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EFFECT OF SOME PACKAGING MATERIALS AND STORAGE TEMPERATURE ON QUALITY ATTRIBUTES OF POWDER AND SLICES OF DRIED TOMATOES

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Abstract

Tomato fruits (Peto 86 variety) were used in this investigation for the production of both tomato powder and dried tomato slices. Ventilated oven dryer was used in the drying process. Powder and slices of tomatoes were packed in three different types of packaging materials i.e milky polypropylene, polyproplene metalized and trilayerbags then stored at both ambient temperature and refrigerator at +5°C for 6 months. Samples were analyzed at intervals of two months for moisture content, total titratable acidity, reducing sugars, total sugars, ascorbic acid, lycopene, color index, microbial count and organoleptic qualities. Lycopene and ascorbic acid decreased while color index increased by increasing the storage period in all samples. Slight changes in sugars and total titratable acidity content were observed. Results also showed that all samples contained less than 30 colonies forming unit per gram for both total bacterial, mold and yeast count during storage. Chemical analysis and organoleptic evaluation revealed that samples packed in trilayer bags and stored in refrigerator were the best during storage.

INTRODUCTION

Tomato crop is among the most important vegetable crops in Egypt. The production reached about 6 millions tons (Statistical Report of Ministry of Agriculture 2000). About 30% of tomato production was spoiled during transportation and marketing. Nguyen and Schwartz (1999) stated that, the more than 50 dietary carotenoids, lycopene, found primarily in tomatoes and tomato products, is the most prevalent in the Western diet and the most abundant in human serum. Scita (1992) mentioned that physical and chemical factors known to degrade other carotenoids, including elevated temperature, exposure to light, oxygen, extreme in pH value and active surfaces could be applied to lycopene as well. Narisawa *et al.*, (1996) mentioned that lycopene has been shown in in-vivo research to inhibit carcinogenes in specific animal model systems, as well as human cell cultures (Kim, 1995). Nguyen and Schwartz (1999) mentioned that processing and storage of tomato products caused lycopene degradation. Heating of tomato juice was shown to result in an improvement in uptake of lycopene in humans (Stahl and Sies, 1992). Gartner *et al.*, (1997) showed that tomato paste, a processed product, has more bio available lycopene than fresh tomatoes when both are consumed in conjunction with corn oil. Lovric *et al.*, (1970) found that, in low moisture products like tomato powder, carotenoids were readily oxidized causing color loss and off flavors. The stability of lycopene during oxidation determines how lycopene would influence food quality and shelf life. Environmental factors such as air, light and temperature may be very important for the isomerization and auto-oxidation of lycopene in tomato powders. Therefore, the suitable packaging materials and optimum conditions can be considered as the important factors to prevent or less oxidize the color and other components during different storage times. Radwan *et al.*, (1998) reported that tomato powder packed in multilayer bags were better compared to those samples packed in polyethylene and polypropylene bags, also they added that samples stored in refrigerator at 5°C for 6 months were better than those stored at ambient temperature.

The aim of the present investigation is the production of high quality tomato powder as well as tomato slices using simple processing technique in the farm by the farmers themselves. Full ripe tomato fruits which may be spoiled during transportation and marketing were used in this work. Effect of drying methods, storage temperature and packaging materials on quality attributes of these products were studied during storage for 6 months.

