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PRODUCTION OF TOMATO POWDER AND DRIED SLICES FOR USE IN SOME FOODSTUFFS

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Abstract

Full ripe tomato fruits from two varieties (UC 82 and Peto 86) were used for preparing tomato powder and tomato dried slices. High lycopene tomato powder was prepared from tomato juice by partially separation of the serum before drying in both ventilated oven and solar dryers at 55°C. Tomato slices were prepared by slicing the tomato fruit to 1 cm thick, and heating in ventilated oven at 110°C for 10 min then dried in both ventilated oven and solar dryers as in tomato powder. Tomato powder was used in some new food manufacturing applications such as normal ketchup powder, hot ketchup powder, koushary sauce powder, potato chips, sausage and tomato paste. Chemical composition of tomato powder and tomato slices compared with the fresh tomato fruits were determined. Total titratable acidity, reducing sugars, non-reducing sugars, total sugars, ascorbic acid and oxalic acid content on dry weight basis decreased in all samples of tomato powder compared with the same contents in fresh tomatoes, while lycopene and crude fiber increased. Slight changes in total titratable acidity, ash, reducing sugars, non-reducing sugars, total sugars, crude fiber and oxalic acid content, while a decrement in ascorbic acid and lycopene content calculated on dry weight basis were observed in all samples of tomato slices compared to the same contents in fresh tomatoes. Microbiological count revealed that all samples contained less than 30 colony forming unit per gram for both total bacterial count, mold and yeast count. Organoleptic evaluation showed that tomato powder, tomato slices and food products prepared from tomato powder with special reference to their constituents were highly acceptable.

INTRODUCTION

Tomato crop is the first vegetable crop from the viewpoint of the planted area, production and financial value. The annual yield of tomatoes reached about 6 million tons. (Statistical Report of the Ministry of Agriculture, 2000). The waste of tomato crop reached about 30%. Somia *et al.*, (1995) Tomato powder was prepared from tomato juice by partial separation of tomato serum followed by drying by both ventilated oven and sun drying, Radwan *et al.*, (1998). He also mentioned that refrigerated tomato powder was more stable compared to those stored at ambient temperature. Lycopene as the principal carotenoid found in tomatoes; is also one of the major carotenoids present in human serum and organs (Stahl and Sies, 1996). It was shown that, during preparation of diet, lycopene undergoes isomerization, increasing the portion of (Z)- isomers. Compared to food, in human blood plasma the isomeric ratio of lycopene was found to be shifted in favour of the (Z)- isomer fraction (Joseph *et al.*, 1997). Franceschi *et al.*, (1994) stated that epidemiological studies have shown that serum

levels of lycopene and dietary intake of lycopene from tomatoes could inversely be related to risk of certain types of cancer, such as prostate cancer, digestive-tract cancers, and lung cancer. Lycopene has been shown also in the in-vivo research to inhibit carcinogenesis in specific animal model systems as well as human cell cultures (Kim, 1995).

The aim of the present research is the production of high lycopene tomato powder and tomato dried slices by a simple processing technique suitable for the productive area using the full ripe tomato fruits most liable for spoilage during transportation and marketing. The aim is also extended to give opportunity for new laborers and solar dryers to produce high quality and inexpensive product from a waste materials. Tomato powder will also be used in preparing some food products.

MATERIALS AND METHODS

Fruits of two tomato varieties UC 82 and Pet 86 in their full ripe stage were used in this investigation. Tomatoes were washed, sorted and divided into two portions. The juice was extracted from the first portion and boiled for two minutes. Each of the obtained juice was poured into a thick muslin bag to partially remove the serum containing some of the hygroscopic reducing sugars and leaving the pulps high in lycopene. The supernatant pulp was spread as a thin layer over trays lined with polyethylene sheets, then dried using both ventilated oven at 55°C and solar dryer until dryness. The dried samples were ground to pass through a standard sieve No. 25 US. The second tomato portion was sliced (1 cm thickness) and heated to 110°C for 10 min. in ventilated oven to increase the permeability of the cell walls, inhibit the oxidative enzymes, pectic enzymes and decrease the microbial load. The previous tomato slices were dried under similar conditions.

