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CHIPS PROCESSING QUALITY OF TWO STORED POTATO CULTIVARS UNDER CONTROLLED CONDITIONS: EFFECT OF COMMERCIAL APPLICATION OF CIPC SPROUT INHIBITOR, RECONDITIONING AND SOME TECHNOLOGICAL TREATMENTS

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ABSTRACT: ***The influences of commercial application of Chloro-Isopropyl n-Phenyl Carbamate (CIPC) sprout inhibitor, reconditioning and some technological treatments on the quality of chips made from stored potato under controlled conditions was examined. CIPC as antisprouting agent after 45 days of storage at 9.5°C and 95 % RH nearly did not influence the determined chemical parameters which included, moisture, starch, reducing sugars, protein, non protein nitrogen and lipids in addition to the acceptability and organoleptic properties of potato chips. 120 days stored potatoes were reconditioned for 12 and 24 hours at room temperature (22±2°C). Reconditioning significantly increased the starch content with a significant decline in the reducing sugars and improved the organoleptic properties of chips. The suggested technological treatments followed in this study let to more reduction in reducing sugars than reconditioning did. The combination between reconditioning and technological treatments was more effective in lowering reducing sugars, improved the color of chips. Generally, the reductions in reducing sugars by different treatments used in this study, reconditioning, technological treatments, reconditioning plus technological treatments, were more pronounced in slices of Herms potato cultivar than Lady Rosetta one. From the organoleptic properties and acceptability of view, the best trail used was first blanching the slices for 3 min. at 95 °C followed by 10 min. freezing at -37 °C for reconditioned potato up to 24 hr at room temperature .***

Key words: ***Potato tubers, anti sprouting agent, storage, reconditioning, technological treatments, chemical composition, chips quality***

INTRODUCTION

Potato chips constitute one of the most popular consumer snake products throughout the world. The acceptability of potatoes for processing as chips with high quality is largely dependent on many factors such as; (A)

Potato variety; the quality of potato chips is highly dependent on genetic characteristics of potato cultivars. Cultivars, which possess hereditary ability to accumulate reducing sugars and other compounds affecting the chip color should be avoided. The choice of potato cultivar for chipping is based on its reducing sugars and total solids contents. The yield of potato chips increases as the specific gravity, or dry matter, of the fresh tuber increase (Melton, *et. al*. 1993 and Yang *et al*., 1999). Proper varieties for chip production should be; (1) resistant to diseases. (2) with less shallow eyes, regular shape and white to light yellow flesh color.(3) high in dry matter and starch content, with few mechanical injuries and slight flesh discoloration.(4) easily conditioned and less susceptible to sugar accumulation during storage (Henk and Sanne,2000) . (B) Environmental factors; the chemical composition of potato tubers depends on local environmental conditions of their cultivation zones, especially microclimate and soil. Potatoes grown on sandy soils usually have higher specific gravities than those grown on heavy soils. Therefore, they are better raw material for chip production, better yield and quality (Atkin and Goodenough, 1981, Bartsch and Blanpied, 1990and Bahman *et al*., 1995). (C) Cultivation practice: All treatments used in potato cultivation, such as irrigation; fertilization, chemical weed control, application of insecticides and fungicides, and removal of potato vines, can affect the chemical composition and quality of chips (Christine and Ayodele, 1995). (D)Transportation and storage ; The factors, which have a marked effect on the quality of chips and are especially dependent on Man's activities, include potato harvesting, shipping and handling at the proper air temperature and humidity. Potato tubers for chips should be transported at a constant temperature near to the prevailing soil temperature in the potato field. The best storage conditions to keep potato very close to fresh one are , 9.5°C, 95% relative humidity, <2500 ppm carbon dioxide, 10-20 cubic feet per minute (cfm) of air per ton, off light and in bulk for 120 days (Moharm *et al*., 2007) . Potatoes may be store for processing, the cold storage (3-4 °C) induced accumulation of high levels of reducing sugars from starch reserves is of concern to the potato processing industry due to the participation of reducing sugars as substances in the Maillard browning reaction during frying (Gurbuz, 1997 and Rebort *et al.,* 2002). High levels of reducing sugars result in the production of dark- colored chips that are unacceptable to the consumer due to their appearance and bitter taste. This deterioration in chips color quality may be reversed by reconditioning the cold stored tubers at warmer storage temperatures (i.e.,>10°C) prior to processing, which decreases reducing sugars content as some of these sugars are converted back into starch. However, reconditioning does not always lower the concentration of reducing sugars to acceptable levels, and long-term low temperature sweetening is considered to be irreversible (Griffiths,1997).

