Effect of Some Technological Practices on Solanine in Potato Tubers

Magda, S. Sharara
Food Science and Technology Dept., Fac. of Agric., Alex. University,
21545, El - Shatby, Alexandria - Egypt

Received: 15 March 2010 *Revised: 7 May 2010* *Accepted: 10 May 2010*

ABSTRACT

The present study was conducted to determine the effect of some technological practices on solanine content in potato sticks .Data indicated that peeling process caused a significant decrease in solanine content in potato, being 14.44% and 58.25 % (on dry weight basis) when the depths of the removal peel were approximately 0.5 and 3 mm, respectively. Boiling process at 100 C° for different periods (3-9 min) did not significantly reduce the solanine content of potato sticks. Frying of potato sticks at 170 C° for 3and 6 min caused a significant decline in solanine content. The percentages of solanine reduction after frying for 3 and 6 min, were 68.79% and 75.58 % (on dry weight basis), respectively. Soaking of potato sticks in 4% acetic acid for different periods led to a significant reduction in solanine. The reduction was10.51%, 26.61%, 32.56% and 48.93% after soaking for 15,30,45 and 60 min, respectively. Soaking of potato sticks in 4% acetic acid for 30 and 60 min then boiling for 9 min or frying for 6 min resulted in a high reduction in solanine content of potato sticks (27.44% ,50.85 %, 80.55% and 89.08%, respectively). Separation of solanine from potato sticks subjected to the aforementioned treatments by TLC confirmed the results obtained in the present study.

Key words:α-solanine, green potato, glycoalkaloids,processing, Solanum tuberosum.

INTRODUCTION

Potato (*Solanum tuberosum*) is one of the important human food crop. The fresh tubers are rich in carbohydrates especially starch along with minerals particularly potassium and phosphorus. An annual production of potato tubers in Egypt is approximately 589000 ton (FAO, 2007). The loss in tubers due to an external and internal defects ranged from 20 to 30% according to potato genotypes, store system and storage conditions (El-Dawoudi,1999). An annual average consumption of such crop was around 3-3.5 kg per capita. The structural variety of the compounds in the white potato are steroids, terpenes, phenols and notably some steroidal glycoalkaloids. The last are significant because some are known to be toxic. They are considered as one of the plant natural defenses (Mondy & Seetharaman,1990). The major glycoalkaloids in potatoes are solanine and the closely related chaconine. The highest concentration of glycoalkaloids are found in the green parts of the potatoes and in the sprouts, within tubers the glycoalkaloid concentration is the highest in the peel and just below it (Friedman, 2006). Accumulation of toxic streoidal glycoalkaloids attributed to the transformation of amyloplasts to chloroplasts which responsible for photosynthetic process (Sanford *et al.*, 1992). Also, the content of total glycoalkaloids in the tuber increases in response to a number of other factors including genotypes, physical injury either from harvesting, storing, and herbivory, fungal attack, poor growing conditions such as unusual cold and hot climate during tuber development and growth (Ruprich *et al.*, 2009), inadequate storage conditions, irradiation and fertilizer use (Machado *et al.*, 2007). The consumption of potato tubers with large total glycoalkaloid concentrations can cause illness and even death. These compounds possess anticholinesterase activity (Mc Gehee *et al.*, 2000) and cause neurological and gastro intestinal disorders. (Heal *et al.*,2001). In human, an oral dose of solanine of approximately 2.8 mg/kg body weight can lead to drowsiness dyspepsia, and hyperesthesia and some what higher doses can produce vomiting and diarrhea (Slanina,1990). Furthermore, Morris & Lee (1984) stated that the toxic dose of total glycoalkaloids is approximately 2-5 mg/kg body weight whereas the lethal one is probably 3 – 6 mg/kg of body mass. In view of the potential toxicity

of glycoalkaloids, a maximum level of 20 mg/100g fresh weight has generally been accepted as the upper acceptable limit in tubers of new potato cultivars (Slanina,1990). The highest amounts of glycoalkaloids were removed during peeling, slicing, washing and frying processes. Cooking or steeping in water does not decrease glycoalkaloids content considerably. Glycoalkaloids are practically water insoluble and heat stable (Merk,2001). Significant decrease of glycoalkaloids, particularly α–solanine content during the process of potato chips production was observed by Peksa *et al.* (2006).

