J. Agric. Sci. Mansoura Univ., 32 (4): 2661 - 2671, 2007

UTILIZATION OF TOMATO CANNERY WASTES (SEEDS) IN FOOD PURPOSES

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ABSTRACT

Tomato seeds as a waste was obtained from Edfina Company for food preservation, Alexandria. These seeds were cleaned, spreaded, dried and ground. The chemical composition, amino acids, fatty acids and some minerals of tomato seeds were assessed. The ground tomato seeds were added to wheat flour by ratio 5, 10 and 15%, respectively. Also, tomato seeds were added to beef burger during frozen storage and then analyzed at different period.

The results indicated that tomato seeds contain high amounts of protein, fat, crude fiber, essential and nonessential amino acids. As well as, the amino acids concentration were arranged in decreasing order glutamic, aspartic, arginine, leucine, lysine, phenylalanine, isoleucine, methionine and cystine was recorded the lowest value. Fatty acids of tomato seeds were contained mainly from palmitic as a saturated fatty acid while, oleic and linoleic as unsaturated fatty acids.

Addition of ground tomato seeds to wheat flour led to increase protein, ash, fiber, all essential and non essential amino acids of pie by increasing the level of added tomato seeds when compared with unsupplemented pie. Also, addition of tomato seeds up to 10% to wheat flour pie did not affect the overall acceptability of baked pies while, at level 15% samples started to affect in aroma, taste, texture and overall acceptability.

Fat content of treated beef burger with tomato seeds was decreased as the time of frozen storage period increased. Also, TBA, pH and acidity values of beef burger were gradually increased by increasing the frozen storage period while, the increment in the treated samples was lower in these parameters as compared with the untreated samples. The total unsaturated fatty acids especially $C_{18:2}$ and $C_{8:3}$ were decreased during frozen storage of beef burger.

INTRODUCTION

Fruits and vegetables processing wastes represent nearly 30 to 50% of the total fresh product. These wastes are a source of pollution due to their accumulation inside food processing plants causing great loss of the project funds. Tomato fruits are among the most popular vegetables grown in Egypt.

The total average of annual cultivated area in Egypt was about 350.000 feddans producing about six million tons (Anonymous, 1997). Tomato wastes remaining after processing represent about 20% of the original fresh tomato (Arad *et al.,* 1996). Tomato processing wastes, or pomace, consist of skins, pulp and seeds.

Daniel and Geisman (1980) reported that the majority 50.55% of the tomato pomace is tomato seeds. These seeds have from 23 to 34% crude protein and from 28 to 32% lipid (Moharram and Ahmed, 1980 and Geisman, 1981). The tomato seed protein is rich in lysine, the limiting amino acid of cereal products (Beth *et al.,* 1981) and is similar in its nutritive value to soy or cotton seed concentrates (Kramer and Kwee, 1977). Tomato seed oil has almost a same fatty acid distribution as cotton seed oil (Ismail *et al.,*

1972). The high unsaturated fatty acid content of tomato seed oil ($C_{18:1}$, 20%; $C_{18:2}$, 55-60%; $C_{18:3}$, 2%) and the nutritive value of the protein make it suitable for supplementing proteins in cereal products (Daniel and Geisman, 1980).

In addition, Szanto (1980) have been reported to possess antioxidant property. Also, Guleria *et al.* (1983) and Sayed *et al.* (1993) studied its effectiveness as a natural antioxidant in butler and ghee. Tomato seeds and skins contained carotenoids (Al-Wandawi, 1985) which are frequently used as natural coloring materials, but they also posses antioxidant activity, specially in the presence of light (Terao, 1989).

This study, aims to assess the chemical composition of tomato seeds as well as their amino acids and fatty acids. Besides, effect of different levels of these ground seeds on quality of wheat flour pie. The study is examing and evaluate tomato seeds as antioxidant of beef burger during different frozen periods.

MATERIALS AND METHODS

Tomato seeds as a waste during the preparation of tomato juice was obtained from Edfina Company for food preservation, Alexandria, Egypt during the spring season of 2003. The seeds were washed three times by running water, spreaded on dried trays and dried in a cabinet drier at 60^{o}C for 6 hrs.