Tomato powder was used in preparing some food items such as normal ketchup powder, hot ketchup powder, koushary sauce powder, potato chips, sausage and for producing tomato paste. The best ingredients ratios applied for the first two items were as follows:

1- Normal or hot ketchup powder

Ingredients	%
Tomato powder	53.82
Red paprika or hot red paprika*	8.42
Onion powder	1.71
Garlic powder	0.28
Cinnamon	0.5
Nutmeg	0.07
Clove	0.3
Sucrose	29.9
Salt	5.0
Ketchup was reconstituted by vinegar	3%

* Hot ketchup powder

2- Koushary sauce powder

Ingredients	%
Tomato powder	74.90
Sucrose	14.98
Salt	5.99
Garlic powder	3.0
Cumin Poeder	1.13

Koushary sauce powder was reconstituted by vinegar 2%.

3- Potato chips and sausage with the addition of 5.0% tomato powder to each product.

4- New method for producing tomato paste

Increasing tomato juice concentration (T.S.S) from 6 to 14% by evaporation in an open pan. Tomato juice concentration was increased to 23% by adding tomato powder. Salt 2% was added to reach 25% T.S.S as recommended in the Egyptian Standard Specifications. Tomato paste was sterilized and packed as usual.

Tomato powder can be reconstituted to the required concentration by adding hot or cold tap water.

The moisture content, sugars, ash, total titratable acidity and ascorbic acid were determined according to the A.O.A.C (1990). Oxalic acid and lycopene content were determined according to the method described by Ranganna (1979). Organoleptic evaluation including taste, odor, color and overall acceptability was applied to all samples using a scale from 1 to 10 and the decitions were as follows: excellent: (10); very good: (8-9); palatable: (6-7); and non-palatable: (0-5) according to Larmond (1970). Total bacterial count was carried out as described by Sharff (1966). Fungi and yeast were counted according to the method described by the American Public Health Association (1958). The collected data on sensory evaluation was statistically analyzed by the standard errors according to Snedecor and Conchran (1980).

RESULTS AND DISCUSSION

1. Chemical composition of tomato powder :

Data in Table 1 and Figures (1-4) indicate the chemical constituents of tomato powder dried by both ventilated oven and solar dryers compared to fresh tomato fruit of UC 82 and Peto 86 varieties. Moisture content of tomato varieties UC 82 and Peto 86 decreased from 94.6 and 95.0% to 6.93 and 7.31%, respectively by dehydration using ventilated oven while it was reduced to 6.05 and 6.82%, respectively using the

Table 1. Chemical constituents of tomato powder dried by both ventilated oven and solar dryer compared with fresh tomato fruits of UC 82 and Peto 86 varieties

Chemical constituents g/100g dry weight	Varieties of fresh tomatoes		Tomato powder dried by oven dryer		Tomato powder dried by solar dryer	
	UC	Peto	UC	Peto	UC	Peto
Moisture content	94.6	95.0	6.93	7.31	6.05	6.82
Ash content	9.12	9.30	7.45	8.03	7.64	8.35
Reducing sugars	46.9	35.3	37.5	29.9	36.8	30.2
Non reducing sugars	11.6	10.9	6.3	8.9	7.9	8.9
Total sugars	57.3	46.2	43.8	38.8	44.7	39.1
Crude fibers	7.34	7.99	8.83	9.66	8.85	9.65
Ascorbic acid mg/100g	227.81	226.32	161.9	166.3	152	158.9
Lycopene mg/100g	139.6	123.8	206.1	156.6	198.6	149.4
Oxalic acid mg/100g	418.1	434.8	370.7	381.1	369.1	380.7
Titratable acidity	5.76	6.40	4.23	5.26	4.31	5.02