The success of such trend along with improving the good storage practices will help in reducing the potato tuber losses and maximize their utilization in food purposes. So, the efficiency of some food processing techniques on reducing solanine content in the green stored potato tubers (which are excluded during sorting step) was the main aim of the present study.

MATERIALS AND METHODS

Materials

Ten kilograms of green potato tubers (Fig .1) were obtained from sorting and packaging station of Societè Nationale Du Commerce (SONAC) Company, Damanhour, Egypt. The sorting process was carried out using trained workers around the sorting belts. The samples were transported to the pilot plant of Food Science and Technology Department, Faculty of Agriculture, Alexandria University, Egypt, in opaque polyethylene bags and kept at room temperature (22±2C°) until used. Refined sunflower oil in polyethylene teriphathelate (PET) bottles were purchased from Alexandria market, Egypt. An analytical grade chemical were used in the present study.

Methods

Technological methods

Peeling: After dry cleaning, the potato tubers were peeled manually using stainless steel knives. The peeling process was carried out to remove approximately o.5 and 3.00 mm from the outer layers (peel) of the tuber as measured by a hand caliper.

The potato tubers which peeled to remove approximately 0.5 mm from the outer layers were cut into sticks (1×1×6 cm dimensions) using stainless steel knives and used in the following experiments.

Boiling: The potato sticks were washed with running tap water, then boiled in tap water for 3, 6 and 9 min.

Frying: The potato sticks were subjected for frying in refined sunflower oil at170C° for 3 and 6 min in a frying pan. The fried sticks were received over tissue paper and left to cool to room temperature (22±2C°).

Soaking: After preparing potatos as described before, the sticks were soaked in 4% acetic acid solution for 15,30,45 and 60 min at a ratio of 1:4 (w:w) sticks to acid at room temperature (22 ± 2C°). The resultant soaked sticks were washed with tap water and left at room temperature over tissue paper to remove the adhered water.

Combination of soaking in acetic acid and each of boiling and frying:-The soaked potato sticks (30 and 60 min) were separately boiled in water for 9 min and also fried for 6 min as described before.

Analytical methods

Isolation and determination of solanine content

Solanine content was isolated and determined according to the method described by Harborne (1973).Five grams of potato sample were extracted with 50 ml of 5% acetic acid in an electrical blender for 3 min. The mixture was continuously stirred with a magnetic stirrer for 2hr. After filtration ,the extract was warmed to 70C° then drops of concentrated NH_4OH were added to adjust pH to 10. The extract was centrifuged at (10,000 XG for 30 min) to get the precipitate. The latter was washed with 1% NH_4OH for several times and recentrifuged. The resultant precipitate (crude solanine) was purified by dissolving in boiling methanol, filtered and concentrated until the alkaloid started to crystallize.The obtained pure crystals were dissolved in solution consisting of 5 ml 96% ethanol and 5 ml 20% H_2SO_4 (1:1 v/v ratio). One ml of the alkaloid solution was mixed with 5 ml 60% H_2SO_4 and after 5 min, 5 ml of 0.5 % solution of formaldehyde in 60% H_2SO_4 was added. The alkaloids were determined colourimetrically at 565-570 nm using Spectronic 20 colourimeter.

The purity and presence of solanine were detected using TLC technique on silica gel G using a mixture of acetic acid : ethanol (1:3 v/v) as a developing solvent and Marquis reagent (1ml formaldehyde in 10 ml conc. H_2SO_4) for detection (Harborne, 1973) .

Moisture content was determined according to the method described in the AOAC (1995).

