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NEW INNOVATIVE PRODUCTS OF HUSK TOMATO FRUIT

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ABSTRACT

Two different dried product samples (sheet, raisins) were produced from fresh husk tomato. Chemical analysis, minerals, Hunter color and volatile components were determined for both two dried samples.

Results indicated a highly vit.C content(١٣٤,٦٧mg/١٠٠g) in fresh fruit while in dried sample were (٨,٤٠mg/١٠٠g), maximum content of reducing sugars and fat in dried sheet sample (٤٨,٤٥ and ٧,٤٦ %) and high values of non-reducing sugars, total sugars, ash and fiber in raisins(٣١,١٤،٧١,٨١،٧,٩٥ and ٢٠,٠٤٪) accompanied with higher levels of calcium, magnesium, phosphorus, potassium and sodium.

Drying process caused a reduction in lightness (L) values and increment in (a) values of redness and yellowness (b). Rehydration quality of raisins was improved and gave higher values of organoleptic characteristics than sheet samples. Methyl chavicol and cadinene (Gamma) were the two major volatile compounds found in fresh husk tomato fruits (٥٤,١ and ١٤,٧٥٪). Many new volatile compounds were also found in the two dried products (sheet and raisins) where, Dill apiole compound was the main compound in sheet and raisins samples (٦٤,١ and ٦٦,٦٪) and reached to ٢/٣ percent from all the other compounds. Keywords: Husk tomato – dried sheet –raisins–volatile compounds

INTRODUCTION

Husk tomato (Physaltis Philadelphica) is a solanceous plant cultivated in Mexico and Guatemala and originating from meso America. It is used in the diet since the pre-Columbian time; (Hernandez and Rivera ١٩٩٤). Individual plants may produce ٦٤ to ٢٠٠ fruits in season and yielded approximately ٩ tons per acre (٤٠٤٦ m^{٢}) as reported by (Wolff, ١٩٩١) and (Quiros, ١٩٨٤). The fruit is small, spherical and green or green purple. They are surrounded by an enlarged calgx or "husk". As the fruit matures, it fills the husk and can splite it open by time of harvest. Tomatillos are available year round, produced in the U.S. mainlyon small – acreoges in California, with large volumes imported from Mexico (Smith *et al.,* ١٩٩٩).

Drying of food stuffs is an important method for preservation and it is applicable to a wide range of industrial and agricultural products (Koyuncu, *et al.,* ٢٠٠٧). Also in most fruit, the skin is the solid part that contains the highest percentage of volatile compounds, which gave the fruit its aroma, and phenolic compounds, which are responsible for the color (Torre*, et al* ٢٠١٠). Dehydrated skins generate interest because of their possible use as well as their addition to musts from grape harvests that are pron in volatile and phenolic metabolites (Torre, *et al*., ٢٠١٠).

Fruit can be dried in a food dehydrator, oven or in the sun by using the right combination of warm temperatures, low humidity and air current.

The optimum temperature for drying food is ١٤٠°F. Increasing temperatures caused cooking INS tend of drying (Paul ٢٠٠٩).

Color assessment of food is of great interest in the food industry and is made by visual or instrumental evaluation. The chromatic parameters usually considered are: lightness (L*), an attribute related to the transmission of light observed in the spectra; hue (hab), the qualitative expression of chromaticity; and Chroma (cab), the quantitative component of chromaticity (Osorio *et al.,* ٢٠٠٧).

The aim of this investigation was the application of drying process for husk tomato fruit to produce dried products (sheet and raisins), increase the consumption period and be available all over the year. Nutritional and sensory evaluations were also studied for both dried products.

MATERIALS AND METHODS

Materials:

Husk tomato fruits (physaltis philadelphica) were obtained from The Field Crops Research Institute, Agricultural Research centre, Ministry of Agriculture, Giza, Egypt.

