J. Food and Dairy Sci., Mansoura Univ., Vol. 7 (3): 201- 206, 2016

UTILIZATION OF TOMATO INDUSTRY BY-PRODUCTS IN PRODUCTION OF PAN BREAD.

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ABSTRACT

This study was carried out to investigate the utilization of tomato processing wastes as replacement of wheat flour at different levels (5, 10 and 15%) to prepare pan bread rich protein and minerals. In this respect, The chemical composition of wheat flours and tomato wastes were determined. Elemental analysis of both defatted tomato seed, defatted tomato peel and wheat flour were performed. Amino acids of tomato seeds and peels protein were identified and quantified.. the fatty acids composition of these oils were also identified and quantified. In addition, Chemical composition and Sensory evaluation of prepared pan bread were also determined. The obtained results revealed that. The defatted tomato seeds contain 36.17% crude protein, 28.11% crude fiber and 5.20% ash while, defatted tomato peels contain 17.33% crude protein, 66.32% crude fiber and 4.11% ash. The most predominant elements in the seeds and peels were phosphorus, potassium, magnesium, sodium and calcium, where their values were 870, 630, 410, 510 and 550 mg/100g in the seeds and 540, 610, 375, 620 and 239 in the peels, respectively. The elements Fe, Mn, Zn and Cu are in lowest values in seeds and peels. The major abundant fatty acid either in tomato seeds or tomato peels oil is linoleic acid where its values were 47.56 and 36.70%, respectively followed by oleic then palmitic in tomato seeds oil and palmitic then oleic in tomato peels oil . The major essential amino acids in seeds protein were leucine, Lysine, phenylalanine and valine, while the most predominant essential amino acids in peel protein were leucine, lysine, Isoleucine and phenylalanine. The results of Sensory evaluation indicated that the pan bread contained tomato seeds up to 15% as substitution of wheat flour were acceptable.

INTRODUCTION

Industrial processing of tomatoes conducts to a very high amount of waste, and seeds are the major by-product. Just a small amount of these seeds are used as feeds or fertilizers, and the rest of quantity represents an environmental pollution problem. The processors were thinking on different ways to capitalize tomato seeds resulting from the tomato processing industry, to increase the profit from this industry (Kong *et al*., 2010 and Botines¸tean, *et al*., 2015).

Tomato (*Lycopersicon esculentum*) is the second most important vegetable crop next to potato. The present world production is about 100 million tones fresh fruits from 3.7 million hectares (Faostat, 2001). Tomato fruits are considered as the most popular vegetables grown and processed in Egypt. The average annual cultivated area in year 2004 was 464491 feddans producing annually 7640818 tones of tomato fruits and about 550.000 to 660.000 tones of tomato pomace are yearly produced from canning industry. Unfortunately, a great part of it is lost without utilization (Anon, 2005).

Commercial processing of tomato produces a large amount of waste. Tomato paste manufacturing units generate 7–7.5% solid waste of raw material and 71-72% of this waste is pomace. The weight pomace contained 33% seed, 27% skin and 40% seed and 56% pulp and skin (Sogi and Bawa, 1998).

Tomato seeds, the major component of pomace contained a good quantity of proteins and lipids. The seed protein could be extracted to produce protein concentrate/isolate. Functional properties of tomato seed protein concentrates have been evaluated and found to be comparable with other plant proteins (Sogi, 2001). In addition, tomato skin and seeds were reported to contain essential amino acids, and the tomato seeds had particularly high amounts of minerals (Fe, Mn, Zn and Cu), and monounsaturated fatty acids (especially, oleic acid) Al-Wandawi *et al.* (1985).

Regarding the fatty acid (FA) composition of tomato seed oil, the major FA component was linoleic acid (C18:2), with a concentration range of 37–57 %. The main saturated FA identified was palmitic acid (C16:0), with a concentration range from 7 to 24 %. Other important FA identified in tomato seed oil were: oleic acid (C18:1) 18–30 %, stearic acid (C18:0) 4–13 %, and linolenic acid (C18:3) 1–6 %. Small amounts of myristic acid (C14:0) 0.1–2.3 %, palmitoleic acid (C16:1) (0.3–7 %), margaricacid (C17:0) 0.1–0.3 % and arachidic acid (C20:0) (0.2–3 %) have been reported (Giannelos *el al*., 2005).