Therefore, to maintain low levels of sugars during long term storage, processing potatoes are generally stored at temperatures around 9-10°C and

treated with dormancy prolonging chemicals to prevent sprouting. Potato chipping is a water-removal process. Hence potatoes with more solids (higher specific gravity) will lose less water and give high chip yield. Also the low specific gravity tubers absorb more oil during deep-frying .Too much oil absorption results a greasy chips with high oil content and also increases the production costs of frying process (Alberto, *et al.* 1999). Good quality potato chips have a light color, little vascular discoloration, a pleasing and desirable flavor. Potatoes with high sugar levels produce dark chips. This results from reaction between reducing sugars and amino acids, a non-enzymatic browning reaction. The flavor of potato chips is more complex than that of boiled, baked or mashed potato products. This may be due to the high temperature of frying process, and the absorbed oil, which contributes to the overall flavor profile of the product (Marquez and Anon, 1986). In this study the influence of commercial application of CIPC sprout Inhibitor, reconditioning and some technological treatments on two cultivars of potato tubers were stored under controlled conditions and the quality of their chips product was investigated.

MATERIALS AND METHODS

Materials:

Two cultivars of fresh full mature potatoes (*Solanum tuberosum* L) namely Lady Rosetta and Herms were brought from the private farm of Societe Nationale Du Commerce "SONAC Co." Alsalhia ,EL-Sharkia governorate, Egypt after harvesting in the middle of May 2002. The harvested potatoes were packed on Jumbo bags and placed on a shaded place before transported by trucks to the cold store. Potatoes were cured at 16°C ±2 °C and 85-90% relative humidity for 15-21 days, then graded mechanically according to their size using grader model 900-1750-1, Bijlsma Hercules BV, Holland, sorting by hand and packed in wooden boxes. The boxes were stored under controlled conditions of 3300 ppm of CO_2, 95 % relative humidity and 9.5°C for 120 days in four rooms of Sonac Co., Damanhour, Behaira governorate, Egypt. Each room has 17.10 x 29.90 x 7.00 meter dimensions, 2 perforated ducts with 70 cm diameter, 1140 box capacity per each room (228 box x 5 boxes height) containing around 5000 tons of potatoes. Samples of stored potatoes were withdrawn after 0.0, 45, 90, and 120 days of storage to evaluate the changes in their quality, before and after frying to chips. CIPC was used as anti sprouting agent after 45 days of storage. The stored potatoes were sprayed with CIPC solution at the rate of 60 gm CIPC / Ton of potatoes to inhibit potatoes buds germination. Fresh palm olein oil was used for frying potato slices. It was obtained from local market at Alexandria, Egypt. It has 0.03% free fatty acids as oleic acid, zero peroxide value and 2.2 red Lovibund color using 5 ¼ inch cell.

Technological methods:

1- Reconditioning of stored tubers: The 120 days stored potato tubers were subjected for reconditioning at room temperature (22±2 °C) for 12 and 24 hours.

2- Treatments of potato slices before frying: The suggested treatments included: (A) Soaking potato slices in warm water (45°C) for 5 minutes. (B) Blanching potato slices for 3 and 6 minutes at 95°C. (C)Freezing of potato slices at –37 °C for 5 min , or for 10 min after blanching at 95 °C for 3 min .

3- Potato chips: Three kilograms sample from stored tubers were manually sorted then washed and cleaned by running water for four minutes, peeled using carbarundum mechanical potato peeler model No20 Fimar Co., Italy, with size14 lbs, grit size1-1.5 mm for 1.5 to 2 minutes. Washed peeled potatoes were trimmed by hand using stainless steel knives, mechanically sliced into slices with 1.3 to 1.5 millimeters thickness by Lama 220 slicer model Shedco, Italy. The resulted slices were washed to remove the released starch forming during slicing by washing in a 50 liter pot containing 25 liter of water. The weight of washed slices was determined after sorting to discard discolored or irregular shaped slices. Slices were placed on perforated trays at a rate of one pound per square foot, dried in a cabinet dryer for 12 minutes at 60°C to decrease their moisture content to about 24 % before frying. The slices were immersed in palm olein vegetable oil at a temperature of 185°C until fried, using pilot fryer with capacity 8 liter, model Bartlett D11E30, Italy. When the oil in the fryer heated to 185°C, power to the fryer was immediately switched off then the basket containing potato slices was placed in the oil. The basket was moved vigorously after 3 minutes from frying prevent the sticking of slices together. Potato chips were drained, cooled, turned onto a white tray, and the weight of the fried sample was recorded to calculate the chips yield. Samples of chips were inspected for green, undesirable color, external and internal defects.