Methods:

Preparation of the husk tomato Sheet and Raisins:

Husk tomato fruit (control) was sorted, washed and divided into two samples. The first sample was blended in a juice blender (National Solid state control model MJ. ١٧٠N) and the puree sample was treated with sodium meta-bisulphate (٠,٢٪).The second sample was divided into two sample. One was treated with sodium meta- bisulphate(٠,٥٪) for ٢٠ min. and the other one was steamed for٢٠ min. Then all samples (control, puree and steamed) were placed in a flat trays and transferred to an air dry oven (shell lab ١٣٧٠fx) at ٦٥ **^{o}C** for ٦hr,then at ٥٠ **^{o}C** for٦hr Fig.(١،٢).All dried samples were packed in polyethylene bags and stored at room temperature (٢٥ **^{o}C**).

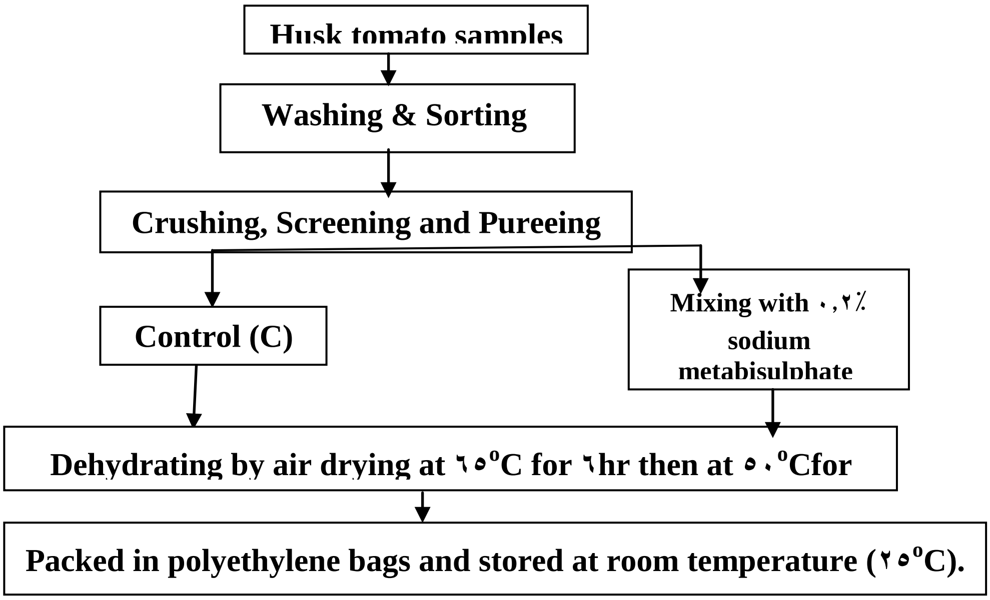

Fig. (١): Pretreatment and dehydration techniques of husk tomato sheets.