Statistical analysis: One way analysis of variance (ANOVA) using the general linear models (GLM) according to Steel & Torrie (1980) was applied to test significance effects of time of each of boiling, frying, soaking in acetic acid and combination of such process on solanine content of potato sticks. Standard deviation was calculated according to Steel &Torrie (1980).

RESULTS AND DISCUSSION

Effect of peeling on solanine content

As shown in Table (1), solanine was found in all parts of the green potato tubers. The results indicate that, removal of peel during peeling process removed the solanine present in the outer layers of the tubers. Cork epidermis and periderm together comprise the peel of potato tuber, the latter represents nearly 7 to 9% of the tuber (El-Kodaby,2005). Removal of the flesh layers directly below the peel during peeling caused more reduction in solanine. Consequently, increasing the depth of the removed outer layers of the green potato tubers from approximately 0.5 mm to 3 mm during peeling process caused highly significantly reduction in solanine from 14.44% to 58.25% (on dry weight basis) (Table 1). This means that solanine is concentrated in the inner or peripheral layers beneath the skin of the potato medulla (Kozukue *et al.*,1987, Friedman, 2006). It was found that removal of about 3mm of the outer layers reduced the level of solanine content of potato tubers from 23.89 to 9.29 mg/100g (on wet weight basis) which is considered less than the higher acceptable limit (20 mg/100g on wet weight basis) as mentioned by Slanina (1990). This means that at this level of peeling (3 mm), potato tubers can be used for edible purposes. These results agree with those of Pavlista (2003) who reported that, solanine formation in potato is localized near the skin usually no deeper than 3mm. Furthermore, Peksa *et al.* (2006) observed that, during the peeling process, 22-28% of initial amount of glycoalkaloids present in potato tubers was removed. The peeling process should remove a significant part of these compounds because they are accumulated mainly in the potato peel and in the outside layer (1.5 mm) of potato tuber.

Effect of boiling on solanine content

The results in Table (2) show that boiling of green potato sticks (0.5 mm peeling depth) in water for different periods (3 to 9 min) did not significantly affect their solanine content. This is an indication that solanine is minimally impacted by boiling. The losses in the solanine were 0.91%, 1.4 % and 2.74% after 3,6 and 9 min of boiling (on dry weight basis), respectively. This could be attributed to the heat stability of this compound as other glycoalkaloids.

Table 1: Effect of peeling process on solanine content of potato tubers

Potato tuber	Solanine content (mg/100g)		(%) Solanine loss
	W W B	D W B	D W B
A –Surface peeling			
(Approximately 0.5 mm depth)			
Whole	24.16 ±1.04^{c}	172.50 ±5.7^{c}	------
Flesh	20.29 ±0.96^{b}	147. 60 ±3.3^{b}	14.44
Peel	3.87 ±0.34^{a}	24.90 ±2.4^{a}	85.56
B- Deep peeling			
(Approximately 3mm depth)			
Whole	23.89 ±0.19^{c}	161.7 ±3.5^{c}	-----
Flesh	9.29 ±0.54^{a}	67.53 ±2.6^{a}	58.25
Peel	14.60 ±0.37^{b}	94.20 ±2.6^{b}	41.75

W W B : Solanine content on wet weight basis.

D W B : Solanine content on dry weight basis.

Means in a column not sharing the same superscript are significantly different at $P \leq 0.05$

Table 2: Effect of boiling in water on solanine content of potato sticks

Boiling period	Solanine content (mg/100g)		(%) Solanine loss
(min)	W W B	D W B	DWB
0	23 29 ± 0.96[a]	167.31 ± 4.8[a]	------
3	23.06 ± 0.12[a]	165.78 ± 2.1[a]	0.91
6	22.88 ± 0.87[a]	164.96 ± 5.2[a]	1.40
9	22.39 ± 0.75[a]	162.72 ± 5.4[a]	2.74

W W B : Solanine content on wet weight basis.
D W B : Solanine content on dry weight basis.
Means in a column not sharing the same superscript are significantly different at $P \leq 0.05$

The same conclusion was stated by Cantwell (1996) who observed that cooking of potatoes did not destroy solanine. Furthermore, Tice (1998) found that freezing, drying or dehydration had little effect, whereas boiling has no effect on solanine in potato tubers.