Tomato seed protein contains approximately 13% more lysine than soy protein which would allow it to be used in fortifying low lysine foods such as cereals (Brodowski and Geisman, 1980 and Yaseen, et al. 1991).

It is economic and successful to utilize protein from tomato seeds, due to its high content of most essential amino acids, as a substitute for wheat flour used in bakery products. (Attia, *et al*. 2000). This study was carried out to investigate the utilization of tomato processing wastes as replacement of wheat flour at different levels (5, 10 and 15%) to prepare rich protein and minerals pan bread

MATERIALS AND METHODS

Materials:

Tomato processing wastes including peels and seeds were obtained from El-Naser Company for Food processing (Kaha), Egypt

Wheat flour extraction 72% and other ingredients used to prepare the pan bread were purchased from local market at Tanta City, Egypt

Methods:

Preparation of wastes for analysis:

The wastes were washed with tap water then with distilled water and dried at 40^0C in a drying oven for 36 hour. The dried wastes were screened to separate the seeds from peels. Then milled using blender mixer, then passed from 60 mesh screen, packed in polyethylene bags and stored at -18 ^{o} C until use.

Preparation of defatted seeds :

A weight of Tomato seeds mill was soaked in n-hexane solvent (40–60^{o}C) at room temperature for 48 hr., then filtered. This process was repeated three times using fresh solvent each time to extract most of the oils from the sample . Then the obtained solution was filtered and the solvent was removed by rotary evaporator according to Kahlon et al. (1992). The defatted Tomato seeds mill was kept in polyethylene bags and stored at -18 ^{o} C until use.

Chemical composition of samples:

Moisture, ash, crude protein (N x 6.25), ether extract and crude fibers of samples were determined according to the method described in A. O. A. C. (2005). Total carbohydrates were calculated by differences.

Minerals contents (Ca, Mg, Fe, Cu, Zn, and Mn) were determined according to the methods outlined in A.O.A.C. (2005) using atomic absorption spectrophotometer (Perkin Elmer Model 4100 ZL), while (Na and K) were determined using flame photometer. On the other hand, phosphorus was determined by ascorbic acid technique using the colorimetric method that described by Murphy and Riley (1962).

Fatty acids composition of tomato seeds and peels oil was determined using gas liquid chromatography according to the method described by Radwan (1978).

Amino acids of protein from either seeds or peels were determined using Beackman amino acid analyzer according to the method of Sadasivam and Manickam (1992). Tryptophan content was determined colorimetrically after subjecting to alkaline hydrolysis as outlined by Miller (1967).

Blends : Defatted tomato seeds flour was added at different ratios (5, 10 and 15%) to wheat flour (72% extraction) to produce pan bread as illustrated in table (A).

Table (A): The ingredients used to make several dough of pan bread blends.

Treatment	Blends
Control	100%wheat flour(72%extraction)
5%	5% DTSF + 95% wheat flour (72%extraction)
10%	10% DTSF + 90% wheat flour (72%extraction)
15%	15% DTSF + 85% wheat flour (72%extraction)

DTSF = defatted tomato seeds flour

Baking techniques: Pan bread was prepared according to the method described by (A.A.C.C. 2000).

Sensory evaluation of pan bread prepared using defatted tomato seeds flour as substitution of wheat flour:

All samples were evaluated by ten panelists from students and staff members in Food Technology Research Institute, Agric. Res. Center, Egypt. Quality score for pan bread included: taste (20), flavor (15), crumb distribution (15), color of crumb (15), color of crust (15) and general appearance (20). The procedure technique was carried out as mentioned by Kralmer and Twigg (1962). The average of total score was converted to a descriptive category as follows: 90-100: very good ; 80-90: good ; 70-79: satisfactory ; less than 70: questionable .

Statistical analysis:

Most of the received data were analyzed statistically using the analysis of variance and the means were further tasted using the least significant difference test (LSD) as outlined by Steell and Torrie (1980).

