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Research Article
Production of Functional Processed Cheese by Using Tomato Juice

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Abstract

Background and Objective: Tomato is most important vegetables that gained attention in the recent period. Tomato contains antioxidants, carotenoids and lycopene which play an important role in the observed health effects. Tomato products decrease a risk of some cancer type. Four batches of processed cheese spread were prepared. First batch let as control. Tomato juice was added with different ratios (10, 20 and 30%) to 2nd, 3rd and 4th batch, respectively. Resultant cheese was subjected for analysis. The purpose of this study is production of process cheese with high nutrition and healthy effect. **Materials and Methods:** Determination of total phenolic contents, antioxidants capacity, lycopene and chemical and physical properties for functional processed cheese which supplemented with tomato as a source of lycopene. **Results:** The results showed that the resultant cheese with tomato juice had ferrous while not detected in control. Potassium (mg kg^{-1}) had highest in treatments and increased by increasing tomato juice. Treatments had a highest Residual Scavenging Activate (RSA%) and phenolic compounds mg/100 g than control and increased by increasing tomato juice lycopene not detected in control but found in all treatments. Penetrometer reading had highest in control and decreased during storage either control or treatments. Control had highest meltability, pH and lowest oil separation than treatments. Sensory evaluation showed that process cheese prepared with tomato juice was acceptable and had a good firmness, crumbliness. About 20% tomato juice had gained highest acceptability than other treatments. **Conclusion:** Addition of tomato juice in preparation of process spread cheese led to produce a good and acceptable spread cheese with high nutritional and healthy food and it's a good for children because tomato contains lycopene which had red color attractive to children beside contains antioxidants and play important roles in the observed health effects.

Key words: Processed cheese, lycopene, tomato, functional food

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Processed cheese is one of the most important sources of calcium in dairy products in a balanced diet and significant source of protein as well as other nutrients.

The food industries are interesting to produce cheaper price, healthier, more appropriate and meet consumer requests[1]. Utilization of vegetables or fruit in processed cheese products is one of ways for development of functional food.

Tomato is most important vegetables that gained attention in the recent period. Tomato contains antioxidant, carotenoids and lycopene which play an important role in the observed health effects. Tomato is one of the most popular fruits of the world, although it is categorized as a vegetable, tomato has a high content of water ranges from 93-95%, the total solid of tomato about 5.5-9.5% of which about 1% is seed and skin[2]. Tomato products decreased risk of some cancer type.

Lycopene, a famous member of carotenoid family, is a fat phase soluble antioxidant synthesized by many plants and microorganisms but animals and humans can't do it[3], it is a red pigment without provitamin-A activity that imparts color to almost vegetables and fruits[4].

The lycopene content in tomato typically range from 70-130 mg kg^{-1} depending on the variety, geographic location, technique of cultivation, climatic conditions and degree of ripeness of tomato. Stability of lycopene depends on the manufacturing process and the type of food which it added. Lycopene in the extract was stable at room temperature and at 4°C for up to 37 months. Takeoka *et al.*[5] reported that throughout processing lycopene losses during processing of tomatoes into final paste.

Lycopene extract content of phytoene, phytofluene, β-carotene, tocopherols-sterols, fatty acids, glycerols, free fatty acids, water lactic acid, organic acid, organic phosphorus phospholips, nitrogen and ash.

Lycopene extract from tomato is used as a source of natural colors for food instead of using industrial sources ranging from yellow to red and also used as food supplement in products (e.g., antioxidant or other claimed health benefits). The product may also be used as antioxidant in food supplement due to the increasing demand of such compound (Carotenoids-lycopene).

The aim of this study is utilization of tomato juice contains lycopene to production a functional processed cheese with high nutritive value and enhancing flavor and color to increase its acceptability among children and develop a novel product by adding tomato juice into the processed cheese for better nutrition and health promoting principles like antioxidants and other beneficial phytochemicals.

MATERIALS AND METHODS

Materials: Ras cheese (1 month old) was obtained from Arabic Food Industrial Co. (Domety) 6th October City, Egypt. Also, matured cheddar cheese (8 months old) was obtained from International Dairy and Fods Co. (Milky Land), 10th Ramadan City, Egypt. Low heat skim milk powder and butter were procured from Irish Dairy Board, Grattan House, Lower Mount St., Dublin, Ireland.