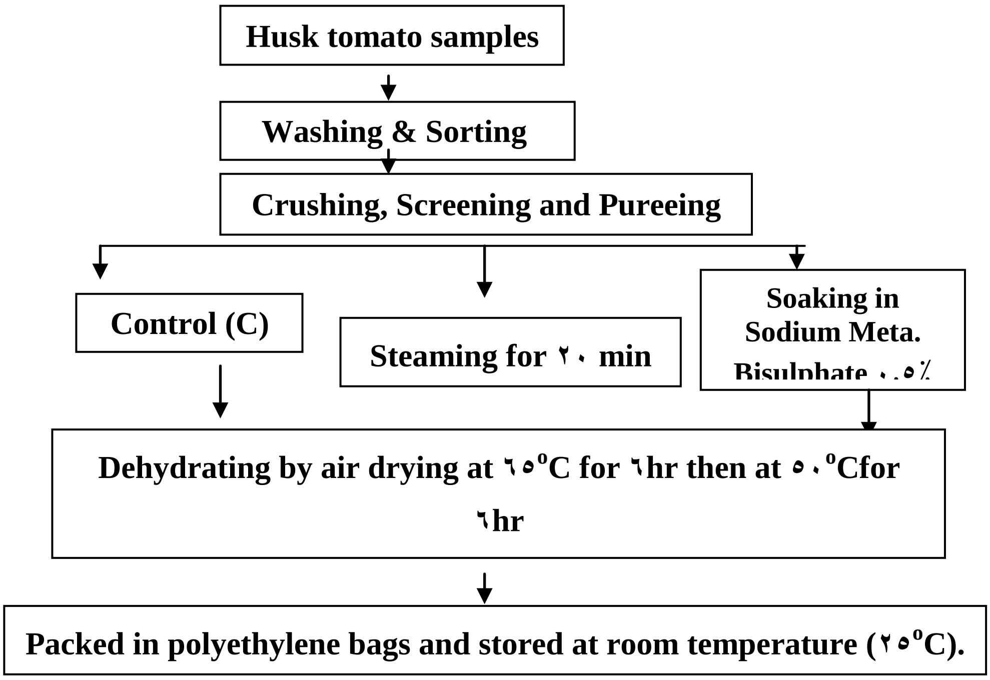

Fig.(٢): pretreatment and dehydration techniques of husk tomato raisins

Preparation and Isolation of volatile compounds:

Reparation of husk tomato extract

One gram of husk tomato in fresh fruit or dried fruits were infused with ١٠٠ ml freshly boiled water for ٥ min followed by filtration.

Isolation of husk tomato volatile compounds:

The volatiles of husk tomato samples (fresh and dried) were isolated according to (Heath &Reineccius, ١٩٨٦) using a dynamic husk tomato system, ١٠٠gm. Dried and fresh samples were subjected to extraction for four hours using diethyl ether and the extracted volatile compounds were dried over anhydrous sodium sulfate, evaporated and concentrated under gentle stream of nitrogen.

Separation and Identification of volatile compounds:

The obtained volatile compounds were analyzed according to the method described by (Adams, ١٩٩٥) using GC-MS apparatus. Separation was performed on thermo gas chromatograph (walnut creek, California, USA) equipped with Finnegan mat SSQ ٧٠٠٠ mass spectrometer and a ٣٠mx. .٠٢٥mm DB-٥ Capillary column. The column temperature was programmed from ٤٠°C (isothermal for min), to ٣٠٠°C at rate of ٥°C/min with ١٠ min. isothermal hold. The injector temperature was ٢٢٠°C and the transition line temperature was ٣٠٠°C. the carrier gas was helium and the column pressure head was ١٠-١٥ psi. the mass spectrometer had a delay of ٣ min. to avoid the solvent peak and then scanned from $m/z^{٥٠}$ to $m/z^{٦٠٠}$. Ionization energy was set at ٧٠eV. Identification of compounds was based on the comparison with the MS computer library (NIST and Wiley software package, Thermo Finnegan) and the published spectra. A linear retention index was calculated for each compound using the retention times of a homologous series of C٦-C٢٦ n-alkanes [Adams, ١٩٩٥). Where no reference spectra were available, tentative identifications were made by comparison with spectra of related compounds.

Chemical Analysis methods :

The content of moisture, protein, fat, fiber, ash, total solids, mineral and vitamin C were estimated according to the methods described by A.O.A.C. (٢٠٠٠). Total soluble solids (TSS %) were expressed as Brix value using a refract meter (ATAGO. Japan). Conversion factors were used to calculate protein, fat and total carbohydrate contents using ٤, ٩ and ٤ k cal/g respectively and expressed in Kcal/١٠٠g (Pearson, ١٩٩١).

Drying Ratio:

The drying ratio was determined as reported by Van – Arsdel et al (١٩٧٣). The drying ratio was calculated as follows:

$$\text{Drying ratio} = \frac{\text{Weight of wet}}{\text{Weight of dried}}$$

Rehydration ratio:

The rehydration ratio of dried samples was evaluated using the method of Ranganna (١٩٧٩).

Ten grams dried sample were boiled in ٥٠٠ml beaker. Covered by a watch glass for ٥ min on an electrical heater, the contents were then dumped into a Buchner funnel for half to one min until the drip from the funnel was almost stopped and there hydration ratio was calculated as follows:

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated sample}}{\text{Weight of dehydrated sample}}$$

Hydration coefficient = b (١٠٠-m١) / ١٠٠ (a – $m_{٢}$)

a = weight of the dehydrated sample.

b= the drained weight of the rehydrated sample.