Effect of frying on solanine content

Table (3) summarizes the influence of frying process on solanine content of the green potato sticks(0.5 mm peeling depth). On contrary to boiling, frying at 170 C° for 3 and 6 min caused significant reduction in solanine. This may be attributed to leaching of solanine into oil during frying process. Extending the frying period from 3 to 6 min elevated the reduction rate of solanine from potato sticks. This was in agreement with that reported by Tice (1998) who found that deep frying at 170C° caused an effective reduction in glycoalkaloids levels of potato. Friedman(2004) found that frying markedly reduced glycoalkaloid contents of snacks or dried potato. Furthermore, Peksa *et al.* (2006) observed a significant decrease of glycoalkaloids particularly solanine content during the process of chips production. According to the data given in Table (3), the reduction in solanine was 68.79 and 75. 58% after 3 and 6 min of frying process (on dry weight basis), respectively. The content of solanine in fried potato sticks especially which were fried at 170 C° for 6 min was less than the higher acceptable limit of this compound (20 mg/100g on wet weight basis) as stated by Slanina (1990).

Effect of soaking in acetic acid on solanine content

Soaking of potato sticks in 4% acetic acid before boiling and frying for different periods (15,30,45 and 60 min) was studied, as described in the method of extracting solanine from the green tubers (Harborne,1973). The data in Table (4) show that gradual reduction in solanine content was occurred with extending soaking period from 15to 60 min. The reduction percentages in solanine content were 10.51, 26. 61, 32.56 and 48.93% after soaking for 15, 30, 45 and 60 min in 4% acetic acid (on dry weight basis), respectively. This means that solanine leached out from potato sticks into soaking medium during soaking process.

Table 3: Effect of frying process on solanine content of potato sticks

Frying periods	Solanine content(mg/100g)		(%) Solanine loss
(min)	W W B	D W B	DWB
0	22.19 ±0.93[c]	161.38 ±4.8[c]	-------
3	17.88 ±0.55[b]	50.36 ±1.5[b]	68.79
6	13.71 ±0.45[a]	39.40 ±1.2[a]	75.58

W W B : Solanine content on wet weight basis.
D W B : Solanine content on dry weight basis.
Means in a column not sharing the same superscript are significantly different at $P \leq 0.05$

Table 4: Effect of soaking in acetic acid on solanine content of potato sticks

Soaking time (min)	Solanine content(mg/100g)		(%) Solanine loss
	W W B	D W B	D W B
0	21.72 ± 0.73^{d}	164.6 ± 5.5^{e}	------
15	19.4 ± 0.80^{c}	147.3 ± 5.0^{d}	10.51
30	15.91 ± 0.28^{b}	120.8 ± 2.2^{c}	26.61
45	14.62 ± 0.74^{b}	111.0 ± 5.6^{b}	32.56
60	11.07 ± 0.89^{a}	84.05 ±3.7^{a}	48.93

W W B : Solanine content on wet weight basis.
D W B : Solanine content on dry weight basis.
Means in a column not sharing the same superscript are significantly different at $P \leq 0.05$

Effect of combination of soaking in acetic acid and each of boiling and frying

The potato sticks soaked in acetic (4%) acid for 30 and 60 min were subjected either for boiling for 9 min or frying for 6 min as described previously. The results of the combination effect of both soaking and each boiling and frying on the reduction of solanine content are presented in Table (5). Boiling after soaking of the potato sticks significantly declined solanine content as compared to boiling process alone. So, the soaking in acetic acid (4%) is an essential step to prepare safe boiled green potato sticks. Extending soaking period before boiling duplicated the reduction loss in solanine from 27.44% to 50.85%.

