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Research Article
Natural Different Bell Pepper Juices as a Nutritional Fortification to Produce of Functional Processed Cheese Spread

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Abstract

Background and Objective: The study was utilized of different (green, yellow and red) Bell Pepper Juice (BPJ) in preparing of Processed Cheese Spread (PCS) to improve its organoleptic, nutritional and functional properties. **Methodology:** The BPJ was added to base blend at the levels of 20%. The prepared samples were analyzed for chemical, physical, microbiological and sensory properties. **Results:** Processed Cheese Spreads (PCSs) were analysis after fortification with BPJ and processing. The vitamins content (A, E, K, D, C and B6) was significantly higher in PCSs incorporation of BPJ, also nicotinic acid, thiamin, riboflavin and folic acid content was significantly increased in cheese spread containing 20% BPJ compared with control or unfortified PCSs. Furthermore, the total phenol compounds and residual scaving activity content were significantly higher in cheese spread containing 20% of BPJ. No significant change was observed in the chemical and physical composition of PCSs made with and without incorporation of BPJ. **Conclusion:** In general, organoleptic grade of the PCSs made with 20% of different BPJ were better among the other treatments. Using of BPJ in PCS makes this dairy product useful as a healthy and a functional food.

Key words: Functional, processed cheese, bell pepper, juices, nutritional

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

INTRODUCTION

The study was utilized of different (green, yellow and red) Bell Pepper Juice (BPJ) in preparing of Processed Cheese Spread (PCS) to improve its organoleptic, nutritional and functional properties. Presently, people have concern maintaining an excellent body figure and good health. Therefore, they have become more accurate in the food they select to consume, looking for food such as fruits and vegetables with total phenol compounds, high antioxidant activity and a high nutritional value. Epidemiological studies have consistently described a reduction in the death rate due to cancer, heart disease and other degenerative diseases, as well as old age by the consumption of fruits and vegetables. In the truth that these foods are the major source of a food containing health-giving additives and having medicinal benefit such as antioxidants, total phenolic compounds, fibre, vitamins and minerals[1,2]. Bell peppers fruits all start out some shade of green and become as they ripen, then they can change to other colors (yellow, orange, red, purple, etc.) and this color change coincides with the seed development and chlorophyll breakdown. The green pepper fruits are less mature and most, if green pepper fruits left on the plant longer, it would be ripen to a yellow or red or some other color. So you can find that the green pepper fruit ones are often considerably less expensive than the other colors of pepper fruits. The nutritional value of the peppers improves as they ripen. Also, the different bell pepper fruit contains high content of total phenol compounds and high antioxidant activity and it is among the most folk of fresh vegetables worldwide due to its blend of some sensory properties and nutritional value[3]. Actually, a wide number of different bell pepper fruit varieties are available in the local markets, most of which change from a green color to yellow, orange, red or purple when they are quite mature. Bell green sweet pepper fruits are harvested before they quite mature and the maturity stage can partly account for the phytonutrients content and so the quantity consumption of antioxidants in the diet[4]. Fresh different bell peppers have especially high amount of ascorbic acid and their appealing red color is due to several carotenoid pigments that include β-carotene with pro-vitamin A activity and oxygenated carotenoids such as capsantin, capsorubin and cryptocapsin, which are not restricted to these fruits and have sure to be efficient at scavenging free radicals[5]. Bell different pepper fruits also contain great concentration of total phenolic compounds which called quercetin, luteolin and capsaicinoids[6]. The high consumption of these total phenol compounds supply useful effects in human health due to their antioxidant properties. However, total phenol compounds protects against the oxidative damage to cells and so prohibit the development of popular degenerative diseases such as cataracts, cancer, diabetes, cardiovascular diseases, Parkinson's and Alzheimer's[3,7,8]. Also, these chemical compounds can block the oxidation of essential fats within the brain cells that are believe quite necessary for its optimal functioning[9].

Pepper extract as vitamins supplements to produce functional processed cheese. Prepare extract is a natural source of vitamins, antioxidants and some mineral and bioactive component that are essential per human health specially children. On another hand, processed cheeses are most of dairy products that having high consumption pattern by high sectors of population specially the children, but processed cheeses lacks vitamins, antioxidants and some minerals specially zinc and iron that is very important specially for teenager, so, the amied of this study were fortifying processed cheese with pepper extract to increase vitamins, antioxidants and some mineral specially. Processed cheeses were made with different pepper extract[10]. Little information is available in the literature on fortified, PCS. Processed cheese spread is an appealing product that revel large popularity. Processed cheeses spread have been important trade foods ago the early years of century[11]. The food industries are interesting to produce, healthier, more appropriate and meet consumer requests[12,13] fortifying PCS with apricot way insure ingestion of the desired amount of PCS with low sodium/potassium ratio and high contents of vitamins and antioxidants. Utilization of vegetables such as carrot in processed cheese products is one of ways for development of functional food by Mohamed *et al.*[14].