Chemical Analysis:

The AOAC (1995) methods were followed to determine the most chemical constituents of potato tubers and chips. Otherwise, the reference was mentioned. All analysis were carried out in triplicates.

Preparation of the samples: Potato tubers were cleaned, peeled and sliced. Part of these slices was immediately analyzed for the moisture, sugars, while the rest was dried at 110°C, then crushed, finally ground in a stainless steel hammer mill, mixed and stored in an air tight glass container for subsequence determinations of the total nitrogen, non –protein nitrogen and crude fat.

Moisture content of potato tubers and chips were determined by drying method at 110 °C and the dry matter (%) was calculated by difference .Reducing sugars were extracted with 80% ethanol, rotary evaporated at 50°C and water diluted extract was subjected to determine reducing sugars using

Lane and Eynan method. Starch was determined by the direct acid hydrolysis method using concentrated HCl for 2.5 hr. The resulted sugars were determined by Lane and Eynan method. Starch was calculated by using a 0.9 conversion factor . The crude protein content was assessed by semi-micro Kjeldahl method using a factor of 6.25 .NPN was determined in the supernatant after precipitation of protein by 10% trichloro acetic acid as described by Singh and Jambuthan(1981) using microKjeldahl method. Protein nitrogen was calculated by subtracting the NPN from total nitrogen. Crude oil was determined by Soxhelt extraction method using petrolium ether (boiling point 40-60°C). Ash was estimated at 550 °C in muffle furnace.

Organoleptic methods: The potato chips were subjected for sensory evaluation using ten panelists of Food Science and Technology Department staff, Agriculture College, Alexandria University. Panelists were asked to evaluate the sensory properties (Color, Texture, Odor and Taste) of potato chips according to Moharm, *et. al*. (2007).
Statistical analysis: Results were analyzed using analysis of variance of the SAS package (SAS,1985).

RESULTS AND DISCUSSION:

1- Effect of CIPC treatment:

Fig.(1) illustrated the sprouting position of the tubers of both Herms and Lady Rosetta potato cultivars after 45 days of storage. It was clear that treatment with CIPC completely stopped the sprouting. The influence of this treatment on chemical properties and acceptability of chips of 45 days stored potato tubers were investigated.

Fig.(1) : Sprouted potato tubers after 45 days of storage

Results in Table (1) indicated that using CIPC as anti sprouting agent after 45 days of storage nearly did not influence the determined chemical

parameters which included, moisture , starch , reducing sugars, protein, NPN and lipids .

Table (1): Effect of CIPC treatment on some chemical components of 45 days stored potato tubers

Potato cultivar	Herms				Lady Rosetta			
Treatment	Before spraying		After Spraying		Before spraying		After Spraying	
Component %	On fresh weight bases	On dry weight basis	On fresh weight bases	On dry weight basis	On fresh weight bases	On dry weight basis	On fresh weight bases	On dry weight basis
Moisture	78.08	--	78.00	--	77.47	--	77.31	--
Starch	14.40	65.69	14.51	65.95	14.93	66.27	15.01	66.15
Reducing sugars	2.34	10.67	2.30	10.45	2.26	10.03	2.21	9.74
Proteins	2.80	12.77	2.82	12.81	2.73	12.12	2.74	12.40
Non protein nitrogen	0.34	1.55	0.34	1.55	0.34	1.51	0.34	1.50
Lipids	0.08	0.36	0.08	0.36	0.09	0.40	0.09	0.41

2- Chips of stored potatoes:

Samples of potato tubers were withdrawn at 45 days of storage under the conditions before and after using CIPC. The withdrawn samples were subjected for frying and the following parameters were evaluated.

Organoleptic properties of chips:

As mentioned before for chemical properties application of CIPC did not affect the acceptability and organoleptic properties of potato chips. Data in Table (2) and Fig. (2) showed that panelists did not observe any difference in sensory properties between 45 days stored untreated and CIPC treated chips. It can be concluded from the above results that:

Treated potato tubers after 45 days of storage with CIPC solution at a rate of 60 gm CIPC /Ton inhibits the potato sprouting completely without affect their chemical composition and the organoleptic properties or acceptability of their processed chips.

Table (2):Influence of spraying with CIPC on the organoleptic quality of chips of 45 days stored potato tubers.