On the other hand, frying of the soaked green potato sticks caused marked reduction in solanine content. Also, the reduction increased with extending the soaking period from 30 to 60 min in an acetic acid (4%) as occurred in boiling. It was found that elongation of soaking period before frying from 30 to 60 min increased the reduction of solanine in potato sticks from80.55% to 89.08 %,respectively.

These results indicated that soaking in 4% acetic acid not only reduced solanine content but also increased the efficiency of frying process to lower solanine content to the safe levels.

To confirm the results, TLC technique was used to detect solanine in raw, boiled, fried, soaked, soaked boiled and soaked fried green potato sticks. As seen in Fig (2) ,the sharp reduction in solanine could be achieved after frying, soaking, and combination of soaking and frying processes.

It could be concluded that green potato tubers which are usually considered as a waste during sorting of potato tubers, can be used after peeling for about 0.5 mm and frying if they subjected for soaking in 4% acetic acid for not less than 60 min before frying.

Table 5: Effect of combination of soaking in acetic acid and each of boiling and frying on solanine content of potato sticks

Process	Solanine content(mg/100g)		(%) Solanine loss
	W W B	D W B	D W B
Boiling (9min) after soaking for			
0 min	20.79 ± 0.82^{c}	151.20 ±5.8^{c}	------
30 min	15.22 ± 0.56^{b}	109.70 ±4.0^{b}	27.44
60 min	9.79 ± 0.78^{a}	74.30 ±5.9^{a}	50.85
Frying (6 min) after soaking for			
0 min	20.79 ± 0.81^{c}	151.20 ±3.2^{c}	------
30 min	10.47± 0.87^{b}	29.40±1.4^{b}	80.55
60 min	6.23 ± 0.98^{a}	16.50 ±1.2^{a}	89.08

W W B : Solanine content on wet weight basis.
D W B : Solanine content on dry weight basis.
Means in a column not sharing the same superscript are significantly different at $P \leq 0.05$

Fig. 1: Potato tubers with high level of solanine content

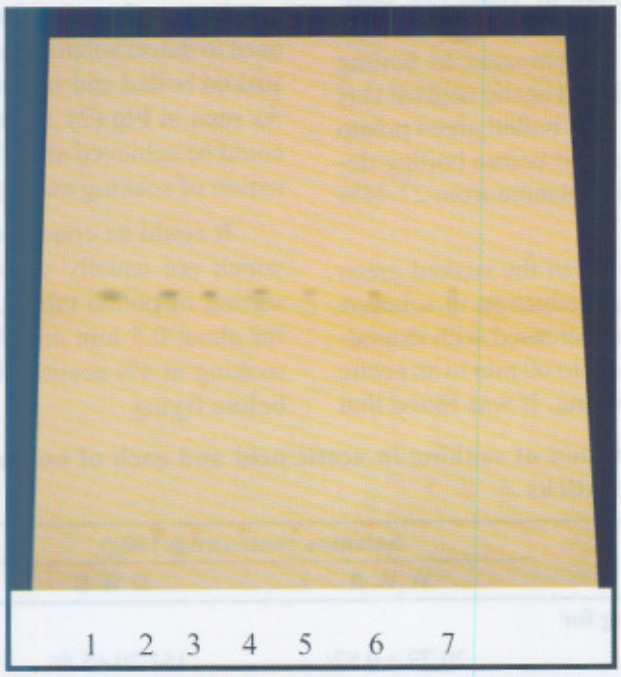

Fig. 2: TLC of solanine separated from potato samples

1 : Solanine standard.
2: Raw potatoes.
3: Boiling at 100 C° for 9 min.
4: Frying at 170 C° for 6 min.
5: Soaking in 4% acetic acid for 1 hr.
6: Boiling at 100 C° for 9 min after soaking in 4% acetic acid for 1 hr.
7: Frying at 170 C° for 6 min after soaking in 4% acetic acid for 1 hr.

REFERENCES

AOAC. **1995**. Association of Official Analytical Chemists. Official methods of analysis of the association of official analytical chemists,Washington, 4, DC, USA.

