World Journal of Dairy & Food Sciences 14 (1): 87-93, 2019
ISSN 1817-308X

DOI: 10.5829/idosi.wjdfs.2019.87.93

Processed Cheese Spreads Fortified with Lycopene Extracted from Tomato Wastes

[1]*Fatma A.M. Hassan,* [1]*Wafaa M. Zaky,* [1]*Eman S.A. Farahat,*
[2]*Abeer F. Zayan,* [1]*A.G. Mohamed and* [2]*Tamer S. AbdulAlim*

[1]Dairy Department, National Research Centre, Giza, Egypt
[2]Food Technology Research Institute, Agricultural Research Center, Giza, Egypt

Abstract: There is an increasing evidence of utilization of tomato by-products as a source of functional components in food processing. Lycopene present in tomato skin is a good source of carotenoids. It is widely used in food industry as natural and nontoxic source of color. It also has health benefits as antioxidant agent. This study aims to extract lycopene from tomato wastes to be added to processed cheese base and produce novel type of healthy dairy product. Lycopene was extracted from tomato wastes using palm oil and kept in refrigerator at 5ºCuntil be used. Two formula of processed cheese were prepared, the first served as control (without lycopene), while the second served as treated-sample (fortified with 25.4% palm oil containing lycopene).The resultant cheese samples were stored for three months at 5 and 25°C. Fresh samples were analyzed for chemical composition, iron, lycopene contents, phenolic compounds, antioxidant activity, as well as sensory properties. They were also evaluated for some physiochemical properties when fresh and through three months at the two degrees of storage. Results showed that fresh treated samples had higher phenolic compounds, lycopene and iron contents as well as antioxidant activity than control. Penetrometer reading and meltability values were higher in treated samples while they had lower values of oil separation. Organoleptic properties indicated that treated samples gained higher scores for all sensory parameters than control In conclusion treated samples had higher content of Lycopene, iron, phenolic compounds and antioxidant activity. In the same time they had higher meltability and less oil separation than control samples. Moreover this study confirms that lycopene which extracted from tomato wastes can be used in preparing processed cheese with high content of iron, antioxidant and phenolic compounds.

Key words: Tomato Wastes · Lycopene · Processed Cheese · Antioxidant · Phenolic Compounds

INTRODUCTION

Lycopene is one of the most potent antioxidants. Its free radical scavenging ability is twice than that of β-carotene and ten times higher than that of á- tocopherol. It is well known that reducing oxidative stress is accompanied by health and decrease the incidence of cancer and cardiovascular ailments [1].Tomatoes and tomato products are rich in lycopene compounds. Tomato has more than 85% of all the carotenoids present in the fruits [2].

Lycopene present in many vegetables and fruits but it is not found in animals or humans [3]. It is a natural red pigment which naturally used as color in food. Lycopene contains several conjugated double bonds and has forty carbon cyclic carotenoids [4-6]. Food fortification with lycopene is completely safe for lactating or pregnant women. Lycopene increase with increasing the consumption of tomato in human milk [7].

Unlike many other natural compounds, lycopene is generally stable to processing when present in the plant tissue matrix. In fact, thermal processing generally improves lycopene bioavailability by disrupting cellular membranes, which allows lycopene to be released from the tissue matrix. Many studies have shown that lycopene from thermally processed tomato products is more bioavailable than lycopene from fresh tomato [8].

Corresponding Author: Fatma A.M. Hassan, Dairy Department, Division of Food Industry and Nutrition, National Research Centre, Giza, Egypt.

On the other side, processed cheese is delicious and popular type of cheeses which consumed by many people and by different ages.

The aim of this study was to extract lycopene from tomato wastes to fortify processed cheese and produce a new functional type of cheese for consumers.

MATERIALS AND METHODS

Ras cheese (1 month old) was obtained from Arabic Food Industrial Co. (Domety), 6th October City, Egypt. Skim milk powder and butter were purchased from Irish Dairy Board, Grattan House, Lower Mount St., Dublin. Matured cheddar cheese (8 months old) was obtained from international Dairy and food Co.(Green Land), 10th Ramadan City, Egypt. Commercial JOHA emulsifying salts were obtained from BK-laden bugcrop Gubh, Germany. Fresh tomato was purchased from local market in Cairo, Egypt.