Treatment	Potato cultivar	Organoleptic characteristic			
		Color	Texture	Odor	Taste
Before spraying	Herms	Good	Excellent	Good	Excellent
After spraying		Good	Excellent	Good	Excellent
Before spraying	Lady Rosetta	Good	Excellent	Good	Excellent
After spraying		Good	Excellent	Good	Excellent

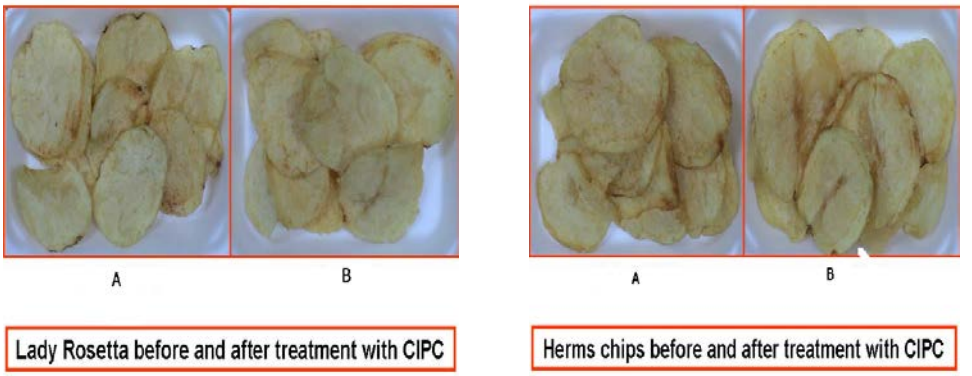

Fig.(2): Appearance of chips of 45 days stored potato tubers before (A)and after (B)treatment with CIPC.

Reconditioning of stored tubers:

The changes in moisture content, dry matter, starch and reducing sugars were determined before and after reconditioning the 120 days stored potato tubers at room temperature (22±2 °C) for 12 and 24 hours. The results were tabulated in Table (3) .The following could be noticed from these results; 1. Slight changes in moisture and dry matter contents of tubers for both stored potato cultivars were observed through the two periods of reconditioning. 2. A steadily increases in starch and gradual decrease in reducing sugars were occurred with extending reconditioning period. 3. The rate of the increase in starch was 2.69 and 3.80% in Herms stored tubers, 3.91 and 6.70% in those of Lady Rosetta cultivar after 12 and 24 hours reconditioning period, respectively. 4. In contrast to starch increase, the reduction in reducing sugars of stored tubers after reconditioning for 12 and 24 hours was 10.94 and 14.96% for Hermes tubers and 6.06 and 14.77% for Lady Rosetta ones, respectively. This means that through reconditioning reducing sugars were converted into starch. According to Harris (1992) during reconditioning process a high proportion of reducing sugars converts to starch by starch synthesizing enzyme. The other part of reducing sugars decline was due to respiration .The reduction rate of reducing sugars was higher than that of rise in starch. Also the above changes were more noticeable in Herms than Lady Rosetta tubers.

Table (3): Effect of reconditioning period at room temperature on some chemical compounds of 120 days stored potato tubers:

Potato cultivar	Herms			Lady Rosetta		
reconditioning period (hr.) / component (%)	0.0	12	24	0.0	12	24
Moisture	*a 77.64	a 77.24	a 77.14	76.19 a*	76.21 a	75.96 a
Dry matter	b 22.36	a 22.76	a 22.86	23.81 b	23.74 b	24.04 a
Starch	c 13.73	b 14.10	a 14.24	14.59 c	15.16 b	15.57 a
Reducing sugars	a 2.74	b 2.44	c 2.33	2.64 a	2.48 b	2.25 a

* Means in a raw (within the same cultivar) not sharing the same superscript are significantly different at P≤ 0.05

Table (4) Fig. (3) illustrates the appearance of the chips prepared from unconditioned and reconditioned potato tubers. The panelists accepted these products. They described the texture as crispy, taste as flat and odour as normal of these products. The acceptability of their color varied from fair (dark yellow) to good (yellow). The reducing sugars in chips with fair color (dark yellow) were ranged from 2.48-2.74%. Meanwhile they were varied from 2.25-2.44% in chips with good color. These results indicated that to prepare chips with an excellent color reducing sugars should be lowered to less than 2.25%. Also short reconditioning period at room temperature (22±2 °C) is not enough to realize the color improving of chips. Moreover the extending of reconditioning periods to more than 24 hours may be not applicable for processing chips in an industrial scale especially in mass production.

Table (4): Effect of reconditioning periods at room temperature on yield and organoleptic properties of chips of 120 days stored potato tubers.

Reconditioning period (hr.)	Potato Cultivar	Yield %	Organoleptic characteristics			
			Color	Texture	Odor	Taste
00	Herms	37.7	Fair	Excellent	Good	Excellent
12		37.32	Good	Excellent	Good	Excellent
24		37.31	Good	Excellent	Good	Excellent
00	Lady Rosetta	36.98	Fair	Excellent	Good	Excellent
12		36.75	Fair	Excellent	Good	Excellent
24		36.13	Good	Excellent	Good	Excellent

Herms (zero time)

Lady Rosetta (zero time)

Herms (after 12 hr.)