The aim of the present study was to determine the content in total phenol compounds and antioxidant activity of different (green, yellow and red) BPJ to produce a nutritional and functional PCS. Also, it was to demonstrate the effect of addition green, yellow and red BPJ as a functional ingredient in the fortification of PCS.

MATERIALS AND METHODS

Materials: Green, yellow and red bell peppers *(Capsicum annum* L.) were supplied by a local supermarket. The fruits were harvested, brought to the supermarket and immediately taken to the laboratory, where they were stored at 4±1°C, until further use. All chemicals used in this study were of analytical grade.

Preparation of bell sweet pepper juice samples: Green, yellow and red bell sweet pepper *(Capsicum annum* L.)

samples representing common cultivars were obtained from local food stores during the fall and winter of 2016 and stored briefly at 4°C until needed. One hour prior to use, fruits were removed from the refrigerator and equilibrated to room temperature. Bell sweet pepper fruits were rinsed with water, seeds removed and sectioned to longitudinal slices. Apple juice samples were prepared from individual bell sweet pepper (green, yellow and red) with a juicerator and then filtered through a double layer cheese cloth to remove pulp. Juice was collected in a beaker to be treated and processed[15]. Bell sweet pepper juice (BPJ) was used as a basal medium in this study. Each assay was performed by triplication.

Preparation of Processed Cheese Spread (PCS): Processed cheese spreads were prepared to contain 20% different green, yellow and red bell pepper fortified. Formulations of the different treatments (3 treatments) are shown in Table 1. The amounts of the used ingredients were calculated in order to fulfill the legal standard specification of the full fat processed cheese spread. The bell green, yellow and red pepper juice were blended and extracted by 2 layers cheese cloth and used bell pepper juice in the formulation before its addition to the other ingredients. The ingredients were mixed, placed in the processing kettle (locally made) of 2.5 kg capacity and then heated by direct steam up to 90°C with continuous mixing at 1400 rpm for 5 min. Heating was discontinued, the hot cheese melt was packaged in wide-open screw capped glass bottles (100 mL capacity) and stored at 5°C until analyzed. Three replicates were made from each treatment and analyzed each in duplicate.

Preparation of Processed Cheese Spreads (PCS) fortified with different Bell Pepper Juice (BPJ): Processed cheese spreads were made from the ingredients presented in Table 1. The composition of each blend was adjusted for moisture and fat contents to obtain a final product with 55% moisture as a maximum and 50% fat to dry matter as a maximum to meet Egyptian Standard[16]. Three different Bell Pepper Juices (BPJ) were used green, yellow and red in the same ratio 20% (Table 2). Formulation was presented in Table 2. All PCS with different bell sweet pepper juice were cooked according to the method of Meyer[17]. The resultant cheeses were analyzed.

Physicochemical analysis of fresh bell sweet pepper juices (BPJ): Bell sweet pepper juice (BPJ) was recovered for pH, titratable acidity and total soluble solids measurements, according to the methods of Chang *et al.*[18]. The pH was measured at 20°C using a digital pH meter (HANNA, HI 902 m, Germany) with combined glass electrode (Electric instruments limited). Titratable acidity was determined by titration with 0.1 N NaOH until pH 8.1 was reached and expressed as g citric acid/100 g fresh weight. The percent Total Soluble Solids (TSS), expressed as °Brix (0-32) or g kg^{-1} was determined at 20°C with a hand refractometer (ATAGO, Japan). All assays for the physicochemical analysis were performed in triplicate.

Table 1: Chemical composition of the ingredients used in cheese making

Parameters	Total Solids (TS) (%)	Fat (%)
Cheddar cheese	66.0	33.5
Ras cheese	54.5	22.5
Skim milk powder	95.0	0.7
Butter	84.0	82.0

Table 2: Formulations of the ingredients (%) used in cheese making

Parameters	Control	Green-BPJ	Yellow-BPJ	Red-BPJ
Cheddar cheese	12.76	12.76	12.76	12.76
Ras cheese (Romy)	38.49	38.49	38.49	38.49
Skim milk powder	5.12	5.12	5.12	5.12
Butter	10.26	10.26	10.26	10.26
Emulsifying salt	2.50	2.50	2.50	2.50
Green pepper juice	-	20.00	-	-
Yellow pepper juice	-	-	20.00	-
Red pepper juice	-	-	-	20.00
Water	30.87	10.87	10.87	30.87
Total 100%	100.00	100.00	100.00	100.00

Chemical analysis of unfortified and Processed Cheese Spreads (PCS) fortified by different Bell Pepper Juices (BPJ): The unfortified and processed cheese spreads fortified by different Bell Pepper Juices (BPJ) samples were analyzed for fat content, total nitrogen content, Total Solids (TS) content and pH values as described by Ling[19]. The ash content was determined according to the IDF[20]. Lactose content was determined colorimetrically using phenol-sulphuric acid method as described by Barnett and Abdel Tawab[21]. The total phospholipid content was calculated by determination of the phosphorus content in the digestable extract according to the method of Snell and Snell[22] and then multiplied by a factor of 25 as reported by Holden *et al.*[23].