MATERIALS AND METHODS

Tomato fruits of Peto 86 variety were used in this study. The fruits were washed and sorted. Half amount of the fruits were crushed in an electric blender and screened to separate seeds and peels. Tomato juice was boiled for two minutes in stainless steel pan. High lycopene content of tomato pulp was extracted by partial separation of serum through a muslin bag to get rid of some hygroscobic reducing sugars. Tomato pulp was spread in thin layer over trays lined with polyethylene sheet then dried in ventilated oven at 55°C. Tomato sheets were ground into fine powder using laboratory mill to pass through a standard sieve No.25 U.S. The second portion of tomato fruits was sliced (1 cm thickness) and heated to 110°C in ventilated oven to inhibit the oxidative and pectic enzymes, increase the water /evaporation by increasing the permeability of cell wall and decrease the microbial load. The tomato slices were dried in ventilated oven at 55°C. Both tomato powder and dried slices were packed in milky polypropylene, polypropylene metalized and trilayer bags (polyester-aluminum foil-polyethylene). Bags were vacuumized to -0.6 atmosphere pressure before sealing then stored at both ambient temperature and refrigerator at +5°C for 6 months. Triplicate samples of every treatment were drawn out every 2 months for analysis. The moisture content, total titratable acidity, reducing sugars, total sugars, lycopene, ascorbic acid, color index, organoleptic evaluation, total bacterial count and fungi-yeast count were determined. The moisture content, sugars, total titratable acidity and ascorbic acid were determined according to the A.O.A.C., (1990). Lycopene content was determined according the method described by Ranganna (1979). Color index was accomplished according to the method described by Dietrich et al., (1962). Organoleptic evaluation was determined according to the method described by Notter et al., (1959). Statistical analysis was applied for the data of sensory evaluation. ANOVA was carried out followed by multiple comparisons using LSD (Snedecor and Cochran, 1973). Total bacterial count was determined according to the method described by Sharff (1966). Fungi and yeast were counted according to the method recommended by the APHA (1958).

RESULTS AND DISCUSSION

CHEMICAL ANALYSIS

1- Total, reducing and non-reducing sugars:

Results in Table 1 represent total, reducing and non-reducing sugars in both tomato powder and dried tomato slices packed in milky polypropylene, polypropylene metalized and trilayer bags and stored in ambient temperature and refrigerator for 6 months. Data reveal that sugars were the main chemical constituents in tomato. Reducing sugars percentage were 41.84 and 52.85% while total sugars were 52.74 and 62.81% in tomato powder and dried slices, respectively on dry weight basis at zero time. A slight decrease was observed in reducing, non-reducing and total sugars in all samples after storage for 6 months. Tomato powder and dried slices packed in trilayer bags showed the less decrement in reducing, non-reducing and total sugars during the storage period. Trilayer bags may be considered as the best packaging material serving as a barrier to atmosphere compared to the other packaging materials. Samples stored in refrigerator were better than those stored at ambient temperature. These results coincide with those obtained by Takoshi (1990).

2- Lycopene content:

Results in Table 2 indicate lycopene content under different conditions. The results show that tomato powder contained higher amount of lycopene (218.23 mg/100g) than that in dried tomato slices (171.71 mg/100g) calculated on dry weight basis at zero time. Lycopene content gradually decreased through the storage periods. Trilayer bags were the best in all samples after 6 months of storage in refrigerator. The decrement percentages were 13.06 and 19.21% in tomato powder and dried tomato slices respectively after 6 months of storage. In all cases the decrement of lycopene in samples stored in refrigerator was less than that stored at ambient temperature. This decrement may be related to auto–oxidation including elevated temperature, exposure to light, oxygen and active surfaces. These data agree with those obtained by Lovric et al., (1970); Scita (1992) and Radwan *et al.*, (1998).

3- Ascorbic acid:

As shown in Table 3 in different samples of tomato powder and dried slices, ascorbic acid contents were 145.2 and 182.4 mg /100gm respectively on dry weight basis at zero time. Gradual decrement in ascorbic acid content was observed during storage in all treatments. In all cases the rate of decrement in samples stored at ambient temperature was higher than those stored in the refrigerator during 6 months. The less decrement percentage was noticed in tomato products packed in trilayer bags and stored in refrigerator for 6 months. They were 20.24 and 23.61% in tomato powder and dried tomato slices respectively. The least protective packaging material was the milky polypropylene bags while the highest was the trilayer bags. This may be related to their permeability to the atmospheric conditions. These data coincide with those obtained by Radwan *et al.,* (1998).

4- Total titratable acidity:

Results in Table 4 show the change in total titratable acidity in tomato powder and dried tomato slices packed in different kinds of packaging materials during 6 months of storage at ambient temperature as well as in refrigerator. A slight decrease was shown in all samples. The rate of decrement ranged from 1.67 to 3.33 % in samples of tomato powder while, it ranged from 2.04 to 5.43 % in dried tomato slices. Samples packed in trilayer bags exhibited the least changes in total titratable acidity. Samples stored in refrigerator remained more stable than those stored at ambient temperature.