$m_{١}$ = moisture content (%) of the fresh sample.

$m_{٢}$ = moisture content (%) of the dehydrated sample.

Color measurements:

The color of different samples was measured using a Spector-colorimeter (tristimulus color machine) with CIE lab color scale (Hunter lab ScanXE, Germany).

Calibrated with a white standard tile of Hunter lab color standarad (LX No. ١٦٣٧٩): X = ٧٧,٢٦, y = ٨١,٩٤ and Z = ٨٨,١٤, (L^* = ٩٢,٤٠, a* = -٠,٨٧, b*= -٠,١٧). Color difference (ΔE) Hue angle and saturation index were calculated from a*, b* and L* values (where a* = redness, b* = yellowness and l*= lightness). Using Hunter – Scotfield's equations (Hunter, ١٩٧٥)

$\Delta E = (\Delta a^* + \Delta b^{٢} = \Delta L^{٢})^{١/٢}$ ……….. (١)

Where Δa = a- ao, Δb = b-bo and ΔL = L-Lo

(ao, bo and Lo were the values of redness, yellowness and lightness for control sample).
ΔE = color difference for a, b, L of sample from the same parameters of control.
Hue angle = tan$^{-١}$ (b/a) ……… (٢)
Saturation index = $\sqrt{a^2+b^٢}$…….. (٣)

Sensory evaluation:

Products prepared from the different concentrations of the husk tomato fruits were evaluated for their appearance, color, taste and flavor as described by Meligaared *et al.,* (١٩٩١) and Fernands and Rodrignes (٢٠٠٧). Organoleptic characteristics results were statically analyzed according to Richard and Gouri (١٩٨٧).

RESULTS AND DISCUSSION

Chemical analysis of fresh and dried husk tomato products

Chemical analysis of fresh husk tomato fruit and its dried products was given in table (١). Results showed a higher content of total sugar (٦٨.٥٦٪) in husk tomato sheet sample than fresh and raisin samples. While non-reducing sugar and reducing sugar content were high in raisins and husk tomato sheet samples (٣١,١٤،٢٠,١١،٤٠,٦٧and٤٨,٤٥٪) respectively compared to all other samples (fresh, raisins) by Abozeid *et al.* (٢٠٠٧).

Table (١): Chemical composition of fresh husk tomato fruits and their dried products:

Constituents (%)	Fresh husk tomato control (%)		Dried sheets (%)		Dried raisins(%)	
	Wet weight	Dry weight	Wet weight	Dry weight	Wet weight	Dry weight
Moisture	٩١,٣٢±٠,٨٧*	-	٢٠,١٦±٠,٧٥	-	٩,٦٧±٠,٣١	-
Red. Sugars	٣,١٢±٠,١٨	٣٥,٩٤±٠,٣١	٣٨,٦٩±٠,٦٣	٤٨,٤٥±٠,٣٦	٣٦,٧٤±٠,٦١	٤٠,٦٧±٠,٥١
Non. Red. Sugars	٢,٣٨	٢٧,٤٢	١٦,٠٩	٢٠,١١	٢٨,١٣	٣١,١٤
Total sugars	٥,٥٠±٠,٢١	٦٣,٣٦±٠,٥٢	٥٤,٧٨±٠,٤٨	٦٨,٥٦±٠,٤١	٦٤,٨٧±٠,٨١	٧١,٨١±٠,٦١
Protein	٠,٤٩±٠,١٥	٥,٦٤±٠,١٢	٥,٤٤±٠,١٢	٦,٨١±٠,٣٢	٦,١٢±٠,١٣	٦,٧٨±٠,١١
Fat	٠,٥٣±٠,٠٨	٦,١١±٠,٣٣	٥,٩٦±٠,١٤	٧,٤٦±٠,٣٦	٥,٩١±٠,١٧	٦,٥٤±٠,١٩
Ash	٠,٦٤±٠,٠٣	٧,٣٧±٠,٢٢	٦,٢١±٠,٢٠	٧,٦٦±٠,٣٨	٧,١٨±٠,١٤	٧,٩٥±٠,١٧
Fiber	١,٥٢±٠,٠٩	١٧,٥١±٠,٤٥	٨,١١±٠,٨١	١٠,١٥±٠,٤٨	١٨,١١±٠,٢٠	٢٠,٠٤±٠,٢٢
Vit. C (mg/١٠٠g)	١١,٦٩±٠,٨٧	١٣٤,٦٧±١,١٨	٦,٧١±٠,٤٣	٨,٤٠±٠,٢٩	٧,٥٠±٠,١٩	٨,٣٠±٠,١٤