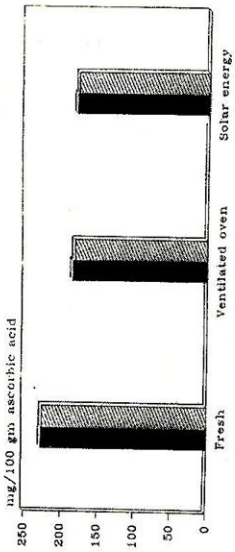

Fig.(6):Effect of dehyration method on ascorbic acid content of tomato slices

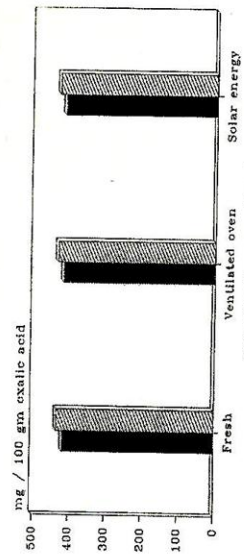

Fig.(8):Effect of dehydration method on oxalic acid content of tomato slices

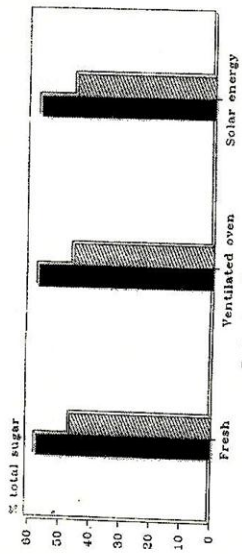

Fig.(5):Effect of dehydration method on total sugar content of tomato slices

Fig.(7):Effect of dehydration method on lycopene content of tomato slices

solar dryer. Total titratable acidity on dry basis also decreased from 5.76 and 6.40% in fresh fruit of UC 82 and Peto 86 varieties, respectively to 4.23 and 5.26% in tomato powder dried by ventilated oven. The corresponding value was 4.31 and 5.02% in tomato powder dried by solar dryer. Such decrement may be as a result of the partially separation of the serum during the tomato powder processing. These results agree with those obtained by Radwan *et al.*, (1998). Similar findings were found concerning the ash concentration in the tested samples. These data are in accordance with those obtained by Somia *et al.*, (1995). Ash content in tomato powder dried by solar dryer was slightly more than that dried in ventilated oven. Reducing, non-reducing and total sugars contents also decreased in all samples of tomato powder as a result of the aforementioned reason. These results are in agreement with those stated by the same aforementioned authors. Crude fibers that were 7.34 and 7.99% in fresh tomato fruits of UC 82 and Peto 86 varieties reached 8.83 and 9.66% on using ventilated oven and 8.85 and 9.65% respectively when solar dryer was applied. Pronounced loss in ascorbic acid was noticed after dehydration in both oven and solar dryers. These results coincide with those obtained by Sukhdev and Stapal (1994). With respect to lycopene content of the tested samples given in Table 1, the data proved the following trends :

- Concentration of lycopene that was 139.6 and 123.8 mg/100g in fresh fruit became 206.1 and 156.6 mg/100g in sample prepared by ventilated oven.

- In case of the sample dried by solar energy, the corresponding values were 198.6 and 149.4 mg/100g dried product.

This may be due to the partial separation of tomato serum so lycopene accumulated in pulp. These results agree with those obtained by Radwan *et al.*, (1998). Oxalic acid decreased from 418.1 and 434.8 mg/100g sample of fresh tomato fruit of UC 82 and Peto 86 varieties, respectively to 370.7 and 381.1 mg/100g, respectively, of tomato powder dried in ventilated oven. While it reached 369.1 and 380.7 mg/100g, respectively, in the samples dried in solar dryer.

Chemical composition of tomato slices :

Results in Table 2 and Figures (5-8) show the chemical composition of tomato slices dehydrated by both ventilated oven and solar dryer compared with the fresh tomato fruits of UC 82 and Peto 86 varieties. Moisture content in tomato slices decreased obviously as a result of dehydration process in all samples compared to that in fresh tomatoes. Slight changes in total titratable acidity, ash, reducing sugars, non-reducing sugars, total sugars, crude fibers and oxalic acid calculated on dry weight basis were noticed in all samples after the dehydration process by both ventilated oven and solar dryer. Ascorbic acid that was 227.81 and 226.32 mg/100g dry sample in

fresh tomato fruits of UC 82 and Peto 86 varieties, respectively reached 185.84 and 182.63 mg/100g dry sample by using ventilated oven and 180.14 and 177.90 when solar dryer was used. Lycopene content in the tested samples decreased from 139.6 and 123.8 mg/100g fresh tomato fruit of varieties UC 82 and Peto 86, respectively to 111.4 and 100.5 mg/100g, respectively in tomato slices after dehydration in ventilated oven, while it was 106.6 and 91.8 mg after dehydration in solar dryer. These results agree with those obtained by Sukhdev and Stapal (1994).