5- Color index:

Data presented in Table 5 reveal the change in color index of tomato powder and dried tomato slices packed in milky polypropylene, polypropylene metalized and trilayer bags and stored in both ambient temperature and refrigerator at 5°C for 6 months. Tomato powder color index in samples packed in milky polypropylene bags and stored at room temperature was the worst. It increased from 0.043 to 0.163. On the other hand it was the best in samples packed in trilayer bags and stored in the refrigerator. It increased from 0.043 to 0.05 only. Trilayer bags were the best packaging material. The best color index of dried tomato slices was also in samples packed in trilayer bags and stored in the refrigerator. It increased from 0.078 to 0.098. A pronounced increase was noticed in color index of tomato slices compared to tomato powder packed and stored at the same condition. It may be related to the method of tomato powder processing which got rid of some of reducing sugars that are the most important factors causing Maillard reaction. In all cases trilayer bags were the best packaging material. This might be related to the low permeability to atmospheric conditions such as moisture and oxygen compared to the other packaging materials. Samples stored in the re-

Table 1. Total, reducing and non-reducing sugars in powder and dried slices of tomatoes (% On dry weight basis).

Constituents	Zero time			2 Months			4 Months			6 Months		
	Reducing sugars	Non-reducing sugars	Total sugars	Reducing sugars	Non-reducing sugars	Total sugars	Reducing sugars	Non-reducing sugars	Total sugars	Reducing sugars	Non-reducing sugars	Total sugars
Tomato Powder												
Ambient temperature												
Milky polypropylene				39.58	11.82	51.4	38.57	12.53	51.1	38.22	12.62	50.84
Polypropylene				40.83	11.41	52.24	40.3	11.01	51.31	38.56	12.41	50.97
Metalized Trilayers				41.64	11.00	52.64	40.69	11.79	52.48	40.12	11.54	51.66
Refrigerator (5 º C)	41.84	10.9	52.74									
Milky polypropylene				40.75	11.51	52.08	39.89	11.47	51.36	39.7	11.38	51.08
Polypropylene				41.00	11.31	52.34	40.74	11.02	51.76	40.01	11.36	51.37
Metalized Trilayers				41.74	10.83	52.57	40.88	10.94	51.82	40.58	11.78	52.36
Dried Tomato Slices												
Ambient temperature												
Milky polypropylene				49.08	12.56	61.64	48.71	11.91	60.62	48.2	13.98	60.18
Polypropylene .				50.28	11.52	61.80	49.16	12.24	61.4	48.36	13.00	61.36
Metalized Trilayers				51.14	11.47	62.62	50.56	11.94	62.5	48.98	12.46	61.44
Refrigerator (5 º C)	52.58	10.23	62.81									
Milky polypropylene				50.37	11.71	62.08	50.17	11.6	61.77	49.16	12.48	61.64
Polypropylene				52.00	10.28	62.28	50.10	11.77	61.87	49.31	12.39	61.7
Metalized Trilayers				52.18	10.51	62.69	51.97	10.27	62.24	50.78	11.23	62.01

Table 2. Effect of some packaging materials and storage temperature on lycopene content during 6 months of storage (mg/100g)*.

Constituents	Zero time	2 Months	4 Months	6 Months
Tomato powder				
Ambient temperature				
Milky polypropylene	218.23	132.24	130.13	73.45
Polypropylene		140.43	116.71	91.12
Metalized Trilayers		207.8	193.48	182.3
Refrigerator(5 º C)				
Milky polypropylene		150.67	144.67	90.19
Polypropylene		169.24	145.43	136.95
Metalized Trilayers		202.62	195.98	189.74
Tomato slices				
Ambient temperature				
Milky polypropylene	171.71	105.76	100.48	81.92
Polypropylene		156.45	108.28	92.84
Metalized Trilayers		162.83	147.96	124.98
Refrigerator(5 º C)				
Milky polypropylene		128.57	117.52	82.7
Polypropylene		166.33	125.45	100.48
Metalized Trilayers		169.34	156.55	138.71

*On dry weight basis

Table 3. Effect of some packaging materials and storage temperature on ascorbic acid content during 6 months of storage (mg/100g)*.