RESULTS AND DISCUSSION

Chemical composition of tomato wastes and wheat flour 72%:

The gross chemical composition of tomato seed, tomato peel , defatted tomato seed, defatted tomato peel and wheat flour 72% are recorded in Table (1). The obtained results show that defatted tomato seed contain a significant high content of crude protein 36.17% compared with that of tomato seed 27.48 % , defatted tomato peel 17.33 %, tomato peel 13.11% and wheat flour (72%) 10.90%,. tomato seed contains highest contents of fat 31.81% followed by tomato peel , defatted tomato seed, defatted tomato peel and wheat flour 72% (9.33, 1.92 ,1.22 and 0.81 %), respectively. This means, the tomato seeds are good sources of protein and oil. Furthermore, the peels contain a high amount of crude fiber (60.20%) . (Attia, et al., 2000, Persia, et al., 2003 , Del Valle, et al., 2006, and Arafa et al.,2008).

Table (1): Gross chemical composition (%) of tomato wastes and wheat flour 72% (on dry weight basis).

Components%	Tomato seed	Tomato peel	Defatted tomato seed	Defatted tomato peel	Wheat flour (72%)
Moisture	7. 29^c	8. 40^b	7. 20^c	8.11^b	11.51^a
Crude protein	27.48^b	13.11^d	36.17^a	17.33^c	10.90^e
Ether extract	31.81^a	9.33^b	1.92^c	1.22^d	0.81^d
Ash	3.91^b	3.08^c	5.20^a	4.11^b	0,71^d
Crude fiber	20.11^d	60.20^b	28.11^c	66.32^a	0.52^e
Total carbohydrates	36.8^e	74.48^c	56.71^d	77.34^b	87.58^a

Values followed by the same letter in row are not significantly different at P $\leq$ 0.05.

Referring to the chemical composition of tomato processing wastes it is clear that addition of defatted tomato seed will lead to increase the nutritive components of final bakery products. While, addition of defatted tomato peel will lead to increase of dietary fibers.

Minerals content of defatted tomato seed, defatted tomato peel and wheat flour 72% :

From the results in Table (2), it could be observed that the P, K, Mg, Na and Ca are the major elements in both defatted tomato seed and defatted tomato peel. The elements Fe, Mn, Zn and Cu are in fewer values either in defatted tomato seeds or in peels as shown in the same Table. The results were agreement with that reported by Shams El-Din and Abd El-Kader (1997) ,Persia, et al. (2003) and Marwa M. Abdel-Hady et al. (2013)

Table (2): Minerals content (mg /100g) of defatted tomato seed, defatted tomato peel and Wheat flour 72% .

Minerals	defatted tomato seed	defatted tomato peel	Wheat flour 72%
Phosphorus (P)	870^{a}	540^{b}	139^{c}
Potassium (K)	630^{a}	610^{a}	140^{b}
Magnesium (Mg)	410^{a}	375^{b}	169.93^{c}
Calcium (Ca)	550^{a}	239^{b}	37^{c}
Sodium (Na)	510^{b}	620^{a}	25.50^{c}
Manganese (Mn)	4.5^{a}	2.6^{b}	0.7^{c}
Zinc (Zn)	3.7^{a}	1.5^{b}	3.06^{a}
Iron (Fe)	20.0^{a}	17.8^{b}	2.10^{c}
Copper (Cu)	2.4^{a}	2.0^{a}	0.13b

Values followed by the same letter in row are not significantly different P ≤ 0.05

Also, it could be observed that wheat flour (72%)) contains lower values in all determined elements compared to defatted tomato seed and defatted tomato peel. The iron content of defatted tomato seed is higher ten times than that of wheat flour. The iron is important for the schoolchildren, which mostly needs more iron to avoid the anemia especially in developing countries. The results indicated that the tomato seeds or peels when added to bakery products would improve their minerals content.

