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RESEARCH ARTICLE

PREPARATION OF FUNCTIONAL AND NUTRITIONAL SPREADABLE PROCESSED CHEESE FORTIFIED WITH VEGETABLES AND MUSHROOM

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ABSTRACT

Background: Recently there is growing interest in preparing healthy foods with high nutritional values and in the same time safe. Therefore, strengthening cheese with vegetables, fruits and mushrooms can be considering a good attempt to apply this interest.

Objectives: The aims of this study were to evaluate the nutritional characteristics and sensory properties of processed cheese incorporated with mixture consists of nine different vegetables and mushroom.

Materials and Methods: Fortified spreadable processed cheeses were prepared by adding 2.5, 5, 7.5 and 10% (w/w)of the mixture of nine types of vegetables (Pumpkin, Parsley, Dill, Celery, Leek, Potato, Carrots, Beans, Pea), and mushroom during the manufacture of cheese.

Results: Fortified cheeses were higher in dry matter, protein, fiber and carbohydrates than control. The fortified cheeses have more unsaturated fatty acids, amino acids, vitamins and minerals with lower sodium potassium ratio than the unfortified cheese. The panelists liked the cheeses fortified with 5 and 7.5 % more than the other added ratios.

Conclusion: Preparing processed cheese spreads with vegetables and mushroom submits healthy and functional products with high nutritional values, and also has high sensory characteristics suitable for different age groups.

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INTRODUCTION

The mounting demand for high-value health dairy products has promote the industries, and therefore the research field, to prepare formulations and emerging dairy food processes able to confirmed functional, wholesome and also safe products (Ehsannia and Sanjabi, 2016). Processed cheese is manufactured by mixing natural cheeses with different degrees of maturity and other dairy and nondairy ingredients in the presence of emulsifying salts associate by heating and mixing to make a homogeneous form with a prolonged shelf life. Non-dairy ingredients perform a big growth potential for the dairy products industry, and may be great researched through the development of novel products and processes. Numerous nondairy ingredients have been used such as mushrooms, vegetables, wheat fiber, egg protein, meat, fruit juices and/or pulp, nuts and oats (Rafiq and Ghosh, 2017a). Encouraging boost in vegetable consumption is one the top standing health advancement policies.

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Also, considerable attention is driven to the behavior of children's eating and how to lead it in a healthy direction. Vegetables contain a huge number of phytonutrients, minerals, dietary fiber and vitamins (Pan *et al.,* 2018). Mushrooms a stunning natural food supplements, they are wealthy source for very high quality proteins and essential amino acids; a gorgeous source of pro-vitamin D and most of B vitamins. Essential unsaturated fatty acids represent 72% of the total fatty acids; which Linoleic acid is a considerable factor in concerning mushroom as a healthy food (Khider *et al.,* 2017). Phenolic and polysaccharide compounds in mushroom possess antioxidants activity, and reducing oxidative damage effects in human due to their high free radical scavenging property (Birhanu *et al.,* 2018). Pumpkin consider a fruity-vegetable and used for its seeds, marrow, leaves or pulp and it is a good source of vitamins, potassium, carotenoids, and also contains high quantity of fibers (Kassem *et al.,* 2017). Pharmacological studies on Cucurbita pepo show that is used in curing many diseases, e.g., as an analgesic for urinary disorders, anti-inflammatory, antioxidant and wound healing (Martha and Gutierrez, 2016). Parsley is used in Egypt folk medicine. It is a very rich source of β-carotene vitamins B, E and C, thiamin, flavonoids, organic minerals and phenols, and useful as a laxative and diuretic. The flavonoids in parsley are function as antioxidant components that bind with high reactive oxygen types and helping stop and prevention of oxygen-based damage of cells (Wahba *et al.,* 2010).The fresh and dried Parsley is highly used as flavoring herb in different foods due to its potent aromatic odor (El-Taweel *et al.,* 2017). Dill is using in gastrointestinal problems from long time, as a stomachic, antispasmodic and carminative. Also pharmacological properties have been mentioned, such as strong antioxidant antimicrobial and antihyper cholesterolaemic activities, (Wahba *et al.,* 2010). Celery is using as medicinal food for long history. It is atonic aromatic bitter herb that relieves indigestion, reduces blood pressure, anti-inflammatory and stimulates the uterus.