Extraction of Lycopene: Fresh tomato was boiled in water to get rid of sugar and inhibit the oxidative enzymes and well squeezed. The resultant tomato waste was strained through cheese cloth, dried at 55°C, grinded then packed in polyethylene bags and kept in refrigerator at 5°C until using. Tomato waste pigments were extracted by using palm oil [9] Lycopene content was determined in the oil as 439mg/100g [10] then kept in closed bottle in refrigerator at 5°C till be used.

The total solids and fat percentage of the ingredients used in manufacture of processed cheese presented in Table 1.

Estimation of total solids and fat of ingredients were done according to AOAC [11].

Processed Cheese Spread Manufacture: Processed cheese spread was manufactured as mentioned by Abdel-Hamid *et al*. [12]. Two formula of processed cheese were prepared ; the first one served as control (without lycopene) while the second one served as treated sample (Supplemented with 25.4% palm oil containing lycopene) this was added before cooking. All samples were stored at 5 and at 25°C for three months (Table 2). Samples were analyzed when fresh and during storage period.

Analytical Methods

Chemical Analysis: Fresh samples were analyzed for total solids, fat, ash and total protein [11]. The pH values were measured using a digital pH meter (HANNA) with combined glass electrode (electric instruments limited).Salt content was determined as described by Bradley *et al*. [13], while total iron content was estimated according to Niedzielski *et al*. [14]. Lycopene content was determined according to Davis *et al*. [10]. Stored samples were monitored for pH, soluble nitrogen content and physicochemical properties.

Table 1: Total Solids and Fat% content of Ingredients Used in Manufacture of Processed Cheese Spread Samples Fortified with Lycopene.

Ingredients	TS	Fat
Acid curd	32.50	00.5
Skim milk powder	97.00	00.1
Butter	84.00	82.00
Ras cheese	55.60	22.50
Palm oil (containing lycopene)	99.50	99.00

Table 2: Formulations of Processed Cheese Spread Samples

Ingredients	Control	Treatment
Ras cheese	47.58	-
Cheddar cheese	15.86	-
Acid curd	-	41.00
Butter	7.61	-
Palmoil (containinglycopene)	-	25.40
Skim milk powder	-	6.39
Salt	-	1.15
Emulsifying salt	2.13	1.80
Cheese flavor	-	2.50
Water	26.82	21.76
Total	100.00	100.00

Total Phenolic Compounds (TPC): Total phenolic compounds in fresh samples were determined according to Zheng and Wang [15] by using Folin-Ciocalteu reagent and expressed as milligram of Gallicacid equivalents (GAE/100g).

Antioxidant Activity: Free Radical Scavenging Activity (RSA %) assay in fresh samples was measured using the method of Locatelli *et al*. [16]. It was expressed as percentage inhibition of the DPPH (2-diphenyl-1-picrylhydrazyl) radical and was calculated by the following equation

$$RSA = \frac{Abs_{control} - Abs_{sample}}{Abs_{control}} \times 100$$

Physiochemical Properties: Penetration, meltability and oil separation were estimated in both fresh and stored samples. Penetrometer was used for Penetration measure (Cochler Instrument Company Inc., USA). Meltability was determined according to the method designed by Savella *et al*. [17]. Oil separation was determined according to the method outlined by Thomas [18].

Sensory Evaluation: Sensory properties of fresh cheese samples were evaluated by the staff members of Dairy department, National Research Centre [19]. Scores ranged from 1 to 10 for each item, then statistically evaluated using SPSS [20].

RESULTS AND DISCUSSION

Tomatoes and tomato-based food products constitute the major dietary source of lycopene, which has demonstrated antioxidant properties and potential role in the prevention of chronic diseases [21].

The analysis of both control and treated samples (Table 3) showed that both samples had nearly the same contents of TS, fat and protein. Control samples had higher contents of salt while fortified samples had higher contents of ash. These findings were due to the formula adjustment of the processed cheese spread.