Fatty acids composition of tomato seeds and peels oil:

Fatty acids are the integral constituents of every fat or oil. The degree of complexity of the glycerides basically depends on the number of fatty acids and their amounts and the chemical behavior of lipids largely depends upon their fatty acid constituents (Amal, 2004). Data presented in Table (3) revealed that, The major abundant fatty acid either in tomato seeds or tomato peels oil is linoleic acid where its values were 47.56 and 36.70%, respectively followed by oleic then palmitic in tomato seeds oil and palmitic then oleic in tomato peels oil. The same Table show that, the total saturated and unsaturated fatty acids in tomato seeds oil were 21.97and 78.03% respectively while in tomato peels oil they were 31.79 and 68.22%, respectively. The high amounts of unsaturated fatty acids, especially essential fatty acids, lead to increase the nutritional values of wheat germ oil. These results are in the same trend of those reported elsewhere (Shams El-Din and Abd El-Kader , 1997; Giannelos, *et al.* , 2005 and Del Valle, *et al.* ,2006)

Table (3): Fatty acids profile of tomato seeds and peels oil.

Fatty acid		seeds oil	peels oil
Myristic	C14:0	0.41	1.39
Palmitic	C16:0	13.40	22.24
Palmitoleic	C16:1	0.90	2.70
Heptadecanoic	C17:0	0.79	0.95
Stearic	C18:0	6.48	5.82
Oleic	C18:1	26.35	20.51
Linoleic	C18:2	47.56	36.70
Linolenic	C18:3	3.22	8.31
Arachidic	C20:0	0.89	1.39
TSFA %		21.97	31.79
TUSFA %		78.03	68.22

TSFA = Total saturated fatty acids, TUSFA = Total unsaturated fatty acids

Amino acids composition of raw materials

The nutritive value of food, especially protein mostly would depend not only on its amino acids profile in general but also on the quantities of the essential amino acids content in particular (Afify et al., 2012). Amino acids composition of defatted tomato seed, defatted tomato peel proteins and wheat flour are given in Table (4). The defatted tomato seeds and peels protein contain most amino acids. Defatted tomato peels protein contains high levels of all determined amino acids comparing with tomato seeds protein. It can also show that in both proteins of seeds and peels, are rich in total essential amino acids, as compared with the FAO/WHO (1985) reference pattern. In the same time it's also have high contents of nonessential amino acids amino acids,

Furthermore, both proteins of defatted seeds and peels, glutamic and aspartic were the most predominant amino acids. The major essential amino acids in seeds protein were leucine, Lysine, phenylalanine and valine, while the most predominant essential amino acids in peel protein were leucine, lysine, Isoleucine and phenylalanine . Tryptophan, Cysteine and methionine were the least abundant amino acids in both defatted tomato seed and defatted tomato peel proteins. These results indicated that the proteins from defatted tomato seeds and peels were considers a good source of essential and nonessential amino acids . Our results were in agreement with (Yaseen, *et al.* ,1991; Attia, *et al.* , 2000; Persia, *et al.* 2003 and Seikova, *et al.* , 2004. This suggests that tomato wastes proteins will markedly contribute to supply of essential amino acids in food product

Table (4): Amino acids profile (g/16g N)) of defatted tomato seed and defatted tomato peel proteins compared with the required pattern content recommended by FAO/WHO/UNU (1985).

Amino acids	defatted tomato seed	defatted tomato peel	FAO/WHO, UNU 1985 recommended pattern gm/100g protein
1. Essential amino acids (IAA)			
Leucine	7.65	7.31	6.60
Isoleucine	4.40	5.30	4.00
Valine	4.52	4.93	3.50
Méthionine	1.99	1.39	2.50
Cystine	2.73	2.96	2.50
Phenylalanine	4.81	5.04	6.30
Tyrosine	3.43	3.49	6.30
Lysine	5.25	6.71	5.80
Threonine	3.46	4.01	3.40
Tryptophan*	1.01	0.91	1.10
Total	39.45	42.04	
2. Nonessential amino acids (DAA)			
Histidine	4.30	3.31	1.90
Arginine	6.13	4.91	
Serine	5.60	6.20	
Alanine	4.95	5.63	
Aspartic acid	9.60	11.11	
Glutamic acid	19.94	18.70	
Glycine	5.81	4.11	
Proline	4.20	4.01	
Total	60.53	57.58	

Tryptophan was determined calorimetrically. .