***The obtained data expressed as a mean value ± standard Deviation.**

There were no variation between protein content in dried sheet and raisins samples but, their values were higher than that of fresh samples. Higher values of fat content (٧,٤٦ and ٦,٥٤%) were observed in husk tomato sheet and raisins samples respectively and ash content was also high in raisins samples compared to other one.

The results also showed that, raisins contained higher levels of fiber (٢٠,٠٤٪) than in fresh fruit (١٧,١٥٪) and in dried sheets (١٠,١٥%) which could be related to the losses during preparation method through cheese cloth. The reduction in vitamin C content was observed in dried sheet and raisins samples compared with both fresh husk tomato, and raisins samples. This may be due to exposure to heat treatment during processing. Results in table (٢), showed that the mineral contents of raisins and dried sheets were relatively higher than in fresh husk tomato, potassium and phosphors appeared to be the higher amount than all other minerals content either raisins (٧٥٣,٤٨ and ٤٦,٥٨mg/١٠٠g) or in dried sheet samples (٧٤١,٣٤ and ٤٤,١٣ mg/١٠٠gm). The lowest components of copper and manganese were in raisins (٠,٢٨ and ٠,٢٧ mg/١٠٠gm) while it was (٠,١٥ and ٠,٢٥ mg/١٠٠gm) in dried sheets respectively.

Table (٢): The minerals content of fresh husk tomato fruits and their dried products

Elements (mg/١٠٠g)	Fresh husk tomato control	Dried husk tomato sheets	Dried husk tomato rasinis
Calcium	٦,٨٩	٩,٩٧	١٠,٥٦
Iron	٠,٥٦	٢,٥٣	٢,٥٥
Magnesium	١٨,٩٧	٢٧,٦٩	٢٨,١٥
Phosphorus	٣٧,٨٥	٤٤,١٣	٤٦,٥٨
Potassium	٢٥٩,٦٤	٧٤١,٣٤	٧٥٣,٤٨
Sodium	٠,٩٢	١,٨٩	٢,٨٧
Zinc	٠,٢٣	٠,٤٠	٠,٤٨
Copper	٠,٠٩	٠,١٥	٠,٢٨
Manganese	٠,١٨	٠,٢٥	٠,٢٧

Table (٣) indicates the changes that occurred in the color values of all samples. It was clearly observed that the values of a and b of dried sheet samples were increased than that in fresh samples.

The darkness values could be related to the larger surface area exposure to heat during drying in an air oven (٦٥°C / ٦ hr). Which explain the more lightness than dried sheets. These results were is in agreement with Paul, (٢٠٠٩) and Osorio et al (٢٠٠٧).

Table (٣): Hunter color values of fresh husk tomato fruits and their dried products

Sample	L	a	b	a/b	Saturation	Hue
Fresh Husk tomato (control)	٤٥,٦٤	١٢,٤٨	٤٩,٧٨	٠,٢٥	٥١,٣٢	٧٥,٩٣
Dried sheets	٤١,٢٦	١٦,٧٧	٥٢,٣٥	٠,٣٢	٥٤,٩٧	٧٢,٢٤
Dried raisins	٤٣,٧٤	١٥,٢٨	٥٠,٣٨	٠,٣٠	٥٢,٦٥	٧٣,١٣

Table (٤) illustrated the significant differences in rehydration between raisins and dried sheet samples. It could be also noticed from table (٤) that, moisture content of rehydration raisins (٨١.١٠٪) exhibited lower values than the dried sheet samples (٨٨,٥٠٪). This means that, the production of ١kg raisins from ٤,٢ kg fresh husk tomato was economically than that for production of ١kg dried sheets from ٧,٢ kg fresh sample.