The herb, root and ripe seeds are diuretic, carminative, stimulant and used in treating kidney complaints and rheumatism (Qureshi *et al.,* 2014). Leeks the highest commercially vegetable produced in the world. Fresh leek is a good source of flavonoids, nitrates, glucosinolates and polysaccharides; in addition to many organosulfur compounds contributing to its rich flavor. Laboratory and epidemiological studies have suggested that Allium possess tumor-inhibitory properties according to its high content of organosulfur components and other bio phenol compounds. These bioactive compounds also have antioxidant, antifungal and inhibitory activity for arteriosclerosis (Abd El-Rehem and Ali, 2013). Potato is a nutritious food that is a rich source for high quality protein and energy and the main nutrient in potato is the storage polysaccharide starch. Potato provided vitamins and important phytochemicals such as polyphenols, ascorbic acid, β-carotene, tocopherol, selenium, dietary fiber and α-lipoic acid, which consider supporting forgood life (Visvanathan *et al.,* 2016). Carrots have bactericidal, diuretic, hematopoietic, anti-sclerotic, anti-inflammatory, analgesic, and laxative effects; so it is used in several cases of visual disturbances, scurvy, loss of strength, rheumatism, anemia and cardiovascular diseases. Currently, increasing the consumption of carrot products is steadily due to the understanding the anticancer and antioxidant activities of β-carotene in carrot (Mohamed *et al.,* 2016).

Beans is nutritional food fit all human ages which summit dietary demands for growing in different age stages. Beans are providing resistant starch, B vitamins, fiber, magnesium and potassium. Studies show that beans manage blood sugar, help in lower blood cholesterol, and their carbohydrates produce a relatively simple blood-glucose response and display a low glycemic index (Winham *et al.,* 2008).The health advantages of pea derive from concentration of protein, phytochemicals, vitamins, starch and minerals. Fibers from the cell walls and seed coat give their gastrointestinal health and function. Peptides in Pea protein have bioactivities, included antioxidant and angiotensin I-converting enzyme inhibitor activity. The minerals and vitaminsin peas prevent from deficiency-attached diseases. Polyphenols in peas have anticarcinogenic and antioxidant activity, while oligosaccharides provide prebiotic beneficial effects in large intestine (Dahl *et al.,* 2012). Food fortification processes have been used commonly as a way to controlling micronutrients deficiency. Fortification of processed cheese is becoming one of the processes of guidance the deficiency of micronutrients in the world; by the addition of nutritional products such as vegetables and fruits with high levels (ILSI/FAO, 1997). In light of previous considerations, it can be prepare a fascinating processed cheese fortified with selected vegetables and mushroom; supplemental nutritional value, adorable natural color features and healthier cheese compared to the traditional products. On the other hand, it is necessary to know the right levels of which they should be added to keep the quality of resulted cheese. Therefore the aims of this study were to evaluate the nutritional characteristics and sensory properties of processed cheese incorporated with mixture consists of nine different vegetables and mushroom.

MATERIALS AND METHODS

Materials

Mushroom, vegetables, Ras cheese and Cheddar cheese were purchased from local market, Cairo, Egypt.Unsalted butter and skimmed milk powder were obtained from Dina farm, Sadat city, Egypt. The emulsifying salts (Commercial JOHA) were gettingfrom BK-Ladenburg corp., Gmbh, Germany.

Methods

Preparation of mushroom and vegetables: All selected vegetables and mushroom were cleaned, washed then prepared as following:

Fresh edible mushroom (*Pleurotus ostreatus* HK35)was prepared the method described bySoliman *et al.,* (2017), before using halved vertically through the stem with a knife and then blanched in 0.1% solution of Sodium chloride (NaCl) at 100ºC for 2 min. Pumpkin (*Cucurbita pepo)*paste was prepared according to Kassem *et al.,* (2017). After removed the outer skin of pumpkin,cut into small cube pieces and blanched in adequate amount of boiling water for 2 min., then ground in a kitchen mixer at 8000 rpm for 10 min until get a smooth orange pumpkin paste andfrozen until used. Parsley (*Petroselinumcrispum)*and Dill (*Anethumgraveolens L.)* were used in form of fresh leaves as mentioned by Josipović *et al.,* (2015). Also favorite form for celery *(Apiumgarveolens L)* was small pieces of fresh leaves as reported byFoda *et al.,* (2008).Green beans (*Phaseolus vulgaris L.)* and leek (*Allium ampeloprasum var. kurrat*) was prepared as reported by Turkmen *et al.* (2006). Each one of them was boiled in water in a stainless steel pan then cooked for 5 min; after that was drained off and rapidly cooled. Potatoes (*Solanumtuberosum*)were husked and cut into small cubes and blanched in boiled water at 100°C for 2 min. as described by Soliman *et al.,* (2017). The paste of carrot (*Daucus carota L.)*was prepared according to the method described by Mohamed *et al.,* (2016). Cleaning carrots were cut into round thin slices and blanched in boiling water (100°C) for 2 min.; then grounded in a kitchen aid mixer at 8000 rpm for 10 min until be a smooth paste.Thecleaning seedsof green peas(*Pisum sativum L.)* were blanched in boiled water at 100ºC for 5 min.,as described by Soliman *et al.,* (2017). The fortified mixture of previous vegetables and mushroom was prepared by adding 10 grams of each one, then mixed well to make one mixture then used in the fortification of processed cheese during manufacture by 2.5, 5, 7.5 and 10 % w/w.