Physical analysis of unfortified and Processed Cheese Spreads (PCS) fortified by different Bell Pepper Juices (BPJ)

Firmness: The firmness of unfortified and processed cheese spreads fortified by different Bell Pepper Juices (BPJ) was determined using a penetrometer supplied by Koehler instrument Company Inc., 1595 Sycamore Avenue, Bohemio, New York 11716, USA. A cone assembly weighted 35 g and the depth of penetration was measured in 1/10 mm and in general the greater the depth of penetration the weaker the body of cheese. The test was performed as follows: The penetrometer cone was adjusted to touch the surface of

processed cheese spreads sample then, the cone was released to penetrate the sample for 5 sec. The penetration depth was recorded in units of 0.1 mm penetrometer reading in related inversly to the firmness of unfortified and processed cheese spreads fortified by different bell pepper juices.

Oil separation: Oil separation was determined according to the method outlined by Thomas[24].

Meltability: Meltability of unfortified and processed cheese spreads fortified by different Bell Pepper Juices (BPJ) samples was determined according to the method designed by Olson and Price[25] as modified by Savello[26].

Colour characteristics determination of unfortified and processed cheese spreads fortified by different bell pepper juices: Colour of unfortified and processed cheese spreads fortified by different BPJ was measured using spectro-colourimeter (Tristimulus Colour Machine) with the CIE lab colour scale (International Commission on Illumination) as mentioned by Hunter[27] and Sapers and Douglas Jr.[15]. Colour of unfortified and processed cheese spreads fortified by different BPJ samples was measured using a HunterLab colourimeter Hunter a*, b* and L*. Parameters were measured with a colour difference meter using a spectro-colourimeter (Tristimulus Colour Machine) with the CIE lab colour scale (Hunter, Lab Scan XE-Reston VA, USA) in the reflection mode. The instrument was standardized each time with white tile of Hunter lab colour standard (LX No. 16379): X = 72.26, Y = 81.94 and Z = 88.14 (L* = 92.46, a* = -0.86, b* = -0.16). The instrument (65°/0° geometry, D25 optical sensor, 10° observer) was calibrated using white and black reference tiles. The colour values were expressed as L* (lightness or brightness/darkness), a* (redness/greenness) and b* (yellowness/blueness). The Hue (H)*, Chroma (C)* and Browning Index (BI) was calculated according to the method of Palou *et al.*[28] as follows:

$$H^* = \tan\text{-}1 \left[\frac{b^*}{a^*}\right] \quad (1)$$

$$C^* = \text{Square root of } [a2^*+b2^*] \quad (2)$$

$$BI = [100\ (x\text{-}0.31)]\ 10.72 \quad (3)$$

Where:

$$X = \frac{(a^*+1.75L^*)}{(5.645L^*+\ a^*-3.012b^*)}$$

$$\Delta E = (\Delta a2+\Delta b2+\Delta L2)\ 1/2 \quad (4)$$

where, all values were recorded as the mean of triplicate readings.

Microbiological evaluation of unfortified and processed cheese spreads fortified by different Bell Pepper Juices (BPJ): Unfortified and Processed Cheese Spreads (PCS) fortified by different Bell Pepper Juices (BPJ) was determined in triplicate for total aerobic bacteria and yeast and moulds according to FDA[29]. Untreated and treated samples were serially diluted with 0.1% peptone (DIFCO Labs., Detroit, MI) and pour-plated in duplicate. Total aerobic bacteria counts: 1 mL aliquot of each sample was plated using a plate count agar medium (Merck KGaA, Darmstadt, Germany) and incubated at 35-37°C for 48 h to counting. Yeast and moulds (Y and M) were determined using malt extract agar (Merck KGaA, Darmstadt, Germany) after incubation at 25°C for 3 days. The number of colonies (total aerobic bacteria or yeast and moulds) that appeared on the plates was counted and expressed as log colony forming unit per milliliter or log CFU mL^{-1}.

Sensory analysis of unfortified and processed cheese spreads fortified by different bell pepper juices: The sensory attributes (colour, odour, taste, texture and acceptability) were assessed by a panel taste of 12 experienced members of the Food Technology and Dairy Departments, National Research Centre, Cairo. Panelists were asked to judge each sensory attribute out of 10 point scale, according to Larmond[30].

Statistical analysis: Mean values from the three separate experiments or replicate analysis were reported. The obtained results were analyzed statistically using Standard Deviations (n = 3) and average as described by Richard and Gouri[31].

RESULTS AND DISCUSSION

Physical properties of fresh green, yellow and red BPJ: The green, yellow and red BPJ had 4.6, 4.7 and 4.8 pH values, but the Total Soluble Solids (TSS) was 9, 10 and 11 °Brix, respectively. Titratable acidity was 10, 13 and 19% as citric acid in fresh green, yellow and red BPJ respectively (Table 3).