Cantwell, M.**1996**. A review of important facts about potato glycoalkaloid. Perishables Handling Newsletter Issue, **87**: 26-27.

El- Dawoudi, H.Y. **1999**. Bacterial and Fungal Diseases of Potato Crop Under Egyptian Conditions (In Arabic). Central Administration of Agriculture Quarantine. Agriculture Ministry, Egypt.

El-Kodaby, H.M. **2005**. Changes in the Quality of Some Potato Cultivars During Storage Under Controlling Condition and Frying. M.Sc. thesis, Food Science and Technology Department, Faculty of Agriculture, Alexandria University. Alexandria .Egypt.

FAO, **2007**. Food and Agriculture Organization of the United Nation. The Statistics Division, http: //www.fao.org.

Friedman, M. **2004**. Analysis of biologically active compounds in potatoes (*Solanum tuberosum*) ,tomatoes (*Lycopersicon esculentum*), and jimson weed (*Datura stramonium*) seeds. Journal of charomatography A, **1054**:143-155.

Friedman, M. **2006**. Potato glycoalkaloids and metabolites: roles in the plant and in the diet. Journal of Agriculture and Food Chemistry, **54**: 8655-8681.

Harborne, J.B. **1973**. Photochemical Methods .John Wily &Sons, Inc New York, pp 182-193.

Heal.K.G., Sheikh, N.A., Holhngdale, M.R., Morrow, W.J. & Taylor-Robinson M.W. **2001**. Potentiation by a novel alkaloid glycoside adjuvant of a protective cytotoxic cell immune response specific for preerythrocytic malaria candidate antigen.Vaccine **19**: 4153-4161.

Kozukue, N., Kozukue, E. & Mizuno, S. **1987**. Glycoalkaloids in potato plants and tubers. Horticulture Science, **22**: 294-296.

Machado, R.M.D., Toledo, M.C.F. &Garcia, L.C. **2007**. Effect of light and temperature on the formation of glycoalkaloids in potato tubers. Food Control, **18**: 503-508.

Mc Gehee,D.S., Krasowski, M.D., Fung, D.L., Wilson, B., Gronert,G.A. & Moss, J. **2000**. Cholinesterase inhibition by potato glycoalkaloids slows mivacurium metabolism. Anesthesiology, **93**: 510-519.

Merck, **2001**. Merck Index,In: An Encyclopedia of Chemical, Drug, and Biologicals,13th ed. O' Neil, Smith, M.J, Heckelman, P.E. (Eds),. Merk& Co., Whitehouse Station, NJ, USA, P.1550

Mondy, N.I. & Seetharaman, K. **1990**. Effect of irradiation on total glycoalkaloids in Kennebec and Russet Burbank potatoes. Journal of Food Science, **55** :1740-1742.

Morris, S.C. & Lee, T.H.**1984**. The toxicity and teratogenicity of solanaceae glycoalkaloids, particularly those of potato (*Solanum tuberosum*) : A review. Food Technology, Australia, **36**: 118 – 124.

Pavlista, D.A. **2003**. Green potato: problem and solution. http//:ianrpubs. unl. edu/ horticulture/ g/437. htm

Peksa. A., Golubowska, G., Aniolowski, K., Lisinska, G & Rytel, E. **2006**. Changes of glycoalkaloids and nitrate contents in potatoes during chip processing. Food Chemistry, **97**: 151-156.

Ruprich, J., Rehurkova, I., Boon, P.E., Svensson, K., Moussavian,S., Vander voet, H., Bosgra,S., Van Klaveren,J.D. & Busk, L. **2009**. Probabilistic modelling of exposure doses and implications for health risk characterization: Glycoalkaloids from potatoes. Food and Chemical Toxicology, **47**: 2899-2905.

Sanford, L.L., Deahl, K.L. Sinden, S.L. & Ladd, T.L. **1992**. Glycoalkaloid contents in tubers from *Solanum tuberosum* populations selected for potato leafhopper resistance. American Potato Journal, **69**:693-703.