The current study, gave high iron content in treated samples (13.1mg/kg) which reflected the potential healthy properties. Iron was reported as an essential nutrient for human body. It can be found in two forms in foods (Heme and non-heme). Heme iron is only found in animal products, while non-heme is only found in plants. Sun-dried tomatoes are rich source of non-heme iron, which is less easily absorbed, but it is also a great source of vitamin C, which helps to increase iron absorption [22]. Similar results were obtained by Mehanna *et al.* [23].

In this study we succeeded to prepare new formula of processed cheese contained palm oil at ratio of 25.4% as fat replacer instead of milk fat from other dairy products (Table 2). This oil contained high level of lycopene as 93.9mg/100g in treated samples (Table 3). Success in preparing formula of processed cheese rich in lycopene could provide a new functional dairy food.

Moreover, Tomato Is a Great Source of Lycopene the Well-known Antioxidant: Concerning radical scavenging activity (RSA %), results showed higher level in fortified samples than control. In the same time phenolic compounds were higher in treated samples than control (Table 4). Previous study recorded the phenolic compounds in whole buffalo milk, curd and palm oil as 3, 7.4 and 3.2 Gallic acid eq. mg/100gm and the antioxidant (DPPH) contents were 3.4, 4.1 and 12.1, respectively [24].

Other studies confirmed that the skin fraction of tomato had significantly high levels of phenols, flavonoids, lycopene and ascorbic acid. Also, it had high antioxidant activity [25, 26].

Table 3: Analysisof Fresh Processed Cheese Spread Samples Fortified with Lycopene

Items	Control	Treatment
TS(%)	45.31	45.32
Fat(%)	25.00	25.00
F/DM	55.17	55.16
Protein(%)	13.63	13.14
Ash(%)	4.83	5.51
Salt (%)	2.46	1.85
pH value	5.51	5.62
Fe (mg/kg)	-	13.1
Lycopene(mg/100g)	-	93.9

Table 4: Antioxidant activity and phenolic compounds of fresh processed cheese spreadsamples fortified with Lycopene

Item	Control	Treatment
RSA (%)	2.0	61.13
Phenolic compounds (GAE/100g)	5.0	11.00

RSA: Radical Scavenging Activity. GAE: Gallic Acid Equivalent

Table 5: Sensory Evaluation of ProcessedCheese Spread SamplesFortified with Lycopene

Scores (1-10)	Control	Treatment
Appearance	7.6^{a}	7.8^{a}
Color	6.8^{b}	8.2^{a}
Flavor	7.8^{b}	8.4^{a}
Texture	7.4^{a}	7.8^{a}
Acceptability	7.4^{a}	7.9^{a}
Overall liking	7.3^{a}	7.8^{a}

Same letters are not significant at ($P < 0.05$).

Regarding the sensory evaluation of fresh processed cheese spread samples (Table 5), parameters specially color and flavor gained significant higher scores in treated samples than control one. The fortification with lycopene provided the treated cheese samples favorable red color and acceptable flavor. Also, the phenolic compounds were reported to affect on the organoleptic properties of dairy products [27]. In the same time the treated sample showed better appearance, texture, acceptability and overall liking than the control sample.

Physicochemical properties of processed cheese spread samples were performed in this study when it was fresh and throughout the storage period. Fig 1 showed that treated samples had noticeable higher penetrometer reading values than control. This means that the fortification with lycopene gave the cheese soft body either fresh or during storage at 5°C and 25°C until three months as a result of the change in the formula [23, 28].

Beside the higher penetration, fortified samples showed also higher meltability values than control when fresh and during storage until three months (Fig. 2). This may be referred to the lower pH of control than fortified samples [29].