Commercial JOHA emulsifying salts were obtained from BK-Ladenburg Crop., Gubh, Germany. Tomato (*Lycopersicone sculentum* L.) was purchased from local market in Cairo, Egypt.

Some chemical composition such as total solids percentage and fat percentage of the ingredients used in the manufacturing of Tomato processed cheese spread (TPCS) presented in Table 1.

Methods

Manufacture of tomato processed cheese spreads: Tomato Processed Cheese Spreads (TPCS) were manufactured, according to the method of Meyer[6]. Four batches of processed cheese spread were made from the ingredients present in Table 2. The 1st batch let as control tomatoes juice was added to 2nd, 3rd, 4th batches with ratios (10, 20 and 30%). Three replicates of each treatment were manufactured and subjected for analysis.

Chemical analysis: Moisture and ash contents were determined according to AOAC[7], fat, total protein according to Ling[8]. Values of pH were measured using a digital pH

Table 1: Chemical Composition of the ingredients used in manufacture of tomato processed cheese spreads

Ingredients	Total soils (TS%)	Fat (F%)
Ras cheese	55	22.5
Cheddar cheese	65	33.0
Skim milk powder	95	0.7
Butter	84	8.2
Tomato Juice	5.0	-

Table 2: Formulations of tomato processed cheese spread

Ingredients	Control	F1	F2	F3
Ras cheese	38.44	38.44	38.44	38.44
Cheddar cheese	12.80	12.80	12.80	12.80
Skim milk powder	5.120	5.120	5.120	5.120
Butter	10.26	10.26	10.26	10.26
Emulsifying salt	2.50	2.50	2.50	2.50
Tomato juice	-	10.0	20.0	30.0
Water	30.88	20.88	10.83	00.88
Total	100	100	100	100

F_1: Formulation with 10% tomato Juice, F_2: Formulation with 20% tomato Juice, F_3: Formulation with 30% tomato Juice meter (HANNA), with combined glass electrode (electric instruments limited). Salt content was determined as described by Bradley *et al.*[9]. Mineral profile of fresh (TPCAS) was assayed for determined K, Na content using a flame photometer (Corning 410, corning medical and scientific instrument, modified MA, USA) as mentioned by Mohamed *et al.*[10]. Lactose content according to the method of Barrnett and Tawab[11].

Preparation of tomato juice: Tomatoes was washed with water then cut into slices and blend in electric blender tomatoes.

Sensory evaluation: Sensory evaluation of tomato process cheese spread was evaluated by the staff members at department of dairy science. National Research Centre according to Bandyopadhyay *et al.*[12].

Statistical analysis: Different statistical analysis were performed according to SPSS[13].

Total phenolic contents (TPC): Total phenolic compounds were determined according to Zheng and Wang[14] by using Folin-Ciocalteu reagent and expressed as mg GAE/100 g.

Antioxidant capacity: Free Radical Scavenging Activity (RSA%) assay of the samples was measured using the method of Brand-Williams *et al.*[15] and expressed as percentage inhibition of the DPPH radical and was determined by the following:

$$\text{RSD} = \frac{\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}}}{\text{Abs}_{\text{control}}} \times 100\ (\%)$$

Lycopene: Lycopene was determined according to Davis *et al.*[16]. Penetration was determined using penetrometer (Koehler Instrument Company Inc, USA). Meltability of the samples of processed cheese were determined according to the method designed by Savello *et al.*[17]. Oil separation was determined according to the method outlined by Thomas[18]. The pH values of cheese samples were measured using laboratory pH meter model "Cole-armer Instrument Company", USA, IL 60648.

RESULTS AND DISCUSSION

Table 3 shows some chemical composition of processed cheese spreads made with different ratios of tomato juice. Control had a lowest content of total solids than other treatments. Total solids increased by increasing the percentage of tomatoes juice. This may be due to the composition of tomatoes juice. This result in agreement to Ayar and Gurlin[19] and Mohamed *et al.*[20] who found that the amount of total solids in processed cheese spreads in control sample was in significantly ($p<0.05$) less than treatment samples (carrot cheese). From the Table 3 it could be notice that control had a highest content of fat/dry matter, total protein and lactose than other treatments. These decreases in treatments due to reduction of those components in the added tomato juice. Control had lowest content of ash and salt in moisture than other treatments. They increased by increasing the percentage of tomato juice.