The process of preparation of fortified spreadable processed cheese (FSPC) with mushroom and vegetables:

The composition of used raw materials is presented in Table 1, and the compositions of various blends of (FPCS) are shown in Table2.All blends were adjusted to attain final products as nearly as possible, with 55 ± 1 % moisture and 50 ± 1% fat in dry matter to similar to the spreadable processed cheese traditionally manufactured according to the Egyptian Standards (1988). The processed cheese was manufactured according to the method described by Khider *et al.,* (2017). Matured Cheddar and young Ras cheeses were grated and mixed with low skim milk powder, butter, emulsifying salt (2.5%) and water into the processing batch type kettle of 10 kg capacities, a pilot machine at the National Research Centrethen cooked at 85°-90°C for 8 min.; using direct injection steam at pressure of 1.5 bar through controlled continued agitation. In case of fortified treatments; mushroom and vegetables mixture was added during cooking process. Thereafter, all samples cooled to 60°C and manually placed into sterilized glass jar which covered after that with aluminum foil and their covers then stored at 7°± 1°C. Three replicates for each treatment were prepared and analyzed after one day of manufacturing.

The treatments of fortified processed cheese spreads were as follow:

T1:cheese with 2.5% Vegetables and mushroom mixture.
T2:cheese with 5% Vegetables and mushroom mixture.
T3:cheese with 7.5% Vegetables and mushroom mixture.
T4:cheese with 10% Vegetables and mushroom mixture.

Chemical analyses

Fortified processed cheese spreads were analyzed for protein, total solids, fiber, fat and ash according to analysis methods of AOAC (2012). Salts content were determined as reported by Bradley *et al.,* (1993). By differences Total carbohydrates were calculated as described by James (1995).The pH values were measured during storage period by a digital laboratory pH meter (HI 93 1400, Hanna instruments) with combined glass electrode.

Nutritional features

Fatty acidsprofile was determined using gas chromatography(GC Hewlett Packard 6890) according to the methods described by AOAC (2006). For amino acid profile, the analysis was carried out as described by AOAC (2006) using Eppendorf-Biotronic LC 3000amino acid analyzer (Eppendorf-Biotronic, Hamburg, Germany). Fat-soluble vitamins (vitamin E and vitamin A (all-trans-retinol)); and water-soluble vitamins (C, B_1, B_2, B_6 and Niacin) in fortified processed cheese samples were determined using HPLC analysis method as reported byLucas *et al.,* (2006). The minerals were determined by atomic absorption spectrophotometry (Varian Model Spectra AA 100 & 200) (AOAC, 2006).

Antioxidant amplitude: The antioxidant amplitude as Free Radical Scavenging Activity (RSA %)was detect by the procedure of Brand-Williams *et al.,* (1995)and expressed by inhibition of the DPPH radical percentage through this equation:

$$RSA\ \% = (Abs_{control} - Abs_{sample}) \times 100 / Abs_{control}$$

Sensory analysis: Fresh fortified processed cheese samples at room temperature (25°±2°C)were organoleptically testedas described by Clark*et al.,* (2009), by ten members of the staff at the Food Science Department, National Research Centre. The score card was consisted of cheese flavor (50 points), body and texture (40 points), color and appearance (10 points) that all show total score of (100 points).

Statistical test

According to SAS program (SAS, 2001) and by one way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test with p≤0.05 being considered statistically significant.

RESULTS AND DISCUSSION

The chemical features of fortified spreadable processed cheese samples (FSPCs): The gross compositions and pH values of processed cheese fortified with mixture of vegetables and mushroom were explained in Table (3).There were increasing in total solids, protein, ash, carbohydrates and fiber contents for all fortified processed cheese samples than the control sample. These increases were only significant(P≤0.05) in the highest ratio of fortification (7.5 and 10 %), that for total solids, protein, carbohydrates and fiber, but it was insignificant for ash in all samples. on contrary of these finding, the content of fat (F/DM) was significantly decreasing in the fortified treatments than the control one; also the content of salt was decreasing but insignificantly for all treatments. It can be noticed that all FSPCsamples show high total solids content comparing to control, that may related to the mixture of vegetables and mushroom that decrease the moisture in resultant cheeses and in the same time this adding increase protein, ash, fiber and carbohydrates contents. Increasing of protein content in fortified samples may be due to high content of this component in bean, pea, pumpkin, mushroom and different vegetables which presented in the fortification mixture. This interpretation also applies to ash, fiber and carbohydrates.