The dried cleaned seeds were ground with blender to pass through 60 mesh sieve. The ground seeds were stored in air tight glass jars at room temp. (25^{o}C until used).

Analytical methods:

Moisture, crude protein, crude fat, ash and crude fiber were determined according to the methods of AOAC (1990). Carbohydrates were calculated by the difference. Amino acids were determined in the acid hydrolysate according to the method described by Petter and Young (1980). Chemical score was calculated following the method of Petter and Young (1980).

Protein efficiency Ratio (PER) was estimated using the equation reported by Alsmeyer *et al.* (1974):

PER = 0.684 + 0.456 (leucine) - 0.047 (proline).

Biological value (BV) was estimated using the equation suggested by Mitchell and Block (1946):

BV = 49.9 + 10.53 PER

Thiobarbituric acid value (TBA) as an indicator for lipid oxidation was assessed as described by Pearson (1970).

pH value was measured by a pH meter according to the method of Krilova and Liskovskaia (1991).

Fatty acids: Fatty acid methyl esters of beef burger samples were prepared and determined according to the method reported by Vogel (1975).

Technological application:

Wheat flour Pie: wheat flour pie prepared using the procedure described by Gad (1987). Ingredients were: 190 gm of wheat flour (72%

extraction), 2 gm salt, 55 gm vegetable oil and 100 gm of water. Baking in hot oven was carried out at 250°C for 15-20 min. Samples were prepared with 5, 10 and 15% of tomato seeds on the expense of the wheat flour. The pies were perceived organoleptically for color, taste, aroma, texture and overall acceptability according to the method of Molander (1960).

Beef burger: Beef burger was prepared by the common method according to the following formulation: 62% beef, 7% onion, 7% egg, 12% extru. soy, 10% iced water, 1.5% salt and 0.5% species mixture. Addition levels of tomato seeds to beef burger were 3, 5, 7% and zero % as a control. All samples were analyzed at zero time and packed individually in polyethylene pouches, then stored at -18°C for period extended to six months. Samples were analyzed after 1, 2, 4 and 6 months of frozen storage.

RESULTS AND DISCUSSION

The results given in Table (1) show the chemical composition, amino acid and fatty acids content of tomato seeds. These data indicate that tomato seeds had contain high amounts of protein (27.54%), fat (23.92%) and crude fiber (16.81%). These components were found to be similar to that found by Beth *et al.* (1981) and Attia *et al.* (2000), who reported that tomato seeds contained 27.92% protein, 24.12% fat and 18.08% fiber. On the other hand, the present results were higher levels than that found by Lech *et al.* (1968) and lower value than that found by Moharam and Ahmed (1980). These variations may be due to the variety of tomato used during juice preparation. While, the increase of fiber may be attributed to the presence of hull which was not remove during preparation of tomato seeds from waste.

Table (1): Chemical composition, amino acids, fatty acids and some minerals of ground tomato seeds.

Chemical composition		Amino acid concentrations		Fatty acid concentrations	
Parameters	**Value, %**	**Amino acids**	**g/100 g**	**Fatty acids**	**Value (%)**
		Essential			
Moisture	6.17	Leucine	6.05	$C_{14:0}$	4.9
Protein	27.54	Arginine	7.47		
Fat	23.92	Histidine	2.67	$C_{16:0}$	13.63
Ash	4.7	Isoleucine	5.16		
Fiber	16.81	Lysine	5.93	$C_{16:1}$	2.29
Carbohydrate	27.03	Methionine	1.27		
		Phenylalanin	5.32	$C_{17:0}$	1.55
		Threonine	3.45		
		Valine	4.93	$C_{18:0}$	6.48
Minerals	Value mg, %	Non-essential			
Ca	156	Alanine	4.79	$C_{18:1}$	27.27
Na	85	Aspartic	10.07		
K	768	Glutamic	18.53	$C_{18:2}$	47.49
P	751.01	Glycine	2.69		
Fe	8.0	Proline	3.16		
Cu	1.94	Serine	4.82		
Zn	3.82	Cystine	0.25		
		Tyrosine	3.88		

Moreover, these results show also that tomato seeds contain high amounts of minerals but its values were lower than that found by George *et al.* (1995) and approximately similar with the results of Moharram *et al.* (1984) except for Na and Fe its values were higher 106.76 and 16.43 mg/100 g, respectively than that found in this study. This may be due to differences in tomato cultivars and type of processes.