Constituents	Zero time	2 Months	4 Months	6 Months
Tomato powder				
Ambient temperature	145.2			
Milky polypropylene		121.92	10.9	94.27
Polypropylene		122.41	1113.95	96.51
Metalized Trilayers		130.44	118.65	108.15
Refrigerator(5 º C)				
Milky polypropylene		123.13	120.13	100.15
Polypropylene		125.51	122.59	103.85
Metalized Trilayers		133.67	131.76	115.81
Dried Tomato slices				
Ambient temperature	182.4			
Milky polypropylene		156.73	133.28	118.87
Polypropylene		163.51	129.21	119.05
Metalized Trilayers		169.93	134.73	128.35
Refrigerator(5 º C)				
Milky polypropylene		161.17	149.49	124.17
Polypropylene		168.29	156.84	125.51
Metalized Trilayers		170.42	159.2	139.33

*On dry weight basis

frigerator showed less color index values than those stored at ambient temperature. This could be related to the higher temperature at ambient conditions which would encourage chemical reactions compared to those in the refrigerator.

MICROBIOLOGICAL EVALUATION

Samples of both tomato powder and dried tomato slices packed in milky polypropylene, polypropylene metalized and trilayer bags and stored at both ambient temperature and refrigerator at 5°C were evaluated for total bacterial count, mold and yeast. Less than 30 colonies forming unit per gram were observed in all samples under investigation during 6 months of storage. This may be related to the high temperature used during processing and to the low moisture content of the tomato product, which was lower and unsuitable for the microbial growth and/or reproduction.

ORGANOLEPTIC EVALUATION

Organoleptic evaluation includes taste, odor, color and overall acceptability were carried out on all samples of both tomato powder and slices. Statistical analysis of data is shown in Table 6. Samples packed in trilayer packaging material showed insignificant differences concerning taste, odor, color and overall acceptability between tomato powder and dried tomato slices after two months of storage, while recorded significant differences after 4 and 6 months. Significant differences between the samples packed in trilayer packs and those packed in both milky polypropylene and polypropylene metalized were also noted after 6 months. Data in the same table show also significant differences between samples stored in refrigerator and those stored at ambient temperature. Conclusively samples of both tomato powder and dried slices packed in trilayer packs and stored in refrigerator were the best. These results may be related to the effect of packaging materials as well as storage temperature and storage period.

Table 4. Effect of some packaging materials and storage temperature on total titeretable acidity during 6 month storage (mg/100g)*.

Constituents	Zero time	2 Months	4 Months	6 Months
Tomato powder				
Ambient temperature	5.4			
Milky polypropylene		5.31	5.29	5.22
Polypropylene		5.31	5.27	5.26
Metalized Trilayers		5.35	5.32	5.29
Refrigerator(5 º C)				
Milky polypropylene		5.36	5.32	5.26
Polypropylene		5.35	5.33	5.28
Metalized Trilayers		5.38	5.35	5.31
Dried Tomato slices				
Ambient temperature	4.36			
Milky polypropylene		7.21	7.1	6.96
Polypropylene		7.24	7.13	6.98
Metalized Trilayers		72.28	7.17	7.08
Refrigerator(5 º C)				
Milky polypropylene		7.27	7.16	7.08
Polypropylene		7.27	7.2	7.11
Metalized Trilayers		7.31	7.27	7.21

*On dry weight basis

Table 5. Effect of some packaging materials and storage temperature on color index during 6 months of storage.

Constituents	Zero time	2 Months	4 Months	6 Months
Tomato powder				
Ambient temperature				
Milky polypropylene	0.043	0.055	0.075	0.163
Polypropylene		0.051	0.06	0.119
Metalized Trilayers		0.051	0.054	0.091
Refrigerator (5 º C)				
Milky polypropylene		0.052	0.06	0.067
Polypropylene		0.051	0.059	0.067
Metalized Trilayers		0.047	0.048	0.05
Dried Tomato slices				
Ambient temperature				
Milky polypropylene	0.078	0.099	0.144	0.321
Polypropylene		0.092	0.149	0.325
Metalized Trilayers		0.09	0.098	0.272
Refrigerator (5 º C)				
Milky polypropylene		0.096	0.102	0.111
Polypropylene		0.091	0.099	0.119
Metalized Trilayers		0.089	0.092	0.098

Table 6: Effect of packaging materials and storage temperature on sensory evaluation during 6 months of storage.