Table (٤): Rehydration quality of dried husk tomato sheets and raisins:

Rehydration quality	Husk tomato sheets	Husk tomato raisins
Rehydration ratio	١:٧,٢^{a}± ٠,٠٧١	١ : ٤,٢^{b}± ٠,٥٦٣
Moisture content of rehydrate sample	٨٨,٥٦^{a}±٠,١١٢	٨١,١٠^{b}±٠,٣٨٥
Hydration coefficient	١,٥٦±٠,٠٤٠	٠,٩٥±٠,٠٦٣

- **The obtained data expressed as a mean value ± standard Deviation.**
- **Alpha level of L.S.D = ٠,٠١**

Sensory evaluation of the dried sheet and raisins samples produced from fresh husk tomato fruit is shown in table (٥). Fernands and Rodrigues (٢٠٠٧).

Results showed that raisins sample received the highest score value (٩٦,٤٣).There was a significant difference in flavor and color between dried sheet and raisins samples. There was also no significant difference in taste and general appearance between the two dried products produced from fresh husk tomato fruit.

Table (٥): Organoleptic characteristics of husk tomato sheets and raisins

Characteristics	Score	Husk tomato sheets	Husk tomato raisins	L.S.D
Flavor	٢٥	٢٢,٦٠^{B}± ٠,٧١	٢٣,١١^{A}±٠,٦٤	٠,٤٧
Color	٢٥	٢٣,٣٣^{B}±٠,٥٣	٢٤,١٢^{A}±٠,٤١	٠,٦٨
Taste	٢٥	٢٤,٢٠±٠,٦١	٢٤,٤٠±٠,٣٨	n.s
General appearance	٢٥	٢٤,٦٠±٠,٤٨	٢٤,٨٠±٠,٥٢	n.s
Total	١٠٠	٩٤,٧٣	٩٦,٤٣	

n.s. = not significant
- L.S.D. = less significant diffewrence at ٠,٠٥ alpha level.

Results obtained in table (٦) showed a variation in volatile compounds of fresh husk tomato. The first main compound was methyl chavicol (٥٤,١٪) while; the other components were cadinene (Gamma) and farnesene, (alpha) compounds were (١٤,٧٥٪ and ٨,١٪) respectively. The other volatile compounds in fresh sample ranged from ٣,٥٪-٦,٥٦٪in which Eudesmol<γ-Gpi-Alpha > was the lowest and Bisabolene< z-Gamma> was the highest. While Cubebol and Eudesmol (γ-Gpi-Alpha > compounds had relatively the same percent. Similar result was noticed by Torres et al (٢٠٠٧). For tetradecane and Bisabolene (Beta) compounds.

Table (٦): Volatile compounds in fresh husk tomato fruit.

No	Compounds	RT	%
١	Methyl chavicol	٢٢:٣٠	٥٤,١
٢	Tetraldecane	٢٢:٧٦	٤,٥٨
٣	Farnesene, (alpha)	٢٣:٢١	٨,١٠
٤	Bisabolene (Beta)	٢٣:٥٣	٤,٨٩
٥	Cadinene (Gamma)	٢٤:٨٥	١٤,٧٥
٦	Cubebol	٢٥:٥٣	٣,٦
٧	Bisabolene< Z-Gamma>	٢٨:٢٦	٦,٥٦
٨	Eudesmol<γ-EPi-Alpha>	٢٨:٦٢	٣,٥

Tables (٧) and (٨) showed the volatile compounds for both dried husk tomato and sheet and raisins. The percent values of several compounds such as furopelargone A, and Dill apiole were higher (٧،٤ and ٦٦،٦٪) in dried husk tomato fruits raisin than in dried sheet sample. The opposite higher results were noticed for opolopenane (beta), unknown, hexadecane, ٢, ethyl and Amyl ciannamldyde (E) in dried sheet of husk tomato. These results may be due to the effect of dehydration process which may break the cells or organelles that contained these compounds and thus, causing effective extraction, as the water decreased, the acidity would have increased, and hydrolysis of these volatile compounds, increased causing the release of these compounds (Torre et al., ٢٠١٠).