Microbial aspects :

All samples were evaluated microbiologically for total bacterial count, mold and yeast count. Data reveal that all samples contained less than 30 colony forming unit per gram for both total bacterial count, mold and yeast count. This might be due to the thermal treatment during processing of both tomato powder as well as tomato slices. The moisture content in all samples was less than that required for microbial growth and /or reproduction.

Table 2. Chemical constituents of tomato slices dried by both ventilated oven and solar dryer compared with fresh tomato fruits of UC 82 and Peto 86 varieties.

Chemical constituents g/100g dry weight	Varieties of fresh tomatoes		Tomato powder dried by oven dryer		Tomato powder dried by solar dryer	
	U C 82	Peto 86	U C 82	Peto 86	U C 82	Peto 86
Moisture content	94.6	95.0	7.03	7.46	6.55	6.63
Ash content	9.12	9.30	9.25	9.38	9.44	9.51
Reducing sugars	46.9	35.3	46.1	34.5	45.8	34.2
Non reducing sugars	10.4	10.9	10.9	11.1	11.0	11.1
Total sugars	57.3	46.2	57.0	45.6	56.8	45.3
Crude fibers	7.34	7.99	7.10	7.89	7.21	7.85
Ascorbic acid mg/100g	227.81	226.32	185.84	182.63	180.14	177.9
Lycopene mg/100g	139.6	123.8	111.4	100.5	106.6	91.8
Oxalic acid mg/100g	418.1	434.8	416.4	432.1	415.1	432.0
Total Titratable acidity	5.76	6.40	5.55	6.28	5.69	6.32

Organoleptic evaluation :

A complete organoleptic evaluation including color, taste and flavor was carried out for tomato powder, tomato slices and some food products containing tomato powder added during processing. Tomato powder was reconstituted by tap water while tomato slices were hydrated by boiling in tap water for 4 minutes. Food products were prepared for panel test as mentioned in materials and methods. Data concerning statistical analysis of organoleptic evaluation for taste, odor, color and overall acceptability of all tomato powder and tomato slices treatments are shown in Table 3. It could be stated that tomato powder dried in ventilated oven (UC 82 and Peto 86 varieties) as well as those dried in solar dryer had the highest palatability compared to all other tomato slices treatments. Concerning the effect of variety on tomato slices prepared therefrom, Peto 86 slices gave better values than those of the UC 82 tomato slices especially for the over acceptability of tomato dried in ventilated oven. Finally tomato slices dried in ventilated oven and solar dryers ranked the last while tomato powder dried by using the same methods gave better values.

Data in Table 4 indicate that organoleptic evaluation of all food products based on the obtained tomato powder were of high quality. High average scores were noticed in all aspects concerning taste, odor and color. Reconstitution of ketchup and koushary sauce by adding diluted vinegar gave high and good odor, a trend which may be as a result of the effect of spices. Rich red color and fresh tomato taste were noticed in these products. This high quality may be related to the method of tomato powder preparation. On the other hand, these high quality products will be more economic concerning energy consumption, transportation, packaging material, storage and for the equipment prices. High score concerning tomato paste prepared by these methods may be related to the short time of cooking and concentration of tomato juice compared with the ordinary method of preparing tomato paste. The decrement of energy and water requirements of tomato paste processing gave more value to this method. Using tomato powder for improving the color and taste of potato chips and sausage as a natural, safe and healthy food stuff made these products more valuable. High quality of these products was observed from its high average organoleptic evaluation scores.