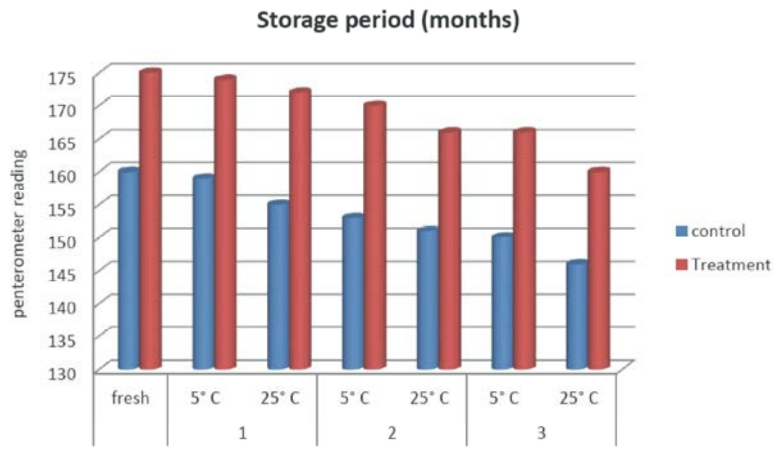

Fig. 1: Changes in penetrometer reading (mm) of Processed Cheese Spread Samples Fortified with Lycopene during storage at 5°C and 25°C.

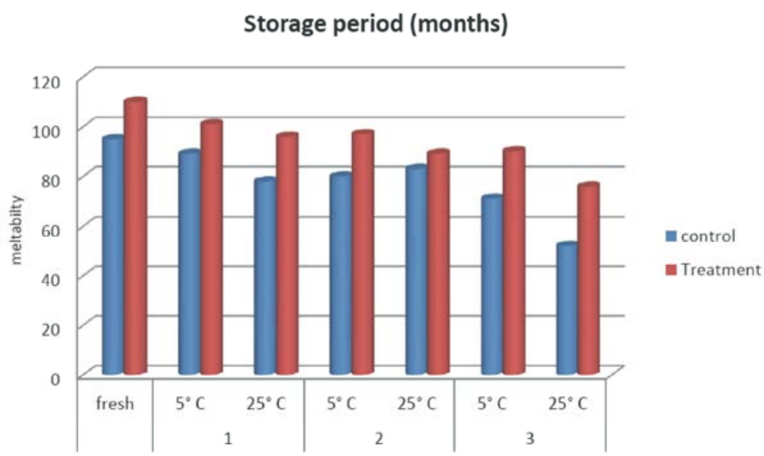

Fig. 2: Changes in Meltabilty (mm) of Processed Cheese Spread Samples Fortified with Lycopene during storage at 5°C and 25°C.

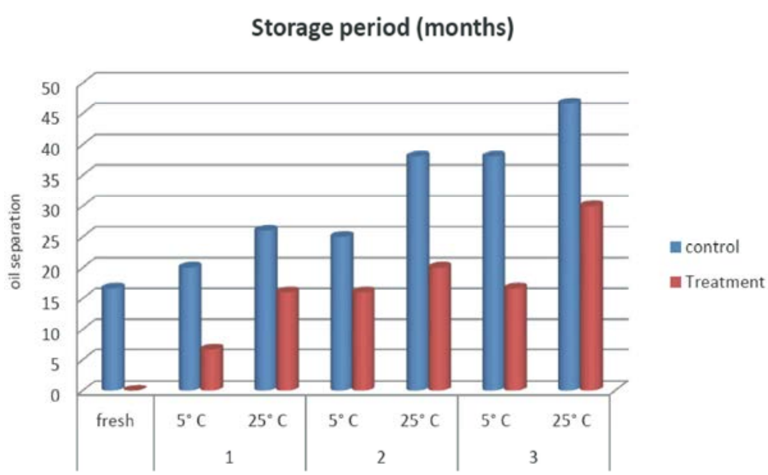

Fig. 3: Changes in oil separation (mm) of Processed Cheese Spread Samples Fortified with Lycopene during Storage at 5°C and 25°C