The obtained results for chemical composition of FSPC treatments were in agreement with El-Taweel *et al.,* (2017) who reported that supplemented Kariesh cheese by parsley has low fat and high protein content than control. Also, Awad *et al.,* (2012) mentioned that addition of other materials such as vegetables and fruits to the base blend of processed decreased the salt content in the resultant samples. The same results for decreasing fat and increasing carbohydrates content in processed cheese incorporated with Potato paste; were obtained by Rafiq and Ghosh, (2017a). Khider *et al.,* (2017) also reported that the addition of dried mushroom increased both of protein and ash contents in resulted processed cheese. The pH values of FSPC were shown in Table (3); there was a significant increasing (P≤ 0.05) in pH values only in the highest ratio of adding of mixture (7.5 and 10%); this may be due to the high pH values of vegetables and mushroom mixture. This finding was in agreement with Khider *et al.,* (2017)who mentioned that the pH values of processed cheese supplemented with dried mushroom were increased by increasing the level of mushroom. Awad *et al.,* (2012), alsofound that supplementing with broccoli paste resulted higher pH values in soft cheese treatments than control. On the same line, Rafiq and Ghosh, (2017b) mentioned that the pH values increased in processed cheese by increasing the ratio of peanut.

Table 1. The Chemical composition (%) of used ingredients in the manufacture of fortified spreadable processed cheese

Ingredient	Total solids	Fat	Protein	Ash	Salt	Fiber	Total carbohydrates
Cheddar cheese	66.88	34.5	25.52[1]	5.33	1.51	Nd	Nd
Ras cheese	54.8	24.14	22.16[1]	4.92	2.07	Nd	1.50
Butter	84.0	82.0	Nd[2]	Nd	Nd	Nd	Nd
Skim milk powder	95.0	1.19	37.65[1]	8.45	Nd	Nd	47.67
Vegetables and mushroom mixture	96.0	4.61	23.00[3]	10.7	Nd	26.61	31.07

[1]Protein % = N × 6.38; [2]Not determined.[3]Protein % = N × 4.38

Table 2.The compositions of various blends used in the manufacture of fortified spreadable processed cheese

Ingredient	Control	T1	T2	T3	T4
Cheddar cheese	12.80	12.80	12.80	12.80	12.80
Ras cheese	38.44	38.44	38.44	38.44	38.44
Butter	10.26	10.26	10.26	10.26	10.26
Skim milk powder	5.12	5.12	5.12	5.12	5.12
Emulsifying salts	2.5	2.5	2.5	2.5	2.5
Vegetables mixture	-	2.50	5.0	7.5	10.0
Water	30.88	28.38	25.88	23.38	20.88
Total	100	100	100	100	100

T1: cheese with 2.5% Vegetables and mushroom mixture. T2: cheese with 5% Vegetables and mushroom mixture.
T3: cheese with 7.5% Vegetables and mushroom mixture. T4: cheese with 10% Vegetables and mushroom mixture.

Table 3.pH values and chemical composition (%) of fortified spreadable processed cheese samples

Treatments	Total solids (T.S)	Fat / dry matter (F/DM)	Protein	Salt	Ash	Carbohydrates	Fiber	pH
Control	44.64^{d}	50.91^{a}	12.74^{b}	1.67^{a}	4.01^{a}	3.49^{b}	Nd	5.73^{c}
T1	46.82^{cd}	43.27^{b}	13.52^{ab}	1.65^{a}	5.06^{a}	4.92^{ab}	1.41^{b}	5.78^{bc}
T2	49.15^{bc}	42.69^{b}	14.32^{ab}	1.52^{a}	5.10^{a}	5.26^{a}	1.97^{ab}	5.85^{ab}
T3	51.11^{ab}	42.12^{b}	15.15^{a}	1.52^{a}	5.15^{a}	5.47^{a}	2.29^{a}	5.87^{ab}
T4	52.76^{a}	41.76^{b}	15.63^{a}	1.48^{a}	5.19^{a}	5.72^{a}	2.71^{a}	5.91^{a}

T1: cheese with 2.5% Vegetables and mushroom mixture. T2: cheese with 5% Vegetables and mushroom mixture.
T3: cheese with 7.5% Vegetables and mushroom mixture. T4: cheese with 10% Vegetables and mushroom mixture.
Means with unlike superscripts in the same column were differ significantly ($p \leq 0.05$) (n = 3)