Also, the volatile compound Furopelargone A, Oplopenane (beta), Hexadecane, ٢, ethyl and Amyl cinnamaldhyde (E) had the same concentration (٧،٤)% in dried husk tomato with different retention times (RT). The results also indicated that, the volatile component dill apiole was the main compound in both dried and husk tomato sheets being (٦٦،٦ and ٦٤،١٪) respectively.

Table (٧): Volatile compounds of dried husk tomato sheet.

No	Compounds	RT	%
١	Furopelargone (A)	٣٢:١٦	٦,٥
٢	Opolopenane (beta)	٣٥:١٨	٧,٦
٣	Dill apiole	٣٧:٢٢	٦٤,١
٤	Un Known	٤٠:١١	٣,٩
٥	Hexadecane, ٢, ethyl	٤٤:١٧	٨,٣
٦	Amyl ciannamldhyde (E)	٤٩:١٢	٨,٦

Table (٨): Volatile compounds of dried husk tomato fruits raisins.

No	Compounds	RT	%
١	Furopelargone (A)	٢٨:٣٦	٧,٤
٢	Opolopenane (beta)	٣٠:٥٤	٧,٤
٣	Dill apiole	٣١:٦٧	٦٦,٦
٤	Un Known	٣٤:٧٥	٣,٧
٥	Hexadecane, ٢, ethyl	٣٩:٦٦	٧,٤
٦	Amyl ciannamldhyde (E)	٤٠:٦١	٧,٤

Conclusion

The present study indicated that husk tomato fruit could be successfully dried to raisins and sheet products having the desired quality of color, taste and rehydration ratio.

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منتجات جديدة مبتكرة من ثمار الحرنكش

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تم في هذا البحث أنتاج ٢ منتج مختلف (اللفائف و الزبيب) بالتجفيف من الثمار الطازجة للحرنكش و قد تم تقدير التركيب الكيماوي و المعدني و القيم اللونية و كذلك المركبات المتطايرة في كل من العينات المجففة للمنتجين. و قد اوضحت النتائج ارتفاع محتوي فيتامين ج (١٣٤,٦٧ ملليجم/١٠٠جم) في الثمرة الطازجة و أعلي محتوي للسكريات المختزلة و كذلك الدهن في عينة اللفائف الجافة (٧,٤٦،٤٨,٤٥)% و كذلك قيم عالية للسكريات الغير مختزلة والسكريات الكلية و الرماد و الألياف في الزبيب (٧,٩٥،٧١,٨١،٣١,١٤ و ٢٠,٠٤%) مصحوبة بأرتفاع مستويات الكالسيوم ، الماغنسيوم ، الفسفور ، البوتاسيوم و كذلك الصوديوم . عملية التجفيف احدثت أنخفاض لقيم lightness (L) و أرتفاع في قيم ال(redness (a و كذلك ال yellowness (b). جودة الاسترجاع لعينة الزبيب تحسنت و اعطت اعلي القيم للصفات الحسية عن عينةاللفائف. و مركبي الميثل شافيكول Methyl chavicol و الكادينين(جاما) الحرنكش الطازجة (١٤,٧٥،٥٤,١)%. و قد وجد العديد من مركبات النكهة الجديدة في كلا المنتجين (اللفائف و الزبيب)حيث كان مركب ال Dill apiole هو المركب الرئيسي في عينات اللفائف و الزبيب (٦٦,٦،٦٤,١%) الذي يصل الي نسبة الثلثين (٢/٣) من كل المركبات الأخري .

قام بتحكيم البحث

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