Table 3: Chemical composition of tomato processed cheese spread

Parameters	C	T_1	T_2	T_3
TS	44.64	44.91	45.11	45.30
F/DM	50.90	50.60	50.31	50.21
Total protein	14.16	13.95	13.90	13.90
Lactose	2.65	2.60	2.50	2.60
Ash	5.01	5.06	5.12	5.21
Salt in moisture	3.01	3.02	3.11	3.15
Na (mg kg^{-1})	16.82	16.82	16.82	1682
K (mg kg^{-1})	10.20	1.80	22.50	280
Na/K ratio	16.49	9.33	7.47	6.00
pH	5.80	5.77	5.70	5.59

T_1: With 10% tomato juice, T_2: With 20% tomato juice, T_3: With 30% tomato juice, C: Without tomato juice

Potassium and sodium content: Sodium content (mg kg^{-1}) is the same in control and treatments whereas potassium (mg kg^{-1}) is lowest in control than other treatments and increased by increasing the ratio of tomatoes juice. On the other hand, Na/K ratio took an opposite trend of K (mg kg^{-1}). Potassium was detected at the highest content in the cheese with highest tomato juice ratio (30%) furthermore, the lowest level of sodium was found in this treatment.

This may be due pH value of tomato juice used in the formula is higher than pH value of control. The proportion of tomato juice to cheese is increasing by decrease the ratio of Na/K. The highest content of potassium in cheese was detected at highest tomato juice ratio (30%) but sodium content in this treatment the lowest level. The results of potassium content are agreeing with Ihemeje *et al.*[21].

Ferrous not detected in control but detected in treatments and increased gradually by increasing the percentage of tomato juice.

pH: Control had highest pH than other treatments and pH gradually decreased by addition of different ratios of tomato juice.

Table 4 illustrated antioxidants activity of processed cheese spreads made with different ratios of tomato juice. From Table 4 it is noticed that residual scavenging activate (RSD%) increased by increasing the ratio of tomato juice.

Control had a less RSA than all treatments. These results are in agreement to Mohamed and Shalaby[22] who found that the RSA% of cheese analogue which supplemented with an apricot pulp was increased by increasing the percentage of fruit pulp. Also, these results were agreeing with Corbett *et al.*[23].

Phenolic compounds (mg/100 g): Phenolic compounds (mg/100 g) took the same trend of RSA. Phenolic compounds increased by increasing by increasing percentage of tomato juice and control had lowest content of phenolic compounds than other treatments. These results are in agreement to O'connel and Fox[24] who reported that cheese contains a small amount of phenols also lacks vitamin C and many important antioxidants[25].

Lycopene: Lycopene the Table 4 shows lycopene content in processed cheese spreads made with different ratios of tomato juice.

Lycopene not detected in control but found in treatments. Lycopene increased by increasing the percentage of tomato juice.

Lycopene plays an important role in the observed health effects. Tomato products decreased risk of some cancer type, Also lycopene extract content β-carotene, tocopherols, sterols and fatty acids[5]. They also indicated that lycopene losses during processing of tomatoes into final paste ranged from 9-28%.

Table 5 shows changes in penetrometer reducing of tomato processed cheese spread during storage. The penetrometer reading of the fresh control was a highest than other treatments and the penetrometer reading gradually decreased during storage until 3 months either control or treatments. These results are in agreement to Fawzia *et al.*[26] who found that penetrometer reading gradually decreased during storage[27].

Table 6 indicated changes in meltability of tomato processed cheese spreads during storage. Control had a highest meltability than other treatments either fresh or during storage. Metability gradually decreased during storage in either control or treatment. These results are in the same line to Abd El-Salam *et al.*[28] who reported that meltability of the PCS increased with the increasing in the percentage added of WPC, while it's decreased with advanced storage.

Table 7 illustrates changes in oil separation of tomato processed cheese spread during storage. Control had a lowest oil separation than other treatments. Oil separation increased during storage until 3 months and the percentage of separation was higher at 25 than 5°C in control and all treatments. These results are in agreement to Omar *et al.*[29] who reported that oil separation values of all treatments even in control tended to increase as storage period progressed.