Table 4. Fatty acids profile for fortified spreadable processed cheese samples

Fatty acid (mg/ 100 g fat)	Control	T1	T2	T3	T4
Butyric acid (C4:0)	739^{a}	736^{a}	731^{a}	727^{a}	724^{a}
Caproic acid (C6:0)	1223^{a}	1212^{a}	1207^{a}	1204^{a}	1200^{a}
Caprylic acid (C8:0)	958^{a}	953^{a}	949^{a}	945^{a}	936^{a}
Capric acid (C10:0)	1369^{a}	1363^{a}	1358^{a}	1350^{a}	1341^{a}
Lauric acid (C12:0)	730^{a}	730^{a}	732^{a}	736^{a}	742^{a}
Myristic acid (C14:0)	2228^{a}	2103^{b}	1982^{c}	1884^{c}	1756^{d}
Myristoleic acid (C14:1)	327^{a}	291^{ab}	280^{ab}	267^{b}	241^{b}
Palmitic acid (C16:0)	6345^{d}	6627^{c}	6872^{b}	7125^{a}	7313^{a}
Palmitoleic acid (C16:1)	476^{a}	491^{a}	509^{a}	523^{a}	534^{a}
Stearic acid (C18:0)	2013^{b}	2031^{b}	2071^{ab}	2110^{ab}	2133^{a}
Oleic acid (C18:1)	4807^{b}	4848^{b}	4871^{ab}	4932^{ab}	4971^{a}
Linoleic acid (C18:2)	574^{e}	837^{d}	1241^{c}	1522^{b}	1784^{a}
α-linolenic acid (C18:3)	173^{e}	307^{d}	491^{c}	667^{b}	868^{a}

T1: cheese with 2.5% Vegetables and mushroom mixture. T2: cheese with 5% Vegetables and mushroom mixture.
T3: cheese with 7.5% Vegetables and mushroom mixture. T4: cheese with 10% Vegetables and mushroom mixture.
Means with unlike superscripts in the same column were differ significantly ($p \leq 0.05$) (n = 3)

The nutritional value of FSPCs

Fatty acids profile of FSPCs: Fatty acids have an important role in the human life and nutrition, especially unsaturated fatty acids, which have a potent beneficial role in the management and prevention of blood pressure, triglyceride level and cardiovascular diseases. On the other hand, saturated fatty acids which are existing in big quantity in foods that of animal origin are linked with the increasing levels of triglycerides in the blood so are related to hypertension etc., (Rafiq and Ghosh 2017b). Fatty acids profile of FSPC is shown in Table 4. It can be seen that saturated fatty acids with short chain (butyric, caprylic and capricacids) were insignificantly decreased in fortified cheese samples than the control. Both of myristic and myristoleic acids were also decreased in fortified cheeses but significantly decreasing than control sample. Conversely, each of the following acidspalmitic, stearic, oleic, linoleic and α-linolenic increased significantly in processed cheese fortified with vegetables and mushroom; and that increasing of fortification ratio increasing the content of the previous fatty acids. The obtained results explained that the addition of vegetables and mushroom mixture to spreadable processed cheese reduced the content of saturated fatty acids, but polyunsaturated fatty acids increased linearly with increasing fortification ratio of mixture. It can be seen that unsaturated fatty acids showed significantly higher ($p \leq 0.05$) levels of oleic, linoleic and α-linolenic acids than the control sample. This may be due to the high level of unsaturated fatty acids in mushroom and leafy vegetables, which confirmed that vegetables and mushroom can be an interesting source of essential unsaturated fatty acids. The gained results for fatty acid profile were in agreement with Rafiq and Ghosh. (2017b) who reported that the supplemented processed cheese with peanut increased significantly the levels of oleic, linoleic and α-linolenic compared to the control. On the same line, Petrović *et al.,* (2015) found that the unsaturated fatty acids were higher and the saturated fatty acids were lower in the soft cheese enhanced with mushroom.