Slanina, P. **1990**. Solanine (glycoalkaloids) in potatoes: Toxicological evaluation. Food and Chemical Toxicology, **28**:759-761.

Steel, R.G.D. & Torrie, J.H. **1980**. Principles an Procedures of Statistics. Mc. Graw Hill, New York. USA.

Tice, R. **1998** . Review of Toxicological Literature Prepared for Errol Zeiger, Ph.D, National Institute of Environmental Health Science. Testing Status of Agents at NTP (National Toxicology Program). February.

Vol. 7, No. 1, pp. 13-20, 2010 *Alex. J. Fd. Sci. & Technol.*

تأثير بعض المعاملات التكنولوجية على السولانين بدرنات البطاطس

ماجدة سالم شرارة

قسم علوم و تكنولوجيا الأغذية - كلية الزراعة - جامعة الإسكندرية، الشاطبى – الإسكندرية – الرقم البريدى ٢١٥٤٥- مصر

أجريت هذه الدراسة على درنات البطاطس المستبعدة خلال عمليات الفرز التي تتم على البطاطس قبل التصنيع لظهور اللون الأخضر بها مما يدل على ارتفاع محتواها من السولانين . أوضحت نتائج الدراسة أن إجراء عملية التقشير لدرنات البطاطس قبل التصنيع هامة جدا و ذلك لقدرتها على إزالة جزء كبير من السولانين حيث أوضحت النتائج أن زيادة سمك القشرة التي تم إزالتها من درنات البطاطس من (حوالى ٠,٥م إلى ٣ م) أدت إلى انخفاض معنوي ملحوظ فى نسبة السالونين في درنات البطاطس بنسبة ١٤,٤٤ ٪ ، ٥٨,٢٥٪(على أساس وزن جاف) على التوالي. تم استخدام درنات البطاطس التى تم تقشيرها على عمق حوالى ٠,٥ م لدراسة تأثير باقي المعاملات على خفض نسبة السالونين فى البطاطس حيث تبين من النتائج أن سلق أصابع البطاطس المرتفعة فى محتواها من السالونين على ١٠٠م° لمدد مختلفة من (٣-٩) دقائق لم يكن له أي تأثير معنوي على نسبة السالونين فى البطاطس مما يدل على الثبات الحراري لهذا المركب . كما تم دراسة تأثير عملية القلي في الزيت على ١٧٠م° لمدة ٣ و ٦ دقائق على محتوى السولانين فى أصابع البطاطس حيث أوضحت النتائج وجود تأثير معنوي ملحوظ لعملية القلي على خفض نسبة السالونين بمعدل ٦٨,٧٩٪و ٧٥,٥٨٪ (على أساس وزن جاف) بعد القلي لمدة ٣ و٦ دقائق على التوالى . تبين أن غمر أصابع البطاطس في حامض الخليك بتركيز ٤٪ لمدة ١٥و٣٠ و٤٥ و ٦٠ دقيقة قد أدى إلى خفض معنوي ملحوظ في نسبة السالونين بنسبة ١٠,٥١٪ و٢٦,٦١٪ ٣٢,٥٦٪ و٤٨,٩٣ ٪ على التوالي. أما إجراء النقع لأصابع البطاطس فى حامض الخليك بتركيز ٤٪ لمدة ٣٠ و ٦٠ دقيقة ثم إجراء معاملة السلق لمدة ٩ دقائق أو القلي لمدة ٦ دقائق فقد أدت إلى الحصول على أعلى النسب الملحوظة للخفض فى السالونين حيث كانت نسبة الخفض ٢٧,٤٪ و ٥٠,٨ ٪ بعد السلق و ٨٠,٥ ٪ و ٨٩,٠٨٪ بعد التحمير على التوالي. كما تم أيضا فصل مركب السالونين من عينات البطاطس موضع الدراسة باستخدام كروماتوجرافيا الطبقة الرقيقة بعد المعاملات المختلفة و تبين توافق نتائج الفصل مع النتائج السابقة.