Lady Rosetta (after 12 hr.)

Herms (after 24hr.)

Lady Rosetta (after 24 hr.)

Fig.(3) :Effect of reconditioning treatments on the appearance of chips 120 days stored potato tubers.

Technological Treatments:

The technological treatments based on treated the potato slices before frying. These treatments can easily apply in chip plant .The main aim behind the application of such treatments is to reduce the level of reducing sugars and consequently improved the chips color.

Changes in moisture content of potato slices:

Table (5) shows the changes in moisture content in potato slices after treating with the pervious technological treatments. Generally soaking the slices in warm water for 5 minute at 45°C, blanching in hot water for 3 and 6 minutes at 95°C in addition to freezing before and after blanching led to small rise in moisture content of potato slices from 75.96 –77.64 % to 76.61-81.66%.

Generally, the highest increases in moisture content of potato slices were observed after blanching in water especially for 6 minute at 95 °C followed by soaking in warm water (45°C) for 5 minute, then freezing at -37°C for 5 or 10 minutes. Also these changes in moisture content was relatively more noticeable in slices of Lady Rosetta cultivar than those of Herms one. The increase in moisture is mainly due to the water uptake by the starch of the potato slices. The ability of starch to absorb water increases with increase temperature. Therefore the moisture content of slices was relatively high in both blanched and soaked slices than frozen one. It could also noticed that the rate of increase in moisture content was relatively more in 12 hours reconditioned slices than both unconditioned and/or 24 hours reconditioned slices.

Table (5): Effect of some technological treatments on moisture content of 120 days stored potato tubers before and after reconditioning

Potato cultivar	Herms			Lady Rosetta		
Reconditioning period /Hour / Technological treatments	0.00	12	24	0.00	12	24
Without treatment	*c 77.64 a**	c 77.24 a	b 77.14 a	c 76.14 a	e76.21 a	e75.96 b
A-Soaking in water for 5 minutes at 45°C	b 78.80 b	a 81.36 a	a 78.49 b	b 78.82 b	a81.09 a	c79.08 b
B-Blanching :						
-For 3 minutes at 95 °C	c 77.96 b	b 80.53 a	a 78.11 b	a 80.86 a	b80.43 a	b80.38 a
-For 6 minutes at 95 °C	a 79.42 b	a 81.66 a	a 78.22 c	a 80.33 b	bc80.12 b	a81.09 a
C- Freezing :						
For 5 minutes at (– 37 °C)	a 79.58 b	a 81.56 a	b 77.22 c	a 80.32 a	d78.56 b	d76.61 c
-For 10 minutes at (– 37°C) after Blanching for 3 minutes at 95°C	a 79.51 b	b 80.71 a	b 76.99 c	b 78.32 b	c79.53 a	c78.16 b

*** Means in a column not sharing the same left superscript are significantly different at P< 0.05.**
****Means in a raw (within in the same cultivar) not sharing the same right superscript are significantly different at P< 0.05.**

Changes in reducing sugars content of potato slices:

Results in Table (6) shows the changes in reducing sugars of potato slices after treating with the different suggested technological treatments. The data in this table reveal that; (1)The suggested technological treatments led to more reduction in reducing sugars than reconditioning process. (2)The technological treatments can be arranged according to their effect in lowering reducing sugars of potato slices in the following decreasing order, blanching for 6 minute at 95° C (20.88-28.47%) , 10 minute freezing of 3 minute blanched slices at 95° C (18.95-22.72%) , 3 minute blanched at 95° C(16.44-20.07%) , 5 minute freezing at -37° C (14.11-17.62%) and lastly soaking for 5 minute at 45° C (8.33-14.59%) .(3)Combination between reconditioning and different suggested technological treatments increased from the reduction of reducing sugars. (4) Generally the reduction in reducing sugars by different trails used in this study, reconditioning, technological treatments, reconditioning plus technological treatments, was more pronounced in slices of Herms potato cultivar than Lady Rosetta one. The rapid freezing of potato slices before or after blanching at -37° C may be caused freezing to the free water and also enhanced from the cell wall permeability of potato slices cells. Such changes help in leaching out some of bound water, which contains reducing sugars. Also blanching before freezing denatured the protein of slices and that may enhances from the leaching out of reducing sugars or help in accelerating from the removing of reducing sugars out the slices.

Table (6): Effect of some technological treatments on reducing sugars content of 120 days stored potato tubers before and after reconditioning .