In general tomato seeds were rich in both essential and non essential amino acids. The present study cleared that amino acid contents were arranged according to their concentration in the following decreasing order glutamic, aspartic, arginine, leucine, lysine, phenlalanine, isoleucine and methionine in addition to cystine were the lowest values. Similar results were found by Canella and Castriotta (1980) and Sara and Dietrich (1983), who reported that tomato seeds contained 5.5 $\pm$ 0.08 lysine, 5.82 $\pm$ 0.34 leucine and 4.26 $\pm$ 0.48 phenylalanine. As well as, Daniel and Geisman (1980) reported that tomato seeds had contained the highest value in glutamic acid, aspartic acid and rich in lysine, arginine and threonine.

Fatty acids of tomato seeds composed mainly from palmitic acid $C_{16:0}$ (13.63%) as a saturated fatty acid while, Oleic acid $C_{18:1}$ (27.27%) and linoleic acid $C_{18:2}$ (47.49%) as unsaturated fatty acids. These findings were similar with those reported by Moharram *et al.* (1984), Botos (1968) and Shams El-Din (1998), who reported that oleic acid $C_{18:1}$ and Linoleic $C_{18:2}$ were the most abundant while, palmitic acid $C_{16:0}$ was the prevailing among all saturated fatty acids in tomato seeds.

The results of the addition of ground tomato seeds to wheat flour at varying replacement levels are given in Table (2). It could be noticed that protein content of supplemented pie increased by increasing the level of replacement. The protein content of pie was reached 15.64% at level 15% of ground tomato seeds while it was 8.81% in unsupplemented pie. Also, noticed that the contents of ash and fiber of supplemented pie tended to increase by increasing the level of added tomato seeds. On the contrary, total carbohydrate and total fat tended to decrease with increasing the supplementation of tomato seed levels. These results are in agreement with those reported by Beth *et al.* (1981) and Moharram *et al.* (1984), who found that addition of ground tomato seeds caused apparent increase in both crude protein and crude fiber in the cake, while, crude fat apparently decreased with the increase in tomato seed percentages addition.

Table (3) shows the effect of adding tomato seeds at the levels of 5, 10, 15% on the amino acids of pie. These data indicate an increase in all amino acids content (essential and nonessential) with increasing the addition of tomato seeds. Total essential amino acids recorded the highest value when pie supplemented with 15% of ground tomato seeds compared with control pie. Also, it was clear that leucine, phenylalanine, isoleucine, valine and lysine were recorded the highest values respectively in both control and supplemented pie. These results similar to that found by Carlson *et al.* (1981), Attia *et al.* (2000), who reported that supplementation of wheat bread with ground tomato seeds led to improve the overall protein quality of the bread.

Table (2): Chemical composition of wheat flour supplemented with different levels of tomato seeds (T.S).

Chemical composition	Moisture	Protein	Fat	Ash	Fiber	Carbohydrate
Treatments	%					
Control	17.81	8.81	19.77	1.31	0.62	69.49
5% T.S	17.72	14.12	19.46	1.76	2.55	62.11
10% T.S	17.63	14.36	19.22	2.11	3.21	61.10
15% T.S	17.61	15.64	18.13	2.34	4.03	59.86

Table (3): Concentration of amino acids in wheat flour pie (g/100 g) with different levels of tomato seeds.