Chemical composition of pan bread prepared with defatted tomato seeds flour:

Data present in Table (5) show the chemical composition of pan bread made using different levels of defatted tomato seeds flour (5, 10 and 15%) as substitution of wheat flour. The results indicate that the crude protein increased markedly with increasing the level of defatted tomato seeds flour. The crude protein content increased from 11.65 % in control to 15.45% in pan bread contained 15% of defatted tomato seeds flour. In addition, the crude fiber and ash contents of pan bread prepared using defatted tomato seeds flour as replacement of wheat flour, increased significantly with increasing in the replacement ratios from (0.95 %) and (0.90 %) to (5.09%) and (1.78%) in pan bread with 15% defatted tomato seeds flour.

Table (5): Chemical composition of pan bread made with different substitution levels of defatted tomato seeds flour

Constituents / Tomato seed meal %	Moisture	Crude protein	Ether extract	Crude fiber	Ash	Total carbohydrates
Control (0% DTSF)	30.11[d]	11.65[d]	1.15[a]	0.95[d]	0.90[c]	86.30[a]
DTSF 5	30.50[c]	12.95[c]	1.21[a]	2.54[c]	1.31[b]	84.53[b]
DTSF 10	31.11[b]	14.23[b]	1.26[a]	3.72[b]	1.52[ab]	82.99[c]
DTSF 15	31.75[a]	15. 45[a]	1.32[a]	5.09[a]	1.78[a]	81.45[d]

Values followed by the same letter in column are not significantly different P ≤ 0.05
DTSF = defatted tomato seeds flour

On the other hand, the ether extract content increased slightly with increasing the level of tomato seeds flour, since the increasing was gradually from 1.15% in control to 1.32% in contained 15% tomato seeds flour. This may be related to the high ether extract content of defatted tomato seeds flour compared with that of wheat flour. It could be also noted that crude fiber and ash increased with increasing of defatted tomato seeds flour. Ekthamasut (2006) found that noodles replaced wheat flour with defatted tomato seeds meal had higher protein and fiber.

Sensory evaluation of pan bread prepared using defatted tomato seeds flour as substitution of wheat flour:

The Sensory evaluation of pan bread prepared using various percentages of defatted tomato seeds flour as replacement for wheat flour was performed and the means of results are given in Table (6) The results show that pan bread made without adding defatted tomato seeds flour (control) gave the highest scores for all characteristics and they had a very good grade (except 15% addition, it had a good grade).

The pan bread prepared using defatted tomato seeds flour gave approximately the lowest scores for all characteristics. The data in the same Table (6) show that the scores for all characteristics of pan bread were decreased with increasing the percent of defatted tomato seeds flour replacement. This results may be due to the wheat flour that contains carbohydrates which cause to formation aroma and color during the baking process. In addition, the replacement of wheat flour with defatted tomato seeds flour may be caused weakening of the net that formed in wheat flour only during the making of pan bread dough.. Generally, until 15% of defatted tomato seeds flour as substitution of wheat flour, pan bread was produced with accepted sensory evaluation.

Table (6): Sensory evaluation of pan bread prepared using defatted tomato seeds flour as substitution of wheat flour:

Characteristics Samples	General Appearance (20)	Color of crust (15)	Color of crumb (15)	Crumb distribution (15)	Flavor (15)	Taste (20)	Overall scores (100)	Grade
Control 0%	19.5[a]	14.6[a]	14.5[a]	14.5[a]	13.4[a]	19.7[a]	96.2	V.G
DTSF 5%	19.2[a]	14.1[b]	13.9[b]	14.4[a]	12.9[b]	19.1[b]	93.6	V.G
DTSF 10%	18.9[ab]	13.6 [c]	13.4[c]	14.1[a]	12.4[c]	18.5[c]	90.9	V.G
DTSF 15%	17.4[c]	13.1[d]	12.9[d]	14.1[a]	11.9[d]	18.1[c]	87.5	G.

Values followed by the same letter in column are not significantly different P ≤ 0.05
DTSF = defatted tomato seeds flour.