Potato cultivar	Herms			Lady Rosetta		
Reconditioning period /Hour Technological treatments	0.00	12	24	0.00	12	24
Without treatments	$^{*a}2.74^{a**}$	$^{a}2.44^{b}$	$^{a}2.33^{c}$	$^{a}2.64^{a}$	$^{a}2.48^{b}$	$^{a}2.25^{c}$
A-Soaking in water for 5 minutes at 45°C	$^{b}2.44^{a}$	$^{b}2.25^{a}$	$^{b}1.99^{c}$	$^{b}2.42^{a}$	$^{b}2.24^{b}$	$^{b}2.05^{c}$
B- Blanching for 3 minutes at 95 °C	$^{c}2.19^{a}$	$^{c}2.00^{a}$	$^{b}1.89^{c}$	$^{c}2.16^{a}$	$^{c}2.07^{b}$	$^{c}1.88^{c}$
Blanching for 6 minutes at 95 °C	$^{e}1.96^{a}$	$^{d}1.82^{a}$	$^{a}1.78^{b}$	$^{d}2.03^{a}$	$^{d}1.63^{c}$	$^{c}1.78^{b}$
C- Freezing for 5 minutes at (– 37 °C)	$^{c}2.26^{a}$	$^{c}2.01^{a}$	$^{bc}1.69^{a}$	$^{c}2.21^{a}$	$^{c}2.13^{b}$	$^{c}1.89^{c}$
Freezing for 10 minutes at (– 37°C) after Blanching for 3 minutes at 95°C	$^{d}2.13^{a}$	$^{d}1.93^{a}$	$^{c}1.85^{c}$	$^{d}2.04^{a}$	$^{c}2.11^{a}$	$^{c}1.76^{b}$

*,** **As in Table 5.**

Organoleptic properties:

Tables (7) and (8) summarize the results of the organoleptic evaluation of the prepared chips .Treating 120 days stored unconditioned potato slices

with different suggested technological treatments gave chips with an excellent taste and odour. Also such processes improved the color acceptability of chips from fair and poor to good except the product prepared from the blanched frozen slices of Lady Rosetta potato. The color of last product had fair acceptability. On the other hand blanching of unconditioned potato slices at 95 °C either for 3 or 6 minutes gain the chip products the firm texture. Meanwhile the other treatments kept the crispy texture of this product.

Although reconditioning of stored potato tubers for 12 and 24 hours didn't affect the acceptability of the taste, odour, and texture of their produced chips, it improved the color acceptability from fair to good, and from poor to fair for chips made from potato Herms and Lady Rosetta cultivars, respectively. Treating 12 hour reconditioned potato slices with the various suggested technological treatments gave chips with an excellent taste, odour, texture and good color. Extending the reconditioning period to 24 hour with the application of the suggested technological treatments on potato slices produced chips with an excellent texture, odour, and taste acceptability. Also the previous conditions improved the acceptability of chips color from good to an excellent except for products made of slices subjected to blanching for 3 min. at 95°C, and that frozen for 5 min. at -37°C.The later products kept their good color acceptability.

Table (7): Effect of some technological treatments on organoleptic properties of chips of 12 hour reconditioned 120 stored potato tubers .

Technological Treatments	Potato Cultivar	Organoleptic characteristics			
		Color	Texture	Odor	Taste
Without treatment	Herms	Fair	Excellent	Good	Excellent
A-Soaking in water for 5 minutes at 45°C		Good	Excellent	Excellent	Excellent
B-Blanching for 3 minutes at 95 °C		Good	Excellent	Excellent	Excellent
6 minutes at 95 °C		Good	Excellent	Excellent	Excellent
C-Freezing for 5 minutes at (– 37°C)		Good	Excellent	Excellent	Excellent
10 minutes at (– 37°C) after blanching for 3 minutes at 95°C		Good	Excellent	Excellent	Excellent
Without treatments	Lady Rosetta	Poor	Excellent	Good	Excellent
A-Soaking in water for 5 minutes at 45°C		Good	Excellent	Excellent	Excellent
B-Blanching for 3 minutes at 95 °C		Good	Excellent	Excellent	Excellent
6 minutes at 95 °C		Good	Excellent	Excellent	Excellent
C-Freezing for 5 minutes at (– 37°C)		Good	Excellent	Excellent	Excellent
10 minutes at (– 37°C) after blanching for 3 minutes at 95°C		Fair	Excellent	Excellent	Excellent

Table (8): Effect of some technological treatments on organoleptic properties of chips of 24 hour reconditioned 120 stored potato tubers.