Amino acids	Control	5%	10%	15%
Essential				
Leucine	6.65	6.41	6.80	6.84
Arginine	3.23	4.28	4.53	4.81
Histidine	2.46	2.63	2.65	2.67
Isoleucine	4.21	4.61	4.90	4.96
Lysine	3.36	3.64	3.95	4.21
Methionine	1.41	1.46	1.55	1.66
Phenylalanin	4.72	5.47	5.68	6.76
Threonine	3.35	3.44	3.57	3.84
Valine	3.39	3.81	4.18	4.30
Non-essential				
Alanine	3.40	3.62	3.68	3.71
Aspartic	3.51	4.15	4.36	4.88
Glutamic	26.41	27.62	27.32	27.37
Glycine	2.92	2.77	2.83	2.95
Proline	8.45	8.49	8.83	9.58
Serine	4.10	4.47	4.49	4.52
Cystine	1.26	0.28	0.29	0.33
Tyrosine	3.10	3.13	3.42	3.67

The amino acid scores (A.A.S) of the supplemented and unsupplemented pies are shown in Table (4). These data indicate that all A.A.S. were increased in treated samples when compared with control one probably due to the improvement in lysine and other essential amino acids. The data cleared that lysine was found to be the first limiting amino acid. So, its chemical score was increased in supplemented samples as compared to that of control, at the same time methionine and cystine became the first limiting amino acid in supplemented pies.

On the other hand, both calculated protein efficiency ratio (PER) and biological value (BV) of the supplemented pies were found to increase as compared with the unsupplemented one. The PER and BV increased from 1.95 and 70.43 in control samples to 2, 70.96 and 1.98, 70.75 in the pies which supplemented with 10 and 15% of tomato seeds, respectively.

Similar results were found by Attia *et al.* (2000), Sara and Dietrich (1983) and Carlson *et al.* (1981), who reported that the chemical score for lysine in wheat flour bread increased with supplementation of wheat bread with tomato seeds and overall protein quality of wheat flour bread was

improved when supplemented with 10% tomato seeds. Also, they recorded that valine, methionine and cystine became limiting.

Table (4): Effect of different levels of tomato seeds on amino acids scores.

Treatments / Essential amino acids	Control	5%	10%	15%	Casein	FAO/WHO g/16 g N
Leucine	95.0	91.25	97.14	97.71	131.40	7.0
Isoleucine	105.25	115.25	122.5	124.0	126.2	4.0
Lysine	61.09	66.18	71.82	77.09	136.5	5.5
Methionine + Cystine	76.28	49.71	52.57	56.86	84.5	3.5
Phenylalanine + Tyrosine	130.33	143.33	151.67	173.83	136.5	6.0
Threonine	83.75	86.0	89.25	96.00	85.7	4.0
Valine	67.80	76.2	83.60	86.00	108.4	5.0
PER	1.95	1.84	2.00	1.98		
B.V	70.43	69.28	70.96	70.75		

Organoleptic evaluation of supplemented pie:

Results of Table (5) indicated that up to 10% of ground tomato seeds supplementation with wheat flour pie did not affect the overall acceptability of baked pies since the samples of control, 5 and 10% products ranked very good (8-9) scores while at level of 15% samples started to affect in aroma, taste, texture and overall acceptability.

Table (5): Sensory evaluation of baked wheat flour pies as affected by different levels of tomato seeds (average score).

Treatments / Factors	Level of supplemented tomato seeds			
	Control	5%	10%	15%
Color	9	9	9	8
Aroma	9	9	8	7
Taste	9	8	8	6
Texture	9	8	8	5
Overall acceptability	9	9	8	6

(8-9) Very good, (6-7): Good, (4-5) Fair.

Fat content of treated beef burger:

Data presented in Table (6) show the fat content in beef burger as affected by adding different levels of tomato seeds during 6 months of frozen storage. From these results, it could be noticed that fat content of beef burger decreased as the added amount of tomato seeds increased. Also, fat content of beef burger samples under investigation was found to decrease as the time of frozen storage period increased. These results are similar with those reported by Shams El-Din (1998). Also, the data cleared that the loss in fat content during frozen storage could be contributed to both enzymatic and oxidative reactions (Awad *et al.,* 1968 and May & Kinsella, 1979)or due to leaching in the drip (Morsi *et al.,* 1975). They also indicated that tomato seeds have been shown to protect partially meat lipids from oxidation during prolonged frozen storage or due to hence reduce the amount of drip.

Table (6): Effect of storage period and different levels of tomato seeds on beef burger content.