Table 3: Physical properties of fresh green, yellow and red BPJ

Bell Pepper Juice (BPJ)	pH	TSS	Titratable acidity*	TSS/acidity ratio
Green-BPJ	4.6	9±0.01	10±0.03	0.90
Yellow-BPJ	4.7	10±0.01	13±0.02	0.77
Red-BPJ	4.8	11±0.01	19±0.01	0.58

*Total or titratable acidity expressed as citric acid (mg/100 g)

The TSS/acidity ratio is the main analytical measurement for quality in green, yellow and red BPJ. The bigger ratio leads to the best the juice flavor[32,33], it was 0.9, 0.77 and 0.58 in fresh green, yellow and red BPJ. This indicates that green, yellow and red BPJ may be advisable for fresh use. However, it could be treated into accepted quality juice. Fellers *et al.*[34] showed that grapefruit juice with TSS/acidity ratios 7.0 had lower consumer priority scores than juice with TSS/acidity ratios above 11.0.

Chemical composition and pH of PCS fortified with BPJ: Table 4 shows the chemical composition of fresh processed cheese fortified with different green, yellow and red BPJ. Total solids, F/DM, protein and lactose contents were similar content in the different green, yellow and red BPJ fortified and unfortified cheese sample. Salt in moisture and ash content increased in different green, yellow and red bell pepper juices fortified samples than in unfortified sample, as shown in Table 4. These increases due to increase of ash and salt in moisture contents in green, yellow and red BPJ. The results showed that the pH values were decreased from 5.75 in unfortified PCS to 5.7, 5.68 and 5.61 in green, yellow and red BPJ fortified cheese samples, respectively. Total solid values followed the adverse pattern as pH, as seen in Table 4. This can be attributed to the acidity of BPJ fortification used. However, the protein contents and pH values of the spreads in the present study were in agreement with values reported for market processed cheeses[35,36].

Phytochemicals of unfortified and PCS fortified with different BPJ: The results obtained for phytochemicals of unfortified and fortified PCS with different BPJ (Total phenols and residual scaving activity) were shown in Table 5. From which, it could be seen that the fortification caused an increase in the phytochemicals content for all different BPJ fortified samples as compared to the unfortified cheese one.

Data given in Table 5 revealed that the total phenols values increased from 4.95 mg/100 L for control cheese sample to >9.598 for all different BPJ fortified cheese samples. As shown in the same Table 5, the residual scaving activity (%) were increased as a result of fortification from 1.9% for control cheese sample to >79.502% for all different BPJ fortified cheese samples. From the obtained results it could be concluded that fortification with different BPJ may be recommended for PCS as it gave a product with good quality attributes and highest phytochemicals content.

Table 4: Chemical composition of unfortified and fortified with different BPJ processed cheese spread

Chemical composition	Control PCS	Green BPJ-PCS	Yellow BPJ-PCS	Red BPJ-PCS
Total solid	45.01	45.07	45.09	45.04
pH	5.75	5.70	5.68	5.61
F/DM	50.56	50.30	50.22	50.25
Total protein	13.98	13.92	13.95	13.94
Lactose	2.60	2.60	2.60	2.55
Ash	5.06	5.09	5.08	5.11
Salt in moisture	3.03	3.11	3.13	3.15

Table 5: Residual scaving activity (%) and total phenol content (mg L^{-1}) of cheese made from green, yellow and red BPJ

Samples	Residual scaving activity (%)	Total phenol content (mg/100 L)
Control-PCS	1.9	4.95
Green BPJ-PCS	84.597	9.988
Yellow BPJ-PCS	83.096	9.598
Red BPJ-PCS	79.502	11.939

Table 6: Vitamins determination (µg/100 g) in processed cheese fortified with green, yellow and red BPJ

Vitamins	Green BPJ-PCS (µg/100 g)	Yellow BPJ-PCS (µg/100 g)	Red BPJ-PCS (µg/100 g)	Control-PCS
Vitamin A	0.0281	0.0557	0.0328	0.0201
Vitamin E	1.274	2.315	1.959	1.194
Vitamin K	3331	13630	11210	1065
Vitamin D	8.498	33.387	15.496	7.754
Riboflavin	61.37	5.378	7.613	0.325
Folic acid	75.52	43.37	50.13	ND
Vitamin B6	89.53	40.31	18.20	1.20
Thiamin	140.9	61.60	52.12	11.65
Nicotinic acid	143.1	50.85	56.75	16.75
Vitamin C	1665	1288	1125	ND

The content of total phenolic compounds as gallic acid (GAE) and free Radical Scavenging Activity (RSA) in BPJ cheese were showed in Table 5. Control cheese content of total phenols and the value of RSA were very low compared to BPJ cheese spread samples, so we did not put it in the statistical analysis. Phenolic compounds content in BPJ was increased by increasing the ratio of different BPJ to the cheese base, so the antioxidant activity of them was also increased in linear way. As a result of presence of total phenolic and antioxidant compounds in the BPJ which added as fortified to the cheese spread base.