Constituents	Zero time				2 Months				4 Months				6 Months			
	Taste	Odor	Color	Overall acceptability	Taste	Odor	Color	Overall acceptability	Taste	Odor	Color	Overall acceptability	Taste	Odor	Color	Overall acceptability
Tomato powder																
Ambient temperature																
Milky polypropylene					8.29	8.29	8.14	8.57	6.71	6.43	6.14	6.14	5.14	5.57	5.29	4.86
Polypropylene					8.29	8.43	8.29	8.57	6.86	6.57	6.57	6.26	5.43	5.71	5.71	5.14
Metalized Trilayers	9.64	9.71	9.78	9.86	8.71	8.57	8.71	9	8.17	8.29	8.29	8.29	7.86	7.86	8	8.29
Refrigerator (5 º C)																
Milky polypropylene					8.57	8.57	8.57	8.43	7	7.71	7.86	7.71	5.29	5.86	5.71	5.71
Polypropylene					8.71	8.71	8.57	8.71	7.29	7.71	7.71	7.86	5.86	5.86	5.71	5.86
Metalized Trilayers					9.29	9.14	9.29	9.57	8.86	8.86	6.86	9	8.71	8.51	8.71	8.71
Dried Tomato slices																
Ambient temperature																
Milky polypropylene					8.43	8.29	8	8.43	6.57	6.43	6.43	6.57	3.86	3.86	3.57	3.71
Polypropylene					8.43	8.29	8	8.57	6.43	6.29	6.43	6.57	4	4.29	3.57	4
Metalized Trilayers	9.21	9.14	9.21	9.07	8	8.71	8.43	9.14	7.86	7.86	7.86	8	7	7.29	7.57	7.57
Refrigerator (5 º C)																
Milky polypropylene					8.29	8.29	8	8.57	7	6.86	6.86	6.86	4	3.71	3.71	4.14
Polypropylene					8.29	8.29	8.57	8.78	7	6.86	7.14	7	4	3.86	4.42	4.71
Metalized Trilayers					8.92	9	9	9	8.29	8.14	8.14	8.14	8	8.14	8.29	8.14

*Means of 7 replicantes.
**Significant decrease ($P<0.05$) from their respective control

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تأثير بعض مواد التعبئة و درجة حرارة التخزين على عوامل الجودة لمسحوق و شرائح الطماطم

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تم استخدام صنف طماطم بيتو ٨٦ في هذا البحث لإنتاج كل من مسحوق الطماطم و شرائح الطماطم المجففة. و كذلك تم إستخدام الفرن المزود بمروحة لتجفيف العينات . و قد استخدمت ٣ أنواع من العبوات و هي .Milky polypropylene, Polypropylene metalized, Trilayer bags في التعبئة و تم التخزين في كل من درجة حرارة الغرفة و الثلاجة لمدة ستة أشهر و قد تم تحليل العينات كل شهرين لتقدير الرطوبة-الحموضة الكلية -السكريات-حمض الأسكوربيك-الليكوبين-كثافة اللون-العد الميكروبي-التقييم الحسي. و قد وجد أن كل من محتوى الليكوبين و حمض الأسكوربيك قد إنخفض بالتخزين بينما إرتفعت كثافة اللون. و قد لوحظ تغيرات بسيطة في محتوي السكر و الحموضة و قد أظهرت النتائج في العد البكتيرى و كذلك الفطر و الخميرة أن جميع العينات كانت تحتوي علي أقل من ٣٠ مستعمرة في الجرام أثناء التخزين. و قد اوضحت نتائج كل من التحليل الكيميائي و التقييم الحسى أن العينات التي عبئت في العبوة ثلاثية الطبقات و خزنت في الثلاجة كانت الافضل أثناء التخزين.