Storage time	Samples	Moisture %	Protein %	Fat %
Zero time	Control	64.5	51.8	37.8
	3%	59.7	51.95	37.62
	5%	58.0	52.03	37.10
	7%	57.1	52.10	36.30
1 month	Control	64.3	51.72	37.48
	3%	59.7	51.90	37.30
	5%	57.8	52.00	36.90
	7%	57.0	52.00	36.23
2 months	Control	64.3	51.63	37.02
	3%	59.5	51.83	37.12
	5%	57.7	51.62	36.30
	7%	57.0	51.91	36.03
4 months	Control	63.9	51.50	35.70
	3%	59.2	51.71	36.50
	5%	57.5	51.74	36.14
	7%	56.0	51.84	35.47
6 months	Control	63.7	51.42	33.20
	3%	58.8	51.60	34.12
	5%	57.4	51.61	34.79
	7%	56.6	51.80	34.87

Table (7) shows the TBA value, pH and acidity of beef burger as affected by using ground tomato seeds. From the present study, it could be observed that the control samples had higher values of TBA than all treatments. This means the using of tomato seeds in beef burger was effective against lipid oxidation. The reveres was recorded of pH and acidity, so the control had slightly lower values than that of treatments, this may be due to the chemical composition of tomato seeds.

On the other hand, the values of TBA, pH and acidity of beef burger were gradually increased by increasing the period of frozen storage till the end of storage but the increment was lower in the treatments than the control, this means that the TBA, pH and acidity were decreased when the addition level of tomato seeds increased during frozen storage period.

These results were confirmed by the finding of Moawad (1995), Shams El-Din (1998) and Moghazy and El-Shaarawi (2001), who reported that control samples of minced beef should not be stored more than 4 months to avoid accumulation of malonaldehyde and other carbonyl compounds responsible for the off. flavors of rancidity. The obtained results of tomato seeds were in agreement with those reported by Szanto (1980) and Guleria *et al.* (1983), who found that tomato seeds are not toxic and used as natural antioxidant protein, peptides, free amino acids and tocopherols decrease the rate of autoxidation and the hydroperoxide content of fatty foods (Seher and Loschner, 1986).

Table (7): Effect of storage period and different levels of tomato seeds on acidity, pH and TBA of beef burger.

Storage time	Samples	Acidity	pH	TBA*
Zero time	Control	0.03	6.23	0.35
	3%	0.05	6.33	0.29
	5%	0.10	6.56	0.26
	7%	0.16	7.13	0.21
1 month	Control	0.12	6.25	0.47
	3%	0.10	6.36	0.38
	5%	0.14	6.58	0.31
	7%	0.16	7.14	0.27
2 months	Control	0.57	6.28	0.65
	3%	0.19	6.40	0.58
	5%	0.19	6.60	0.51
	7%	0.18	7.20	0.37
4 months	Control	0.64	6.32	0.85
	3%	0.27	6.42	0.79
	5%	0.23	6.63	0.59
	7%	0.21	7.20	0.54
6 months	Control	1.40	6.35	1.90
	3%	0.43	6.47	1.83
	5%	0.27	6.63	1.22
	7%	0.22	7.28	0.87

*** TBA = Thiobarbituric acid.**

Table (8) shows the fatty acid composition of beef burger and beef burger with different levels of tomato seeds before and after 6 months of frozen storage. The data cleared that the addition of tomato seeds to beef burger resulted in an increase in total unsaturated fatty acids especially $C_{18:2}$ which find in tomato seed with a high percentage and a decrease in total saturated fatty acids which find with low percentage.

During frozen store, the total unsaturated fatty acids especially $C_{18:2}$ and $C_{18:3}$ were found to decrease in all studied samples. On the other hand, samples with addition of tomato seeds were lower in the losses of unsaturated fat acids during frozen storage period. These results indicated that frozen storage of beef burger did not protect the unsaturated fatty aids form the action of enzymes, which were not completely inactivated during frozen storage, meanwhile tomato seeds were protect partially the unsaturated fatty acids from the continuous oxidation. These results agree with Moawad (1995) and Shams El-Din (1998).

From these results, it could be concluded that tomato seeds as processing wastes can be used as a source of protein to improvement of protein quality for wheat flour products as cleared in studied pie. Also, we can use tomato seeds as a useful natural antioxidant during frozen storage of meat or fatty food products.