Vitamins determination of processed cheese fortified with different BPJ: Table 6 summarize the vitamin content of unfortified and different BPJ fortified cheese spread. To determine the concentration of the vitamin attributable to the fortification, the value obtained for the unfortified product was subtracted from the appropriate fortified product. These

data show that the mean initial level of vitamin A was lower than other vitamin content while the ascorbic acid, thiamin, nicotinic acid and folic acid levels were more than control PCS. Vitamin A was high in yellow and red BPJ fortified cheese than in green BPJ fortified cheese.

The concentration of vitamin K, B6, C, folic acid and nicotinic acid content in the initial samples of green, yellow and red BPJ fortified processed cheese was 3 folds compared with unfortified cheese spread. Whereas, ascorbic acid was not stable in BPJ fortified PCS. But, vitamin thiamin was stable in the BPJ fortified PCS. Vitamin riboflavin content was higher in green BPJ fortified cheese spread than in other BPJ fortified and unfortified PCS. Vitamin E and D content was higher in red BPJ fortified cheese spread than in other BPJ fortified and unfortified PCS. The results of vitamin A as shown in Table 6 indicated that the BPJ treatments were higher than unfortified or control cheese samples. It is increased from 0.0201 µg/100 g in unfortified or control sample to 0.0281, 0.0557 and 0.0328 µg/100 g in green, yellow and red BPJ fortified cheese spread. Also, the results of vitamin (K, E, D, B6 and C) followed the similar pattern of vitamin A, as shown in Table 6, indicated that the BPJ treatments were higher than unfortified or control cheese spread samples.

The higher micronutrients level of vitamins (A, K, E, D, B6 and C) in different BPJ cheese spread samples suggests that they were better sources of these vitamins. These increases in the micronutrients by increasing the addition of BPJ might be refer to interactive effect of BPJ to processed cheese spread analogue treatments. This result certain that when some nutrients from different foods are blended or fortified, the nutrients so produced would be preferable than any other food alone[37]. Also, in Table 6 it can be seen that there was a linear and significant increase in the nicotinic acid, thiamin, riboflavin and folic acid content in the different BPJ cheese spread samples with increasing portion of BPJ, which was obvious. The higher nicotinic acid, thiamin, riboflavin and folic acid content of BPJ cheese treatments suggest that they were fairly good source of the nutrients. However, the absence of nicotinic acid, thiamin, riboflavin and folic acid content in the unfortified or control processed cheese analogue is an indication of its poor source of the nutrients. In the same context, Mohamed *et al.*[14] reached that the nutrients content (vitamins) of fortified cheese with carrot paste was increased. However, bell different pepper fruits are famed to be an superb source of vitamin C. Data from other studies has shown that the concentration of this vitamin increases with fruit matures[38,39]. In this regard, Navarro *et al.*[40] established that the amount of vitamin C incremented from the unripe state of the fruit (green) to maturity (red) with a higher concentration in the transformation from green to red.

Changes of penterometer, meltability and oil separation in unfortified and fortified with different BPJ processed cheese spread: A firmness values, expressed in millimeter was prepared for the determination of processed cheese firmness. It has been generally considered as an important parameter for cheese quality and it is related inversely to the firmness of processed cheese. Meltability was expressed as the distance of processed cheese spread flow in millimeter. Also, no clear differences were found in penetrometer, meltability and oil separation reading between the unfortified or control PCS and those contained 20% of green, yellow and red BPJ. The penetrometer, meltability and oil separation values of all PCS fortification with green, yellow and red BPJ even in unfortified or control were closely constant tended to maintain cheese quality in spreads, as represented in Table 7.

Color parameters of fresh and PCS fortified with different BPJ: The Hunter color parameter (L*), (a*) and (b*) are widely used to characterize color changes during processing of cheese spread. However, it recommended using Hue angle and chroma as more practical measure of color. The color degradation of the PCS samples can also be expressed as a single numerical value ΔE. This value defines the volume of the total color differences. Preferred colors are those closest to the original color of fresh samples.

The results of color parameters (L, a, b, ΔE, Hue and chroma) for unfortified and fortified PCS with different BPJ samples are presented in Table 8. The results showed that,

Table 7: Changes of firmness (mm), meltability (mm) and oil separation (mm) in unfortified and fortified with different BPJ processed cheese spread

Samples	Firmness	Meltability	Oil separation
Control-PCS	34.8	98	25.66
Green BPJ-PCS	34.5	96	25.00
Yellow BPJ-PCS	34.3	95	25.00
Red BPJ-PCS	34.4	95	25.33