Amino acids content of FSPCs: Amino acids (AA) are main unit in the formation of protein, andnutritionally classified to nonessential AA (NEAA) andessential amino acids (EAA). NEAA can be synthesized enough in the body as substrates need for protein synthesis, but EAA cannot synthesize in the body, so it is necessary taken from diet. Some amino acids are synthesized in the body but insufficient amount, and this type of amino acids were called semi-essential amino (such as histidine and arginine). Both of EAA and NEAA should be believed in the conventional "ideal protein" formulation of balanced diets to maximize protein development and enhanced health in humans (Guoyao, 2010).The amino acid content of FSPC is summarized in Table (5); data show that there was a significant difference between amino acid content of fortified cheeses and the control sample. Some of EAA were increased significantly by the fortification process of processed cheese; these amino acids are leucine, histidine, threonine and tryptophan. On the other hand, some of these essential EAA were decreased significantly but in the highest ratio of fortification, included isoleucine, lysine, methionine, phenylalanine and valine. The same manner was observed for NEAA, some of it was significantly increased such as arginine, cysteine, alanine, aspartic and tyrosine; the rest NEAA (glutamic, glycine, proline and serine) were decreased significantly ($p \leq 0.05$). From these obtained profile of amino acids, it can be concluded that the enhancement of cheese with different types of vegetables beside mushroom can producing almost complete product with essential and non-essential amino acids needed for all human ages. Some of previous results were in agreement with that obtained by Khider *et al.,* (2017) who found that both of leucine, histidine, arginine, cysteine, alanine and tyrosine were increased in the supplemented processed cheese with dried mushroom.

Table 5. Amino acids content (mg/100 g) for fortified spreadable processed cheese

Amino acid	Control	T1	T2	T3	T4
Essential amino acids					
Isoleucine	735[a]	690[ab]	663[ab]	610[ab]	545[b]
Leucine	1295[d]	1480[c]	1701[b]	1920[a]	1985[a]
Lysine	1067[a]	1022[ab]	996[ab]	959[b]	928[b]
Methionine	384[a]	345[ab]	281[b]	256[b]	231[b]
Histidine	391[c]	445[bc]	508[b]	567[ab]	629[a]
Phenylalanine	735[a]	621[b]	546[b]	458[c]	295[d]
Threonine	469[d]	670[c]	853[b]	1048[a]	1137[a]
Tryptophan	186[b]	208[ab]	224[ab]	246[a]	263[a]
Valine	905[a]	842[a]	735[b]	662[bc]	605[c]
Non-Essential amino acids					
Arginine	431[d]	630[c]	802[b]	1005[a]	1007[a]
Cysteine	46[b]	70[ab]	92[ab]	111[a]	128[a]
Alanine	430[e]	660[d]	879[c]	1110[b]	1240[a]
Aspartic	962[d]	1134[c]	1302[b]	1517[a]	1603[a]
Glutamic	2660[a]	2430[b]	2227[c]	2051[d]	1830[e]
Glycine	277[a]	250[ab]	228[ab]	197[ab]	169[b]
Proline	1415[e]	1580[d]	1703[c]	1856[b]	2004[a]
Serine	792[c]	734[bc]	653[b]	576[ab]	521[a]
Tyrosine	735[e]	890[d]	1028[c]	1185[b]	1301[a]

T1: cheese with 2.5% Vegetables and mushroom mixture.
T2: cheese with 5% Vegetables and mushroom mixture.
T3: cheese with 7.5% Vegetables and mushroom mixture.
T4: cheese with 10% Vegetables and mushroom mixture.
Means with unlike superscripts in the same row were differ significantly ($p \leq 0.05$) (n = 3)

Vitamins content of FSPCs

Vitamins are vital natural nutrients that have essential biochemical activities in human body and required in convenient amounts in the daily diet to prevent from many odious health problems. Researchers reported that intake of vitamins were increased since last decade according to their vital role in the raise of main immunity of human body (Aslam *et al.,* 2017).Table (6) included some of fat-soluble and water soluble vitamins of FSPC. Fat Soluble Vitamins (A, E) are absorbed and transported by intake fat, the excess of these vitamins are stored in the liver and the body depends on stored vitamins when needed. Vitamin A has big role in eye sight enhancement, formation of blood cells, improves immunity and growth; The main sources of this vitamin are carrots, green leafy vegetables, dairy products, potatoes and Pumpkin. The content of this vitamin in fortified samples was significantly ($p \leq 0.05$) higher than the control cheese. This may be due to the presences of many sources for it in the fortification mixture. Vitamin E or α-tocopherol is well known its role in the formation of blood vessels, preserving immune and effective antioxidant; the main sources of vitamin E are dairy products, fortified cereals, vegetable oils and peanuts. The content of this vitamin is decreased by fortification process of processed cheese but insignificantly way. Water-soluble vitamins (vitamin B complex and vitamin C) are not of natural stored in high amounts in the human body, which makes them needed supplying daily. Vitamin C boosts up human immunity towards infections and cold illnesses, stimulates iron absorption, acting as antioxidants and also a potent anti-inflammatory agent; the main sources of vitamin C are fruits and green vegetables. As shown in Table (7) the content of vitamin C was significantly higher in FSPC than the control cheese, this may be due to that dairy product are poor source of vitamin C, but vegetables are consider rich source for it. Vitamin B complex was historically assumed as single vitamin but subsequent it was found that it consists of many components that can be divided into different categories based on their functional role. Vitamin B complexes are consider good antioxidant factors and used to enhance the defensive function for better health. As seen in Table (7), cheeses enhanced with mushroom and vegetables mixture showed significantly higher vitaminB1, B2, B3 and B6 contents than the control cheese. The results of vitamins confirmed that the fortification of cheese with vegetables and mushroom completed the deficiency contents of these vitamins in the cheese to make it very useful for daily intake for needed vitamins. These results were in the same line with that obtained by Awad *et al.,* (2012) and El-Taweel *et al.,* (2017).