Table (8): Fatty acid concentrations of beef burger supplemented with different levels of ground tomato seeds before and after storage.

Samples	Control		3%		5%		7%	
F.F.A	1	2	1	2	1	2	1	2
C_{14}	4.5	4.85	3.7	4.15	3.64	3.81	3.6	3.75
$C_{14:1}$	1.48	1.46	1.58	1.54	1.46	1.41	1.39	1.38
C_{16}	26.8	27.68	26.44	27.24	26.25	26.66	26.0	26.11
$C_{16:1}$	5.61	5.6	5.9	5.8	5.8	5.77	5.72	5.72
C_{17}	1.42	1.51	1.22	1.33	1.18	1.19	1.12	1.16
$C_{17:1}$	1.02	1.04	1.05	1.03	1.00	0.99	0.93	0.91
C_{18}	15.14	15.75	13.52	14.22	13.35	13.65	13.28	13.61
$C_{18:1}$	41.02	41.16	41.63	41.79	41.49	41.68	41.35	41.71
$C_{18:2}$	1.73	0.69	3.65	2.37	4.41	3.81	5.41	4.35
$C_{18:3}$	1.28	0.26	1.31	0.53	1.27	0.83	1.20	0.81
Total sat.	47.86	49.79	47.88	46.94	44.42	45.31	44.00	44.63
Total unsat.	52.14	50.21	55.12	53.06	55.43	54.49	56.00	55.28

(1) before storage **(2) after storage**

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الاستفادة من مخلفات تعليب الطماطم (البذور) فى الأغراض الغذائية

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أجرى هذا البحث على بذور الطماطم التى تم الحصول عليها من شركة أدفينا للصناعات الغذائية بالإسكندرية. أعدت تلك البذور بالتنظيف والفصل عن المخلفات الأخرى وجففت ثم طحنت. أجرى تحليل كيماوى لتلك البذور وكذلك الأحماض الأمينية والأحماض الدهنية وبعض الأملاح المعدنية. أيضا أضيف مطحون بذرة الطماطم إلى دقيق القمح بنسب ٥ ، ١٠ ، ١٥% لعمل فطائر كما أضيف إلى الهامبورجر خلال تخزينه.

ولقد أشارت النتائج إلى ارتفاع محتوى بذور الطماطم من البروتين والدهن والألياف الخام والأحماض الأمينية الضرورية والغير ضرورية. كما وجد أن الحمض الأمينى الجلوتاميك يسجل أعلى تركيز يليه بالترتيب أحماض الأسبارتك والأرجنين والليوسين والليسين والفنيل الأنين والإيزوليوسين والميثيونين بينما السيستين كان أقل الأحماض الأمينية تركيزا فى بذور الطماطم. وكان حمض البالمتيك أعلى الأحماض الدهنية المشبعة بينما حمض الأوليك والنيوليك أكثر الأحماض الدهنية الغير مشبعة فى بذور الطماطم.

كذلك أشارت النتائج أن إضافة مطحون بذور الطماطم إلى فطيرة دقيق القمح أدى إلى زيادة محتواها من البروتين والأملاح والألياف والأحماض الأمينية الضرورية والغير ضرورية وكانت تلك الزيادة مرتبطة طرديا مع زيادة نسبة إضافة البذرة. كما لوحظ أن الإضافة إلى ١٠% إلى فطيرة دقيق القمح لم يؤثر على أى من مقاييس القابلية (Over all acceptability) بينما وجد أن نسبة ١٥% كان لها تأثير على كل من الرائحة والطعم والقوام.

بينما أوضحت النتائج أن مستوى الدهن للهامبورجر المعامل بإضافة مطحون بذرة الطماطم انخفض مع زيادة مدة التخزين. بينما مستوى TBA و pH والحموضة للهامبورجر المعامل إزداد مع زيادة فترة التخزين. بينما زيادة تركيز اضافة بذرة الطماطم للهامبورجر أدى إلى انخفاض تلك المقاييس عند مقارنتها بمجموعة الكنترول. أيضا كانت الأحماض الدهنية الغير مشبعة وخاصة حامض اللينوليك واللينولينيك منخفضة مع زيادة فترة تخزين الهامبورجر.

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