Table 8: Color characteristics of PCS fortified with green, yellow and red BPJ

Samples	L*	a*	b*	ΔE	OD_{420nm}	H*	C*	BI
Control-PCS	79.41	-2.56	22.78	25.88	24.02	83.59	22.92	29.85
Green BPJ-PCS	77.33	-0.84	27.51	29.48	27.82	88.25	27.52	41.82
Yellow BPJ-PCS	76.44	-1.06	29.78	34.41	26.51	87.96	29.80	45.15
Red BPJ-PCS	71.94	14.71	39.73	45.01	19.91	69.68	42.37	109.87

L*-values decreased, whereas, a* and b*-values increased for all the fortified cheese samples as compared to the control one. Hue, BI and chroma values followed the same pattern as a*-values. This could be due to the change in the values of both redness (a*-value) and yellowness (b*-value) as a result of the fortification with different BPJ. It was reported that chroma is the indicator of color saturation and intensity. The higher the values, the more desirable they are with the finding of McGuire[41]. There are slight differences in brightness, redness and yellowness values of all fortified cheese samples with different BPJ. Consequently, slight differences in ΔE values were observed. Nevertheless, this minute total color difference cannot be distinguished by the naked eye in some cases. These results were in a good agreement with the finding of Osuna-Garcia *et al.*[39], Howard *et al.*[38] and Navarro *et al.*[40]. In the light of the obtained results, it could conclude that all the fortified cheese samples revealed optimum color values.

Microbiological evaluation of unfortified and fortified with different BPJ processed cheese spread: The total bacterial, mold and yeast counts for unfortified and different BPJ fortified PCS samples were shown in Table 9. The data showed that the fortification caused a sharp decrease in the microbial load for all different BPJ fortified cheese spread samples as compared with the unfortified or control sample one.

The total bacterial count decreased from 2.83 log CFU g^{-1} for control cheese samples to 2.46, 1.94 and 1.84 log CFU g^{-1} for green, yellow and red BPJ fortified PCS samples. Unfortified cheese spread samples had also the highest mold and yeast count 2.76 log CFU g^{-1}, while all different BPJ fortified cheese samples had lower values 0.88-2.46 log CFU g^{-1}. This could be due to the high level of BPJ addition in fortified cheese spread samples which suppress the growth of microorganisms. Similar results were reported by Mohamed *et al.*[14].

The high contamination level could be attributed to the high natural micro flora of the components cheese as well as the general conditions during their processing, handling, storage, distribution and sales. However, it was reported that the microbial status of the components cheese is not so much caused be secondary contamination during processing, but it is primarily due to the fact that the raw materials have their own microbial flora[42].

Sensory evaluation of unfortified and fortified with different BPJ processed cheese spread: Sensory analysis indicated that scores for the different attributes were affected by the different green, yellow and red BPJ fortification for PCS samples, as shown in Table 10. Processed cheese color is one of the most parameter affected by the different green, yellow and red BPJ fortification. Compared to the color of control sample, the colour of PCS with yellow and green BPJ had higher judging score acceptable but without BPJ fortification (control) gained lower by the scoring persons. Processed cheese fortified with red BPJ gained relatively odor score like control sample. Overall, processed cheese fortification with red BPJ had gained acceptable organoleptic properties. Green and yellow BPJ fortified cheese samples had higher score color more than control and red BPJ fortified cheese sample led to reject by the scoring persons especially of processed cheese color. Also, no difference was found in texture between unfortified and fortified samples, as seen in Table 10. It can be observed that the processed cheese samples fortified with red BPJ gained the highest score for the taste, odour, acceptable and overall preference were generally better and preferable by the panelists. Statistical analysis indicated that the taste, odour and overall preference gained the highest score significantly ($p<0.05$) in PCS with red BPJ. Generally, the organoleptic properties of the red BPJ fortified cheese sample were the best as compared with the other green and yellow BPJ fortified cheese samples.

Table 9: Microbiological evaluation log (CFU g^{-1}) of PCS fortified with green, yellow and red BPJ

Samples	Total plate count	Yeast and mold count
Control-PCS	2.83±0.05	2.76±0.07
Green BPJ-PCS	2.46±0.03	2.46±0.05
Yellow BPJ-PCS	1.94±0.08	0.88±0.09
Red BPJ-PCS	1.84±0.06	1.94±0.02

Table 10: Sensory evaluation unfortified and fortified with different BPJ processed cheese spread

Samples	Taste	Odour	Colour	Texture	Acceptability	Overall
Control-PCS	7.8±1.3^{b*}	8.4±0.7^{a}	6.9±1.1^{d}	7.5±1.5^{c}	7.8±0.9^{b}	7.8±0.8^{b}
Green BPJ-PCS	7.2±0.9^{c}	6.7±0.8^{d}	8.1±1.2^{a}	7.5±1.5^{a}	7.4±1^{c}	7.5±1^{b}
Yellow BPJ-PCS	7.7±0.9^{b}	7.5±0.7^{b}	8.0±1^{b}	7.2±0.9^{c}	7.7±0.8^{b}	7.1±2.5^{c}
Red BPJ-PCS	8.0±1.3^{a}	8.4±0.7^{a}	7.3±1.3^{c}	7.5±1.6^{b}	7.9±1^{a}	7.9±0.9^{a}