Mineral content of FSPCs

Minerals havean important role in various biological functions in human body, such as controlling diabetes, enhancement of immunity, physical growth digestion and appetite. Benefits of minerals also areregulation of body temperature, transmission of nerve impulses, production of energy; it is also important for proteins of muscle, the formation of healthy teeth and bones (El-Taweel *et al.,* 2017). Minerals content of FSPCare given in Table (7). The minerals content of the treatment samples were significantly different than the control for the entire tested mineral. The fortified samples have significant ($P \leq 0.05$) higher level of potassium, magnesium, zinc and iron than control; this may be due to high minerals content in the added mixture of vegetables and mushroom.

Table 6. Vitamins contents of fortified spreadable processed cheese samples

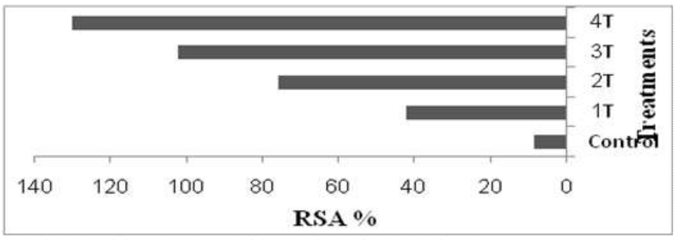
Vitamins	Control	T1	T2	T3	T4
Vitamin A (µg/100 g fat)	1230^{d}	1292^{c}	1404^{b}	1456^{a}	1488^{a}
Vitamin E (µg/100 g fat)	277^{a}	271^{a}	270^{a}	266^{a}	261^{a}
Vitamin Cascorbic acid (mg/100 g)	1.24^{e}	3.51^{d}	5.73^{c}	7.21^{b}	10.50^{a}
Vitamin B1Thiamin (mg/100 g)	1.10^{e}	2.26^{d}	3.48^{c}	5.07^{b}	6.54^{a}
Vitamin B2Riboflavin (mg/100 g)	0.86^{d}	1.73^{cd}	2.52^{c}	4.22^{b}	6.12^{a}
Vitamin B6 (mg/100 g)	0.7^{c}	1.39^{c}	3.32^{b}	3.95^{b}	5.17^{a}
Niacin B3 (mg/100 g)	0.9^{d}	1.22^{d}	3.48^{c}	6.72^{b}	8.08^{a}

T1: cheese with 2.5% Vegetables and mushroom mixture.
T2: cheese with 5% Vegetables and mushroom mixture.
T3: cheese with 7.5% Vegetables and mushroom mixture.
T4: cheese with 10% Vegetables and mushroom mixture.
Means with unlike superscripts in the same row were differ significantly ($p \leq 0.05$) (n = 3)

Table 7. Minerals content (mg/100g) of fortified spreadable processed cheese samples

Mineral	Control	T1	T2	T3	T4
Potassium	72.2^{e}	99.5^{d}	127.7^{c}	154.3^{b}	189.6^{a}
Sodium	512.3^{a}	490.1^{b}	456.4^{c}	427.2^{d}	389.3^{e}
Na/K ratio	7.09^{a}	4.93^{ab}	3.57^{bc}	2.77^{c}	2.05^{c}
Calcium	526.3^{a}	490.1^{b}	450.3^{c}	411.7^{d}	375.3^{e}
Phosphorous	500.6^{a}	441.3^{b}	391.8^{c}	350.7^{d}	310.4^{e}
Magnesium	19.4^{b}	21.2^{b}	23.0^{ab}	24.2^{ab}	26.6^{a}
Manganese	0.357^{d}	0.981^{c}	1.213^{c}	2.151^{b}	3.083^{a}
Zinc	0.184^{a}	0.167^{a}	0.141^{ab}	0.117^{b}	0.101^{b}
Iron	0.116^{c}	0.148^{bc}	0.183^{b}	0.217^{ab}	0.256^{a}