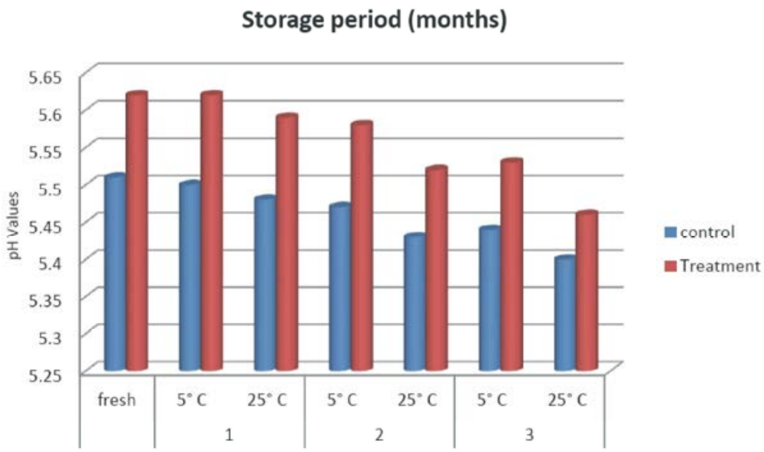

Fig. 4: Changes in pH Values of Processed Cheese Spread Samples Fortified with Lycopene during Storage at 5°C and 25°C

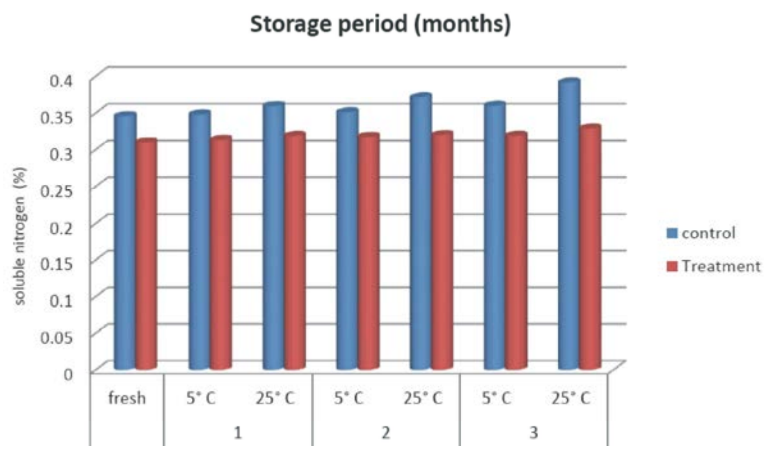

Fig. 5: Changes in soluble nitrogen (%) of Processed Cheese Spread Samples Fortified with Lycopene during Storage at 5°C and 25°C

Meltability gradually decreased by increasing temperature during storage until three monthsthis may be due to the increased acidity or lower pH by high temperature [29].

Changes in oil separation of processed cheese spread samples fortified with lycopene (Fig. 3) showed that control had higher oil separation than treatment.

Oil separation increased by time of storage and increased temperature similar results were previously recorded by Mehanna *et al*. [23] and Omer *et al*. [30]. There is evidence that the individual fat globules decrease in size during the storage time [31]. The heating of cheese during manufacture induces some changes in the fat globule microstructure and may induce coalescence and rupture of fat globules with increased free oil formation [32]. In food systems, the presence of antioxidants, protect lipids against oxidation by quenching free radical reactions. This fact may explain the increased oil separation in control samples more than treated samples due to the antioxidant power of lycopene that may keep the microstructure of fat globules and keep them homogenized for longer time.

The change in pH values showed that control had a lower pH than treatment. This was explained by Johnson [33] who stated that the decrease in pH is a race between the amount of acid developed and the rate at which the buffering agent can pick up the hydrogen ions. So, we suggest that presence of the antioxidant (lycopene) in the treated samples lowers the concentration of free radicals and consequently keep the pH higher than control samples.

The current study recorded slight decrease in pH by time and elevated temperature in both groups (Fig 4). This may be due to increased ionization of water content by temperature elevation and liberation of hydrogen ions [33].

The current study showed that the soluble nitrogen content of fortified samples had higher values in control than treatment either in fresh state or by storage. Also it is elevated by increased temperature during the three months of storage (Fig. 5). This may be due to enzymatic activity of heat resistant proteinases or hydrolysis of polyphosphate present in emulsifying salt which cause more solubilization of proteins. These results are in agreement with those reported by Awad *et al*. [34].