*±STDEV = STDEV/n

CONCLUSION AND FUTURE RECOMMENDATIONS

The combination of different Bell Pepper Juice (BPJ) in PCS gives rise to quality products with functional and nutritional factors. Moreover, the use of different BPJ in processed cheese can be improving its antioxidant activity, many vitamins contents (A, K, E, D, B6, nicotinic acid, thiamin, riboflavin, folic acid and C), residual scavering activity and total phenols compounds compared with unfortified or control cheese, which is desirable ago there is a search for healthful foods. In the same time, the different BPJ fortified PCS which has all milk comments and different (green, yellow and red) BPJ and sugar taste was good choice for children than any other healthy foods.

It is commendation for industry new processed cheeses spreads using different green, yellow and red bell sweet pepper juices (ratio of 20%) to improve organoleptic, physical and functional properties and lead to process new cheese spreads as a nutritional fortification and functional food. In future, it can be applied these results at industrial scale.

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REFERENCES

1. Bayili, R.G., F. Abdoul-Latif, O.H. Kone, M. Diao, I.H.N. Bassole and M.H. Dicko, 2011. Phenolic compounds and antioxidant activities in some fruits and vegetables from Burkina Faso. Afr. J. Biotechnol., 10: 13543-13547.
2. Kaur, C. and H.C. Kapoor, 2001. Antioxidants in fruits and vegetables-the millennium's health. Int. J. Food Sci. Technol., 36: 703-725.
3. Blanco-Rios, A.K., L.A. Medina-Juarez, G.A. Gonzalez-Aguilar and N. Gamez-Meza, 2013. Antioxidant activity of the phenolic and oily fractions of different sweet bell peppers. J. Mex. Chem. Soc., 57: 137-143.
4. Shotorbani, N.Y., R. Jamei and R. Heidari, 2013. Antioxidant activities of two sweet pepper *Capsicum annuum* L. varieties phenolic extracts and the effects of thermal treatment. Avicenna J. Phytomedicine, 3: 25-34.
5. Deepa, N., C. Kaur, B. Singh and H.C. Kapoor, 2006. Antioxidant activity in some red sweet pepper cultivars. J. Food Compos. Anal., 19: 572-578.
6. Hasler, C.M., 1998. Functional foods: Their role in disease prevention and health promotion. Inst. Food Technol., 52: 63-70.
7. De Guevara, R.G.L., J.E. Pardo-Gonzalez, R. Varon-Castellanos and F. Navarro-Albaladejo, 1996. Evolution of color during the ripening of selected varieties of paprika pepper (*Capsicum annuum* L.). J. Agric. Food Chem., 44: 2049-2052.
8. Russo, V.M. and L.R. Howard, 2002. Carotenoids in pungent and non-pungent peppers at various developmental stages grown in the field and glasshouse. J. Sci. Food Agric., 82: 615-624.
9. Oboh, G. and J.B.T. Rocha, 2007. Distribution and antioxidant activity of polyphenols in ripe and unripe tree pepper (*Capsicum pubescens*). J. Food Biochem., 31: 456-473.
10. Kapoor, R. and L.E. Metzger, 2008. Process cheese: Scientific and technological aspects-A review. Comprehen. Rev. Food Sci. Food Saf., 7: 194-214.
11. 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.
12. Abd El-Razik, M.M. and A.G. Mohamed, 2013. Utilization of acid casein curd enriched with *Chlorella vulgaris* biomass as substitute of egg in mayonnaise production. World Applied Sci. J., 26: 917-925.
13. Mohamed, A.G. and S.M. Shalaby, 2016. Texture, chemical properties and sensory evaluation of a spreadable processed cheese analogue made with apricot pulp (*Prunus armeniaca* L.). Int. J. Dairy Sci., 11: 61-68.
14. Mohamed, A.G., S.M. Shalaby and W.A. Gafour, 2016. Quality characteristics and Acceptability of an Analogue processed spreadable cheese made with carrot paste (*Daucus carota* L.). Int. J. Dairy Sci., 11: 91-99.
15. Sapers, G.M. and F.W. Douglas Jr., 1987. Measurement of enzymatic browning at cut surfaces and in juice of raw apple and pear fruits. J. Food Sci., 52: 1258-1285.
16. Egyptian Standards, 2002. Processed cheese. Part II. Spreadable processed cheese. Egyptian Organization for Standardization and Quality Control, Egypt.
17. Meyer, A., 1973. Processed Cheese Manufacture. 1st Edn., Food Trade Press Ltd., London, UK., Pages: 329.
18. Chang, T.S., M. Siddiq, N.K. Sinha and J.N. Cash, 1995. Commercial pectinases and the yield and quality of Stanley plum juice. J. Food Process. Preserv., 19: 89-101.
19. Ling, E.R., 1963. A Textbook of Dairy Chemistry. Vol. 1-2, 3rd Edn., Chapman and Hall Ltd., London, pp: 58-65.
20. IDF., 1964. Determination of the Ash Content of Processed Cheese Products. International Dairy Federation, Brussels, Belgium, Pages: 2.
21. Barnett, A.J.G. and G. Abdel Tawab, 1957. A rapid method for the determination of lactose in milk and cheese. J. Sci. Food Agric., 8: 437-441.
22. Snell, F.D. and C.T. Snell, 1949. Colorimetric Methods of Analysis, Volume 2. 3rd Edn., Van Nostrand Company Inc., New York, USA.