Technological Treatments	Potato Cultivar	Organoleptic characteristics			
		Color	Texture	Odor	Taste
Without treatments	Herms	Good	Excellent	Excellent	Excellent
A-Soaking in water for 5 minutes at 45°C		Excellent	Excellent	Excellent	Excellent
B-Blanching for 3 minutes at 95 °C		Good	Excellent	Excellent	Excellent
6 minutes at 95 °C		Excellent	Excellent	Excellent	Excellent
C-Freezing for 5 minutes at (– 37°C)		Good	Excellent	Excellent	Excellent
10 minutes at (– 37°C) after blanching for 3 minutes at 95°C		Excellent	Excellent	Excellent	Excellent
Without treatment	Lady Rosetta	Fair	Excellent	Good	Excellent
A-Soaking in water for 5 minutes at 45°C		Excellent	Excellent	Excellent	Excellent
B-Blanching for 3 minutes at 95 °C		Good	Excellent	Excellent	Excellent
6 minutes at 95 °C		Excellent	Excellent	Excellent	Excellent
C-Freezing for 5 minutes at (– 37°C)		Good	Excellent	Excellent	Excellent
10 minutes at (– 37°C) after blanching for 3 minutes at 95°C		Excellent	Excellent	Excellent	Excellent

Moisture and reducing sugars :

Table (9) shows the levels of moisture contents of the chip products. Generally potato chipping is a water removal process. Therefore the water content of the chips depends on the initial moisture content of potato slices in addition to frying conditions especially frying time and temperature. As mentioned in materials and methods section, the frying conditions were 185° C, 3 minutes using pilot fryer. Therefore, the small differences in moisture content were noticed between the prepared chips (1.61-1.96%). These were mainly attributed to the variations in moisture content of the potato slices which treated with different suggested technological treatments before frying.

Table (9): Effect of some technological treatments on moisture content of chips prepared from 120 days stored potato tubers before and after reconditioning.

Potato cultivar	Herms			Lady Rosetta		
Reconditioning period /Hour	0.00	12	24	0.00	12	24
Technological treatments						
Without treatment	$^{*b}1.82^{a**}$	$^{a}1.77^{b}$	$^{d}1.61^{c}$	$^{ab}1.95^{a}$	$^{a}1.93^{bc}$	$^{a}1.90^{c}$
A-Soaking in water for 5 minutes at 45°C	$^{b}1.80^{a}$	$^{a}1.66^{c}$	$^{b}1.76^{b}$	$^{b}1.92^{a}$	$^{a}1.96^{a}$	$^{a}1.90^{b}$
B-Blanching :						
-For 3 minutes at 95 °C	$^{b}1.83^{a}$	$^{a}1.63^{b}$	$^{b}1.78^{a}$	$^{a}1.98^{a}$	$^{a}1.94^{a}$	$^{bc}1.85^{b}$
-For 6 minutes at 95 °C	$^{b}1.79^{a}$	$^{a}1.73^{b}$	$^{b}1.78^{a}$	$^{b}1.91^{a}$	$^{a}1.92^{a}$	$^{bc}1.85^{a}$
C- Freezing :						
For 5 minutes at (– 37 °C)	$^{a}1.92^{a}$	$^{a}1.73^{b}$	$^{c}1.69^{c}$	$^{ab}1.94^{a}$	$^{a}1.93^{a}$	$^{c}1.83^{b}$
-For 10 minutes at (– 37°C) after blanching for 3 minutes at 95°C	$^{b}1.81^{b}$	$^{a}1.73^{c}$	$^{a}1.88$	$^{ab}1.95$	$^{a}1.94^{a}$	$^{ab}1.89^{b}$

* Means in a column not sharing the same left superscript are significantly different at P< 0.05.
** Means in a raw (within in the same cultivar) not sharing the same right superscript are significantly different at P< 0.05.

As shown from Table (10) reducing sugars of the chips products varied from 0.38 to 0.57%. Generally such values represent the remained unreacted reducing sugars in chips after frying. They were lower in chips of 24 hours reconditioned potato than 12 hour reconditioned and unconditioned ones. Also the suggested technological treatments reduced the reducing sugars of the prepared chips. This reduction was increased when such treatments were combined with reconditioning process. Among the technological treatments, the highest reduction in reducing sugars was relatively observed in chips prepared from blanched frozen potato slices followed by those produced from blanched, frozen, and warm water soaked potato slices , respectively.

Table (10): Effect of some technological treatments on reducing sugars content of chips prepared from 120 days stored potato tubers before and after reconditioning.