T1: cheese with 2.5% Vegetables and mushroom mixture.
T2: cheese with 5% Vegetables and mushroom mixture.
T3: cheese with 7.5% Vegetables and mushroom mixture.
T4: cheese with 10% Vegetables and mushroom mixture.
Means with unlike superscripts in the same row were differ significantly ($p \leq 0.05$) (n = 3)



T1: cheese with 2.5% Vegetables and mushroom mixture.
T2: cheese with 5% Vegetables and mushroom mixture.
T3: cheese with 7.5% Vegetables and mushroom mixture.
T4: cheese with 10% Vegetables and mushroom mixture.

Fig. 1. Antioxidant efficacy (RSA %) of fortified spreadable processed cheese

However, all these elements were increased with increasing ratio of fortification in processed cheese. On the other hand, the significant highest mean values of sodium, calcium and phosphorous were observed in the control cheese. Also, it could be noticed that fortification with mushroom and vegetables increased K content of processed cheese; consequently Na / K ratio was decreased. As long this ratio is decreasing, the resultant cheese become healthier; because the strong relation between sodium and potassium contents with high blood pressure in human. The role of potassium in reduced high blood pressure is well-documented. Potassium reducing both of diastolic and systolic blood pressure; also decreases risk factors of heart diseases. The hypertension is decreased by increasing potassium and decreasing the ratio of sodium to potassium (IFICF, 2011). The results of minerals content assured that the fortification of processed cheese with vegetables and mushroom achieved many goals, one on it increasing the content of iron than the normal cheese and the second decreasing the sodium to potassium ratio. Thence gain healthy cheese product for adults and children. These results were in agreement with that introduced by Awad *et al.,* (2012) who found the enhancement of cheese with broccoli increased the content of potassium, magnesium, zinc and iron contents in resultant cheese, while the calcium content was lowerthan control cheese. By different way, El-Taweel *et al.,* (2017) mentioned that the addition of parsley to cheese increased potassium, magnesium, zinc and iron; also calcium content was increased than the control.

Antioxidant efficacy of FSPCs

There is certainly a link between eating vegetables and fruits; and preventing from diseases according to high contents of natural antioxidants in vegetables and fruits. Cheese products also have antioxidant properties so considered a good choice for the growing of its natural antioxidants by fortification by many of vegetables and mushroom. Figure 1 revealed that, fortified cheese treatments have RSA values significantly ($p \leq 0.05$)higher than control, and these values increased by increasing the ratio of fortification mixture. The obvious antioxidant activity could be as a consequence of the high content of several antioxidant components in vegetables and mushroom. The obtained results were in the same line with Mohamed *et al.,* (2016); Kassem *et al.,* (2017) and El-Taweel *et al.,* (2017).

Sensorial evaluation of FSPCs

Preparatory experiments were carried out to define the best ratios for the fortification by mushroom and vegetables mixture. The results displayed that the fortification by more than 10 % was unacceptable for flavor and texture as processed cheese product. Organoleptic properties are important indicator for possibility consumer preferences, so the sensory evaluation of FSPC is shown in Table (8). The results appeared that, panelists liked processed cheese enriched with vegetables mixture more than control cheese. The fortification by 5% was the highest scores in all the tested characteristics, but it was insignificantly than the other added ratios. The results confirmed that the fortified cheeses by 5% and 7.5% ratios were the best treatments flowed by 2.5 and 10%.Overall acceptance scores of fortified cheese were graded higher and were more agreeable to most of panelists in compared to control cheese. This pilot experiment can be decide how the addition of vegetables and mushroom mixture boost up the flavor, texture and overall nutritional values of processed cheeses; which confirmed that these products will be highly acceptable for the consumers. These previous results were in agreement with those gained by Petrović *et al.,* (2015) and Khider *et al.,* (2017).

Conclusion

Fortification of spreadable processed cheese with mixture of vegetables and mushroom resulted product with high compositional, nutritional, and sensorial qualities. These new enriched products are functional and healthy. The improvement of nutritional value of processed cheese is a necessity due to public need for healthy food. In the current study, it was found that addition of vegetables and mushroom by 5 and 7.5% increased the total solids, protein, fibers and carbohydrates. By another side boost up the nutritional values of traditional processed cheese by increasing unsaturated fatty acids, the content of amino acids, vitamins, minerals and reduced sodium potassium ratio; in the time the panelists praised and accepted these products. Further work is needed to study the texture and physical properties, also to investigate the phenolic compounds and its role as antioxidant compounds combined with the effect of cold storage period.

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