23. Holden, T.F., N.C. Aceto, E.S. Dellamonica and M.J. Calhoun, 1966. Seasonal variation of phospholipids and their influence on the foaming characteristics of concentrated whole milk. J. Dairy Sci., 49: 346-350.
24. Thomas, M.A., 1973. The use of a hard milkfat fraction in processed cheese. Aust. J. Dairy Technol., 28: 77-80.
25. Olson, N.F. and W.V. Price, 1958. A melting test for pasteurized process cheese spreads. J. Dairy Sci., 41: 999-1000.
26. Savello, P.A., 1983. Meltability and rheology of model process cheese containing acid and rennet casein. Graduate Theses, Utah State University, Utah.
27. Hunter, R.S., 1975. Scales for Measurements of Color Difference. In: The Measurement of Appearance, Hunter, R. and R.W. Harold (Eds.). Wiley-Interscience, New York, pp: 162-192.
28. Palou, E., A. Lopez-Malo, G.V. Barbosa-Canovas, J. Welti-Chanes and B.G. Swanson, 1999. Polyphenoloxidase activity and color of blanched and high hydrostatic pressure treated banana puree. J. Food Sci., 64: 42-45.
29. FDA., 1998. Bacteriological Analytical Manual. 8th Edn., Association of Official Analytical Chemists, Gaithersburg, MD., USA.
30. Larmond, E., 1977. Laboratory Methods for Sensory Evaluation of Food. Research Branch, Canada Department of Agriculture, USA., ISBN: 9780662012719, Pages: 73.
31. Richard, J. and B. Gouri, 1987. Statistics: Principles and Methods. John Wiles and Sons, New York, pp: 403-427.
32. Choi, J., H.J. Kim, J.H. Kim, B.S. Chun, D.H. Ahn, G.H. Kim and J.W. Lee, 2010. Changes in colour and antioxidant activities of *Hizikia fusiformis* cooking drips by gamma irradiation. LWT-Food Sci. Technol., 43: 1074-1078.
33. Eissa, H.A., M.S. Shaheen and H.W. Botros, 2014. Impact of γ-irradiation on aroma flavour, bio-active constituents and quality attributes of water melon juice. J. Plant Pathol. Microbiol., Vol. 5. 10.4172/2157-7471.1000227
34. Fellers, P.J., R.D. Carter and G. de Jager, 1988. Influence of the ratio of degrees Brix to percent acid on consumer acceptance of processed modified grapefruit juice. J. Food Sci., 53: 513-515.
35. Khader, A., A. Hamed, A.F. Al-Khamy, G.A. El-Garawany and M.H. Abd El-Salam, 1997. Chemical composition and some properties of market processed cheese. Egypt. J. Dairy Sci., 25: 269-279.
36. Mahfouz, M.B., H.F. El-Dien, S. El-Shibiny, H.F. Maggag and M.N. Mahgoub, 1986. Chemical and microbiological quality of market processed cheese. Egypt. J. Dairy Sci., 14: 33-41.
37. Egbekun, M.K., P.C. Isolokeu and P.I. Akubor, 2004. Chemical and Sensory properties corn cassavasoybean flour blends for the production of Ojeaku-A Nigeria traditional food. Book of Abstracts, Nutrition Society of Nigeria, pp: 9.
38. Howard, L.R., R.T. Smith, A.B. Wagner, B. Villalon and E.E. Burns, 1994. Provitamin A and ascorbic acid content of fresh pepper cultivars (*Capsicum annuum*) and processed jalapenos. J. Food Sci., 59: 362-365.
39. Osuna-Garcia, J.A., M.W. Wall and C.A. Waddell, 1998. Endogenous levels of tocopherols and ascorbic acid during fruit ripening of new mexican-type chile (*Capsicum annuum* L.) cultivars. J. Agric. Food Chem., 46: 5093-5096.
40. Navarro, J.M., P. Flores, C. Garrido and V. Martinez, 2006. Changes in the contents of antioxidant compounds in pepper fruits at different ripening stages, as affected by salinity. Food Chem., 96: 66-73.
41. McGuire, R.G., 1992. Reporting of objective color measurements. HortScience, 27: 1254-1255.
42. Abou-Donia, S.A., 2008. Origin, history and manufacturing process of Egyptian dairy products: An overview. Alex. J. Food Sci. Technol., 5: 51-62.