CONCLUSION

Tomato waste product is rich in lycopene, iron and antioxidants which have beneficial properties for health. It could be used as a valuable added ingredient in dairy products. In the current study we produced a novel type of processed cheese fortified with lycopene. This type of cheese is considered functional food. It has accepted sensory properties. Lycopene improved the physical properties of cheese, increased meltability, decreased oil separation. Moreover this study confirms that lycopene which extracted from tomato wastes can be used in preparing processed cheese with high content of iron, antioxidant and phenolic compounds.

REFERENCES

1. Erdman, J.W., N.A. Ford and B.L. Lindshield, 2009. Are the health attributes of lycopene related to its antioxidant function? Arch BiochemBiophys, 483(2): 229-235.
2. Abreu, W.C., M.F.P. Barcelos, E.P. Silva and E.V.B.V. Boas, 2011. Physical and chemical characteristics and lycopene retention of dried tomatoes subjected to different pre-treatments, Rev. Inst. Adolfo. Lutz., 70(2): 168-74.
3. Chauhan, K., S. Sharma, N. Agarwal and B. Chauhan, 2011. Lycopene of tomato fame: Its role in health and disease. Intr. J. Pharm. Sci. Rev. Res., 10: 99 115
4. Burgess, L.C., E. Rice and T. Fischer, 2008. Lycopene has limited effect on cell proliferation in only two of sever human cell lines (Both cancerous and nano cancerous) in an *invitro* system with doses across thephysiological range. Toxico *In vitro*, 22(5): 1297-1300.
5. VanBreemen, R.B. and N. Pajkovic, 2008. Multi targeted therapy of cancer by lycopene. Cancer Lett, 269(2): 339-351.
6. Jackson, H., C.L. Braun and H. Emst, 2008. The chemistry of novel xanthophylls carotenoids. Am. J. Cardiol, 101(10A): 50D-57D.
7. Alien, C.M., A.M. Smith, S.K. Clinton and S.J. Schwartz, 2002. Tomato consumption increases lycopene isomer concentrations in breast milk and plasma of lactating women. J. Am. Diet. Assoc., 102(9): 1257-1262.
8. Nguyen, M.L., D. Francis and S.J. Schwartz, 2001. Thermal isomerisation susceptibility of carotenoids in different tomato varieties. J. Sci. Food Agric., 81(9): 910-17.
9. Ranganna, S., 2001. Hand Book of Analysis and Quality Control for Fruits and Vegetable Products. 7th Edition, Tata McGraw Hill Book Co., New Delhi, pp: 594-625.
10. Davis, A.R., W.W. Fish and P. Perkins-Veazie, 2003. A rapid spectrophotometric method for analyzing Lycopene content in tomato and tomato products. Postharvest Biology and Technology, 28: 425-430.
11. .AOAC., 2012. Official Methods of Analysis. 18thEdn., Association of Official Analytical Chemists Inc., Arlington, TX., USA.
12. Abdel-Hamid, L.B., S.A. El-Shabrawy, R.A. Awad and R.K. Singh, 2000. Chemical properties of processed Ras cheese spreads as affected by emulsifying salt mixtures. J. Food Process. Preserv., 24: 191-208.
13. Bradley, R.L., E.A. Arnold, D.M. Barbano, R.G. Semerad, D.E. Smith and B.K. Vines, 1992. Chemical and physical methods. In: (Ed. Marshall RT). Standard Methods for The Examination of Dairy Products. 16th Ed. Washington, D.C.: American Public Health Association. pp: 433-531. ISBN: 0-87553-210-1.
14. Niedzielski, P., M.Z. Dawidziak, L. Kozak, P. Kowalewski, B. Szlachetka, SylwiaZalicka and W. Wachowiak, 2014. Determination of iron species in samples of iron-fortified food. Food Anal. Methods, 7: 2023-2032.
15. Zheng, W. and S.Y. Wang, 2001.Antioxidant activity and phenolic compounds in selected herbs. J. Agric. Food Chem., 49: 5165-5170.
16. Locatelli, M., R. Gindro, F. Travaglia, J. Coisson, M. Rinaldi and M. Arlidio, 2009. Study of DPPH-scavenging activity. Development of free software for the correct interpretation of data. Food Chemistry, 114: 889-897.
17. Savella, P.A., C.A. Ernstrom and M. Kalab, 1989. Microstructure and meltability of model process cheese mode with rennet and acid casein. J. Dairy Sci., 72: 1-11.