Table 3. Organoleptic evaluation of reconstituted tomato powder as well as tomato slices

Sample	Taste	Odor	Color	Overall acceptability
	X±SE.	X±SE.	X±SE.	X±SE.
Tomato powder				
Dried in ventilated oven				
UC 82 variety	9.57^{a}+0.133	9.50^{a}+0.154	9.71^{a}+0.149	9.57^{a}+0.176
Peto 86variety	9.85^{a}+0.092	9.50^{a}+0.154	9.71^{a}+0.149	9.57^{a}+0.170
Dried in solar dryer				
UC 82 variety	9.50^{a}+0.218	9.50^{a}+0.154	9.50^{ab}+0.218	9.50^{a}+0.154
Peto 86 variety	9.50^{a}+0.154	9.00^{ab}+0.218	9.78^{a}+0.101	9.64^{a}+0.154
Tomato slices				
Dried in ventilated oven				
UC 82 variety	8.50^{c}+0.154	8.00^{c}+0.218	8.50^{c}+0.154	8.50^{bc}+0.154
Peto 86 variety	9.00^{b}+0.154	8.50^{bc}+0.154	$9.00b^{c}$+0.218	8.93^{b}+0.170
Dried in solar dryer				
UC 82 variety	8.00^{d}+0.154	8.00^{c}+0.154	8.50^{c}+0.154	8.21^{c}+0.240
Peto 86 variety	8.57^{c}+0.154	8.00^{c}+0.218	$9.00b^{c}$+0.189	8.50^{bc}+0.218
F-value	18.068**	15.273**	9.910**	10.61**

Means with the same letter are not significantly different
** Highly significant at 1%
X = Mean
SE = Standard error

Table 4. Organoleptic evaluation of reconstituted tomato products from tomato powder

Sample	Taste	Odor	Color	Overall acceptability
Normal ketchup	9.5	9.5	9.5	9.5
Hot ketchup	9.5	9	10	9.5
Koushary sauce	9	9.5	8.5	9
Tomato paste	9	9.5	9	9.2
Potato chips	9	9	9	9
Sausage	8.5	8	9	8.5
Averages	9.0833	9.0833	9.166	9.033
S.E	0.1536	0.2386	0.2108	0.2261

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إنتاج مسحوق وشرائح الطماطم لإستخدامها في التصنيع الغذائي

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الملخص العربي

تم إستخدام طماطم كاملة النضج من صنفي UC 82 and Peto 86 لتحضير مسحوق طماطم وشرائح طماطم. وقد تم تحضير مسحوق طماطم عالية في الليكوبين من عصير الطماطم بواسطة الفصل الجزئي للسيرم ثم التجفيف بإستخدام كل من الفرن الهوائي والمجفف الشمسي علي درجة ٥٥°م وتم تحضير شرائح الطماطم وذلك بعمل شرائح طماطم مسمك ١ سم والتسخين علي درجة حرار ١١٠°م لمدة ١٠ ق في فرن هوائي ثم التجفيف كما سبق في تحضير مسحوق الطماطم. تم إستخدام مسحوق الطماطم في بعض المنتجات الغذائية مثل مسحوق الكاتشب العادية والحارة ومسحوق صلصة الكشري والبطاطس الشيبس والسجق وكذلك في طريقة جديدة لإنتاج عجينة الطماطم. وتم تقدير التركيب الكيماوي لكل من مسحوق الطماطم وشرائح الطماطم مقارنة بالطماطم الطازجة وقد وجد أنه قد إنخفض محتوي كل من الحموضة الكلية والرماد والسكريات المختزلة والسكريات الغير مختزلة والسكريات الكلية وحامض الأسكوربيك وحامض الأوكساليك في جميع العينات من مسحوق الطماطم محسوبة علي الوزن الجاف مقارنة بمحتواها في الطماطم الطازجة بينما زاد المحتوي من الليكوبين والألياف الخام. أما في شرائح الطماطم فقد وجد أن هناك تغيرات بسيطة في المحتوي من الحموضة الكلية والرماد والسكريات المختزلة والسكريات الغير مختزلة والسكريات الكلية والألياف الخام وحامض الأوكساليك بينما حدث إنخفاض في محتوي الليكوبين وحامض الأسكوربيك محسوبة علي الوزن الجاف مقارنة بمحتواها في الطماطم الطازجة. وقد أوضح العد الميكروبي أن جميع العينات تحتوي علي عدد أقل من ١٠ مستعمرة لكل جرام من العد البكتيري وعد الفطر والخميرة. وقد أظهر التقييم الحسي لكل من مسحوق الطماطم وشرائح الطماطم وكذلك المنتجات الغذائية التي إستخدمت فيها مسحوق الطماطم أنها منتجات عالية الجودة.