The addition of tomato seed meal to wheat flour for making bread improved both volume and nutritive value of produced loaf. This may be related to the content of fat and protein (Beth, *et al*. 1981). The bread supplemented with 10% tomato seed meal exhibited a good sensory characteristics and improved protein quality (Sogi, *et al.* 2002).

CONCLUSION

Defatted tomato processing wastes can be used as a rich source of minerals, amino acids and essential fatty acids. These wastes can be used as a fortified source during preparation of bakery products with a good quality properties and high nutritive value.

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الإستفادة من مخلفات تصنيع الطماطم في انتاج خبز القوالب

عدلى سمير عبد الستار سعد و محمد احمد البنا
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أجريت هذه الدراسة بهدف دراسة إمكانية الاستفادة من مخلفات تصنيع الطماطم كبديل لدقيق القمح بنسب استبدال مختلفة (٥، ١٠ و ١٥٪) لإعداد خبز القوالب الغنية بالبروتين والمعادن حيث تم دراسة التركيب الكيماوي لهذه المخلفات وكذلك المخلفات منزوعة الدهن ودقيق القمح كما تم تقدير العناصر المعدنية بهما و تم التعرف على الأحماض الأمينية فى بروتينات البذور والقشور وتم تقدير كميتها و تقدير الأحماض الدهنية الموجودة فى البذور والقشور وبالإضافة إلى ذلك تم تقدير التركيب الكيماوي والتقييم الحسي خبز القوالبوكان ملخص النتائج كما يلي:

احتوت بذور الطماطم المنزوعة الدهن تحتوي على البروتين الخام ٣٦.١٧٪، والألياف الخام ٢٨.١١٪ والرماد 5.20 ٪ بينما القشور المنزوعة الدهن تحتوي على البروتين الخام 17.33٪، والألياف الخام ٦٦.٣٢٪ و الرماد ٤.١١٪.

تحليل المعادن أظهر إحتواء البذور والقشور علي عدد كبير من العناصر منها ما هو بكميات كبيرة مثل الفوسفور والبوتاسيوم والمغنيسيوم والصوديوم والكالسيوم، حيث كانت قيمتها ٨٧٠، ٦٣٠، ٤١٠، ٥١٠ و ٥٥٠ م ملجم جم /100 في البذور و ٥٤٠، ٦١٠، ٣٧٥، ٦٢٠ و ٢٣٩ ملجم جم/100 في قشور، على التوالي .عناصر الحديد والمنجنيز والزنك والنحاس كانت في أدنى القيم في البذور والقشور .

تم التعرف وتقدير الأحماض الدهنية في زيت بذور وقشور الطماطم .حيث كان حمض اللينوليك هو الأكثر تواجدا سواء في زيت البذور أو القشور حيث أن كميته كانت ٤٧.٥٦ و ٣٦.٧٠٪، علي التوالي متبوعا بحمض الأوليك ثم البالميتيك في زيت البذور وحمض البالميتيك ثم الأوليك في زيت القشور

احتوت البروتينات علي معظم الأحماض الأمينية الأساسية بكميات كبيرة.والمستوي الأعلي لهذه الأحماض في بروتين البذور كان الاحماض اللليوسين والليسين والفينايل ألانين والفالين بينما كان المستوي الأعلي في بروتين القشور الأحماض الليوسين والليسين. وايزوليوسبن والفينايل ألانين. وأظهرت الدراسة أيضا أن إضافة دقيق البذورمنزوعة الدهن إلي خبز القوالب أدي إلي إرتفاع محتواها من البروتين والألياف والرماد. وتم إجراء التقييم الحسي لخبز القوالب الذي أوضح أن دقيق البذورمنزوعة الدهن أعطي خواص قريبة من الكنترول عند نسب استبدال ٥ و١٠%.

وبناءا على ما تقدم ,يوصى باستخدام مخلفات صناعة الطماطم منزوعة الدهن كمصدر للمعادن و الأحماض الأمينية والأحماض الدهنية الأساسية كما يمكن استخدام هذه المخلفات في تدعيم المخبوزات لإعطاء منتجات عالية الجودة والقيمة الغذائية.