18. Thomas, M.A., 1973. The use of hard milk fat fraction in processed cheese. Aust. J. DairyTechnol., 28: 77-83.
19. Bandyopadhyay, M., R. Chakraborty and U. Raychaudhuri, 2007.Role of carrot on shelf stability of dairy dessert (Rasogolla) during refrigerated storage. J. Food Process. Preserve, 31: 714-735.
20. SPSS, 2007. Statistical Package for Social Sciences for Windows. Version 16.0, SPSS Company Inc., Chicago, USA., pp: 444.
21. Borguini, R.G. and E.A.F. Da Silva Torres, 2009. Tomatoes and tomato products as dietary sources of antioxidants. Food Rev. Int., 25: 313-325
22. Nour, V., M. E. Ionica and I. Trandafir, 2015. Bread enriched in lycopene and other bioactive compounds by addition of dry tomato waste. J. Food Sci. Technol., 52(12): 8260-8267
23. Mehanna. S. N., A. M. F. Hassan, T. M. El-Messery and A. G. Mohamed, 2017. Production of functional processed cheese by using Tomato juice. Int. J. Dairy Sci., 12 (2): 155-160.
24. Sreeramulu, D. and M. Raghunath, 2011.Antioxidant and Phenolic Content of Nuts, Oil Seeds, Milk and Milk Products Commonly Consumed in India. Food and Nutrition Sciences, 2: 422-427.
25. George, B., C. Kaur, D.S. Khurdiya and H.C. Kapoor, 2004. Antioxidants in tomato (Lycopersiumesculentum) as a function of genotype. Food Chem., 84: 45-51.
26. Toor, R.K. and G.P. Savage, 2005. Antioxidant activity in different fractions of tomatoes. Food Res. Int., 38: 487-494.
27. O'Connella, J.E. and P.F. Fox, 2001. Significance and applications of phenolic compounds in the production and quality of milk and dairy products: a review International Dairy Journal, (11): 103-120.
28. AbdRabou, F.H., A.M. Abd El-Fattah, M.M. El-Sayed and A.G. Mohamed, 2008. Effect of some formulated emulsifying salts on processed cheese properties. Egypt. J. Dairy Sci., 39: 126-131.
29 Sołowiej, B., 2007. Effect of pH on rheological properties and meltability of processed cheese analogs with whey products.. Pol. J. Food Nutr. Sci. 57(3A): 125-128.
30. Omar, M.A.M., A.G. Mohamed, E.A.M. Ahmed and A.M. Hasanain, 2012. Production and quality evaluation of processed cheese containing legumes. J. Applied Sci. Res., 8: 5372-5380.
31. Guinee, T.P., E.P. Feeney, M.A.E. Auty and P.F. Fox, 2002. Effect of pH and calcium concentration on some textural and functional properties of Mozzarella cheese. Journal of Dairy Science, 85: 1655-1669.
32. Rowney, M.K., P. Roupas, M.W. Hickey and D.W. Everett, 2003. The effect of compression, stretching and cooking temperature on free oil formation in Mozzarella curd. Journal of Dairy Science, 86: 449-456.
33. Johnson, M., 2002. Cheese pH, What's behind the rise and fall. A Technical Resource of Dairy Manufacture, 14(4): 6-11.
34. Awad, R.A., L.B. Abd El-Hamid, A.E. Haggras and O.A. Zammar, 2003. Rheological and sensory properties of low fat processed cheese spread with low fat mozzarella cheese in the base blend. Egyptian Journal of Dairy Science, 31(2): 361-373.