Potato cultivar	Herms			Lady Rosetta		
Reconditioning period /Hour Technological treatments	0.00	12	24	0.00	12	24
Without treatment	^{*a} 0.56 ^{a**}	^{a} 0.50 ^{b}	^{a} 0.48 ^{b}	^{a} 0.57 ^{a}	^{a} 0.55 ^{a}	^{a} 0.51 ^{a}
A-Soaking in water for 5 minutes at 45°C	^{b} 0.50 ^{a}	^{b} 0.43 ^{b}	^{b} 0.43 ^{b}	^{b} 0.51 ^{a}	^{b} 0.48 ^{a}	^{b} 0.43 ^{b}
B-Blanching : -For 3 minutes at 95 °C -For 6 minutes at 95 °C	^{c} 0.48 ^{a} ^{d} 0.44 ^{a}	^{b} 0.42 ^{b} ^{b} 0.40 ^{b}	^{bc}0.42 ^{b} ^{bc}0.41^{ab}	^{b} 0.50 ^{a} ^{bc}0.49 ^{a}	^{b} 0.47 ^{a} ^{b} 0.45 ^{a}	^{a} 0.42 ^{a} ^{b} 0.41 ^{c}
C- Freezing : For 5 minutes at (– 37 °C) -For 10 minutes at (– 37°C) after blanching for 3 minutes at 95°C	^{d} 0.45 ^{a} ^{d} 0.44 ^{a}	^{b} 0.42 ^{b} ^{b} 0.41 ^{b}	^{b}0.44^{ab} ^{c}0.38 ^{b}	^{b} 0.50 ^{a} ^{c} 0.47 ^{a}	^{b} 0.47 ^{a} ^{b} 0.46 ^{a}	^{b} 0.40 ^{b} ^{b} 0.39 ^{b}

* **Means in a column not sharing the same left superscript are significantly different at P< 0.05.**
****Means in a raw (within in the same cultivar) not sharing the same right superscript are significantly different at P< 0.05.**

CONCLUSION

Using of CIPC as antisprouting agent after 45 days of storage nearly did not influence the chemical composition of potato tubers , acceptability and organoleptic properties of potato chips .Although reconditioning of potato tubers at room temperature (22±2°C) for up to 24 hr. resulted in a significant increase in starch content with a parallel reduction in reducing sugars, reconditioning was not enough to realize the color improving of potato chips. Simple and applied technological treatments should be taken into consideration to overcome this problem. The suggested technological treatments followed in this study let to more reduction in reducing sugars than reconditioning did. The combination between reconditioning and technological treatments was more effective in lowering reducing sugars, improved the color of chips and the effect was more pronounced for Herms cultivar than Lady Rosetta one From the organoleptic properties and

acceptability of view, the best trail used was first blanching the slices for 3 min. at 95 °C followed by 10 min. freezing at -37 °C for reconditioned potato up to 24 hr at room temperature .

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جودة الشيبس الناتج من صنفين من البطاطس تحت ظروف متحكم فيها: تأثير التطبيق التجاري لمثبط الإنبات CIPC و التهيئة و بعض المعاملات التكنولوجية.

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الملخص العربي

تم دراسة تأثير التطبيق التجاري لمثبط الإنبات كلورو ايزو بروبايل –ن– فنيل كربامات (CIPC) ، عملية التهيئة ، بعض المعاملات التكنولوجية على جودة الشيبس المصنع هذا و لم يؤد استخدام CIPC بعد ٤٥ يوم من التخزين على درجة حرارة ٩.٥ م° و رطوبة نسبية ٩٥% أي تأثير يذكر على المكونات الكيماوية والتى اشتملت على الرطوبة و النشا والسكاكر المختزلة و البروتين و النيتروجين غير البروتيني و الدهون فضلاً عن خواص جودة الشيبس المصنع منها هذا وقد تم تهيئة البطاطس المخزنة بعد ١٢٠ يوم لمدة ١٢، ٢٤ ساعة على درجة حرارة الغرفة (٢٢ ± ٢ م°) و قد أدت عملية التهيئة إلى حدوث زيادة معنوية في محتوى النشا قابله انخفاض معنوي في محتوى السكاكر المختزلة مع تحسن في الخواص العضوية للشيبس الناتج . و قد أدت المعاملات التكنولوجية موضع الدراسة إلى مزيد من الانخفاض في السكاكر المختزلة بدرجة أكبر من تأثير التهيئة ، إلا أن الاقتران فيما بين التهيئة و المعاملات التكنولوجية كأن أكفأ في خفض محتوى السكاكر المختزلة و حسن من لون الشيبس الناتج . ومن منظور الخواص العضوية الحسية والتقبل العام فإن انسب الظروف هي سلق الشرائح لمدة ٣ دقائق علي ٩٥ م° المتبوعة بالتجميد لمدة ١٠ دقائق علي –٣٧ م° وذلك للبطاطس التي سبق تهيئتها علي درجة حرارة الغرفة لمدة تصل إلي ٢٤ ساعة .