Table 8 shows changes in pH of tomato processed cheese spread during storage. We noticed that control had highest. The pH than other treatments either fresh or during storage pH gradually decreased during storage until three months either control or treatments. The pH decreased at 25 more than 5°C in all treatment.

Table 9 show sensory evaluation of tomato process cheese spread. We studied character assessed for process

Table 4: Antioxidants activity of tomato processed cheese spread

Parameters	C	T_1	T_2	T_3
RSA (%)	2.1	80.28	81.75	83.33
Phenolic compounds (mg GAE/100 g)	5.2	7.9	9.8	10.1

C: Control (without any tomato juice), T_1: With 10% tomato juice, T_2: With 20% tomato juice, T_3: With 30% tomato juice, RSA: Free radicals scavenging activity, GAE: Gallic acid equivalent

Table 5: Physical properties changes in penetrometer reading of tomato processed cheese spread during storage

		Storage period (months)					
		1		2		3	
Penetrometer reading (mmL)	Fresh	5°C	25°C	5°C	25°C	5°C	25°C
C	35.5	35.0	34.2	31.3	28.7	28.3	25.5
1	34.7	34.1	33.7	30.3	29.4	27.7	25.0
2	34.3	33.3	33.0	29.5	28.1	27.1	24.8
3	32.5	31.7	31.0	28.7	27.7	26.4	24.1

Table 6: Changes in meltability during storage of tomato process cheese spread

		Storage period (months)					
		1		2		3	
Penetrometer reading (mmL)	Fresh	5°C	25°C	5°C	25°C	5°C	25°C
C	105	100	97	95	90	91	85
1	98	97	94	91	89	88	84
2	96	93	90	88	86	86	82
3	94	92	89	84	80	83	79

C: Control, 1: With 10% tomato Juice, 2: With 20% tomato Juice, 3: With 30% tomato Juice

Table 7: Change in oil separation of tomato process cheese during storage

		Storage period (months)					
		1		2		3	
Penetrometer reading (mmL)	Fresh	5°C	25°C	5°C	25°C	5°C	25°C
C	20.33	20.66	22.00	22.66	24.33	25.00	27.33
1	20.66	21.00	21.66	23.00	25.33	25.66	28.00
2	22.00	22.66	23.33	24.33	26.66	27.66	29.33
3	22.66	23.33	24.00	25.66	27.33	28.00	30.66

Table 8: Changes in pH of tomato process cheese spread during storage

Penetrometer reading (mmL)	Fresh	Storage period (months) 1		2		3	
		5°C	25°C	5°C	25°C	5°C	25°C
C	5.80	5.79	5.76	5.76	5.73	5.72	5.69
1	5.77	5.75	5.72	5.72	5.70	5.70	5.65
2	5.70	5.69	5.68	5.66	5.63	5.64	5.59
3	5.59	5.57	5.5	5.5	5.50	5.53	5.48

C: Control, 1: With 10% tomato Juice, 2: With 20% tomato Juice, 3: With 30% tomato Juice

Table 9: Sensory evaluation of tomato process cheese spread

Character assessed	C	T_1	T_2	T_3
Firmness (1-5)*	1.81[a]	1.84[a]	1.86[a]	1.90[a]
Spreading (1-5)**	4.85[a]	4.82[a]	4.78[ab]	4.52[b]
Stickiness (1-5)***	1.40[a]	1.54[a]	1.77[ab]	1.92[b]
Crumbliness (1-5)†	1.22[a]	1.25[a]	1.30[a]	1.44[a]
Acceptability (1-5)††	4.00[a]	4.22[a]	4.65[ab]	4.43[b]

*1 very soft-5 very firm, **1 difficult to spread-5 easy to spread, ***1 not sticks-5 very sticky, †1 not crumby-5 crumby, ††1 dislike very much-5 likes very much

cheese, it is found that there are high significant between treatment (T3) and control for spreading, stickiness and acceptability, while no significant between all treatment and control for firmness and crumbliness.

CONCLUSION

Addition of tomato juice in preparation of process spread cheese led to produce a good and acceptable spread cheese with high nutritional and healthy food and it's a good for children because tomato contains lycopene which had red color attractive to children beside contains antioxidants and play important roles in the observed health effects. The addition of tomato juice led to increase the Iron content in resultant product.

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