L	0.00 i	0.00 h
	L 5 ml/L	0.00 i	0.66 h
	C+T+E+L (1.25 ml/L of each one)	0.00 i	0.00 h
	Control	25.00 efg	23.33 ef
Diamonte	C 5 ml/L	11.00 ghi	12.67 fgh
	T 5 ml/L	2.66 i	3.00 h
	E 5 ml/L	3.00 i	6.33 h
	L 5 ml/L	6.66 hi	7.66 gh
	C+T+E+L (1.25 ml/L of each one)	21.00 fg	20.00 fg
	Control	51.00 c	50.00 c

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test at 5% probability.

The best effect with Provento cv resulted from caraway, eucalyptus, limonene and (T + C + E + L) oils application, any one was fully suppressed sprouting incidence (from 24.1 to 0.0%). The effect of interaction treatments could be related with the similar effect of their individual factors (Tables 5 and 6).

Herein, it is of benefit to be observed the relatively higher concentration of the applied oils (5 ml/L). This based on the possibility of losing some suppressive effect of such oils due to some leakage of oil vapour through the rice straw cover at the open storage site.

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تقنيات جديدة لتخزين أصناف مختلفة من البطاطس بطريقة فعالة وآمنة على درجات الحرارة العادية

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نفذت تجارب لتخزين أصناف مختلفة من البطاطس بالمحطة البحثية بالمنصورة التابعة لمعهد بحوث البساتين بالجيزة لدراسة تأثير بعض المعاملات على تخزين أصناف مختلفة من البطاطس لمدة ٦ شهور على درجات الحرارة العادية . وفيما يلى ملخص النتائج للتجارب المختلفة:-

١- عملت كل الزيوت العطرية المستخدمة بكفاءة كمضادات تزريع خاصة عند التركيزات المنخفضة وأظهرت كفاءة أعلى عند خلطها معاً. ويمكن معاملة الدرنات مباشرة برش الزيوت على حالتها السائلة فى حيز مغلق أو مكان مفتوح أو بطريقة غير مباشرة بالسماح لها بالتطاير وإنتشار بخارها فى حيز مغلق.

٢- أدى إستخدام الزيوت إلى تحسن كبير فى القابلية التخزينية لكل الأصناف وإلى نقص واضح فى نسبة التزريع ونسبة الفقد فى الوزن ونسبة التلف والحد من إستطالة النبوت والإحتفاظ بمحتوى مرتفع من المواد الصلبة الذائبة الكلية.

٣- كانت أفضل المعاملات التخزينية لكل صنف كالتالى:-

أ- الصنف ديتا: رش الدرنات المخزنة فى حيز ضيق (مرتان) بمخلوط زيوت (الزعتر + الكراوية) بتركيز ١ مل/لتر لكلا منهما. أو بتعريض الدرنات المخزنة فى حيز ضيق لبخار (زيت الزعتر + زيت الكراوية) بتركيز ٥ مل لكلا منهما يليه تركيز ١٠ مل لكلا منهما / حيز مغلق حجمه (٦٠ × ١٠ ^{٣} سم^{٣}).

ب- الصنف سبونتا: رش الدرنات (مرتان) بمخلوط زيوت (الشبت + الزعتر + الكافور) بتركيز ١ مل/لتر لكلا منهما وكذلك مخلوط زيتى (الشبت + الزعتر) (١ مل/لتر) لكلا منهما فى حيز مفتوح.

ج- الصنف بوليستا: رش الدرنات المخزنة تحت غطاء من قش الأرز (مرتان) بزيت الليمونين بتركيز (٥ مل/لتر) فى مكان مفتوح ، وقد أدى هذا إلى تخفيض نسبة التزريع من ٩٧,٥ إلى ١٩,٨%.

د- الصنف دايمونت: رش الدرنات المخزنة بنفس الطريقة (مرتان) بزيت الكافور (٥ مل/لتر) ، وقد أدى هذا إلى تخفيض نسبة التزريع من ٥٠% إلى ٢,٣% أو زيت الكافور (٥ مل/لتر) كذلك خفض نسبة التزريع إلى ٤,٦%.

هـ- الصنف بروفينتو: رش الدرنات المخزنة تحت نفس الظروف (مرتان) بأى من زيوت الكراوية أو الكافور أو الليمونين بتركيز (٥ مل/لتر) كانت كلها متساوية فى التأثير وأعطت تثبيط كامل للتزريع حيث إنخفضت النسبة من ٢٤,١ إلى صفر %.

فى النهاية يمكن التوصية بإستخدام هذه المعاملات كتقنيات جديدة وذات فوائد كثيرة لتخزين البطاطس خارج الثلاجات على درجات الحرارة العادية وبدون الحاجة لإستخدام مانعات تزريع تخليقية وذلك لمدة ٦ شهور.