International Journal of

Dairy Science

ISSN 1811-9743

Academic
Journals Inc.

www.academicjournals.com

International Journal of Dairy Science 9 (1): 1-14, 2014
ISSN 1811-9743 / DOI: 10.3923/ijds.2014.1.14

Production of Functional Spreadable Processed Cheese Analogue Supplemented with Chickpea

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ABSTRACT

A nutritional Spreadable Processed Cheese Analogue (SPCA) supplemented with cooked chickpea suitable for children and adults was produced. Cheese base (Ras and Cheddar) was replaced by 10, 20 and 30% w/w of chickpea. Preliminary experiment indicated that 20% chickpea in SPCA was the most acceptable. Gradually increases in Total Solid (TS), protein and ash content were observed with added chickpea except for the level of 10%, while fat content took an opposite trend. Titratable acidity, soluble nitrogen and oil separation index values of control recorded low levels when fresh or during cold storage period, while Total Volatile Fatty Acids (TVFAs) and the meltability values were in the opposite direction. The nutritive values (PER, BV and NPU) in 20% chickpea SPCA were higher. Total essential amino acids were higher in 20% chickpea SPCA. The sulfur containing amino acids were lower in cheese analogue while arginine, histidine, isolucine, lucine, lysine, alanine, aspartic, glutamic and proline were higher. However, the results revealed that both control and SPCA supplemented with 20% chickpea highly provide pre-school and school children their needed of essential amino acids especially arginine. Supplementation with zinc and iron provide about 30% from the daily intake for these children.

Key words: Processed cheese analogue, chickpea, zinc, iron, physicochemical properties, amino acids and nutritive value

INTRODUCTION

Traditionally processed cheese is made by mixing and heating natural cheese, emulsifying salts, water and fat. The conversion of these materials into processed cheese was originally developed in the late nineteenth to early twentieth centuries and was used as a preservation measure and mainly extending the shelf life of the cheese. Nowadays, processed cheese is made for reasons more other than preservation, such as for versatility, convenience and cost reduction and functional product (Berger *et al.*, 1998; Guinee *et al.*, 2004; Lee *et al.*, 2004; Lee and Anema, 2009).

Legumes, including beans, occupy an important place in human nutrition as in many countries they are one of the staple food. Bean seeds have unique nutritive value. Besides being a cheap source of valuable proteins, saccharides and several micronutrients including minerals and vitamins, they are known as rich in dietary fiber and low in fat (Sgarbieri, 1989; Soral-Smietana *et al.,* 2002). The contribution of legumes in the daily diet has many beneficial physiological effects as it allows to prevent common metabolic diseases, such as diabetes mellitus, Coronary Heart Disease (CHD) and cancer (Bazzano *et al*., 2001; Champ, 2001; Mathers, 2002).

A regular intake of beans, or any other pulse, may contribute to the lowering of the plasma cholesterol level (Leterme, 2002). In addition, beans, together with peas, lentils and chickpeas, are also shown as the best sources of folate, the vitamin that lowers the blood level of homocysteine. Therefore, their consumption is supposed to have a positive correlation with reducing the CHD death (Mann and Chisholm, 1999). Legumes contain a wide range of biologically-active micro-constituents that cannot be considered as nutrients, however possess many beneficial properties, like anti-oxidative, anti-inflammatory, detoxicating, which may be useful in certain diseases prevention.

It is well known that plant proteins are an alternative to proteins from animal sources for human nutrition particularly in developing countries where average protein intake is less than that required. Therefore, constant search for unconventional legumes as a new protein sources for use as both functional ingredients and nutritional supplements (Molina *et al*., 2002; Arab *et al*., 2010). For example, Chickpea (Cicer arietinum) is one of the top five important legumes on the basis of whole grain production. Chickpea is a valuable, ancient leguminous plant which grows well in different soils and climates. It is common food surrounding the Mediterranean Sea. It has been used for the preparation of various traditional foods and as an ingredient in bakery products, imitation milk, infant foods formulations and meat products (Hefnawy and El-Shourbagy, 2010).

Zinc is a metal with great nutritional importance and is particularly necessary in cellular replication and development of the immune response. Therefore, if the growing fetus and infants are at risk of development of zinc deficiency, then an adequate supply of this element is essential for normal growth development (Salgueiro *et al*., 2002). So, zinc fortification is an important need especially because daily intakes appear to be more useful physiologically than intermittent doses (Gibson *et al*., 1998). Many forms of zinc salts are used in many supplementation trials. The solubility of these compounds is very important and strongly associated to the absorbability. Zinc sulphate is very soluble and zinc acetate is freely soluble (Gibson *et al*., 1998; Allen, 1998). There is a great deal of work yet to be done to find an adequate way to prevent zinc deficiency, but it appears that zinc supplementation or food fortification with an adequate zinc compound may be the key to overcome such a worldwide nutritional problem (Salgueiro *et al*., 2002). Iron is an essential nutrient for haemoglobin and myoglobin formation and is vital for health and peak performance. Much of our iron requirement is met through recycling of the iron in red blood cells (Samman, 2007). The amount of iron stored is carefully regulated by intestinal absorption, as we have a limited ability to excrete excess iron (Frazer *et al*., 2008). On the other side, iron deficiency in the diet leads to prevalent anemia which considered an important problem in rural countries. Therefore, supplementation of various foods stands as a reasonable solution to increase dietary iron levels. Dairy products could be considered as a good source for high quality proteins, some minerals and vitamins, but they are a poor source for iron (El-Sayed *et al*., 1997). Fortification of dairy products with iron may improve dietary iron level of the products (El-Sayed *et al*., 1997).

In Egypt intensive investigations were made concerning the use of soy proteins in several estimated dairy products. Abd El-Salam *et al*. (1997) studied the effect of whey proteins, sour milk on processed cheese properties. However, little or no information concerning the use of chickpea as a source of protein supplementation in food are available.

Therefore, the target of this study is to prepare a healthy processed cheese analogue supplemented with chickpea. Also fortified with zinc and iron salts to offer protection from deficiency of these elements for pre-school children (2-5 years old) and school children up to 12 years old.

MATERIALS AND METHODS

Materials

Raw materials: Dried chickpeas, Egyptian Ras cheese, Australian cheddar cheese as well as butter oil brand name NZ (New Zealand dairy board) were purchased from local market, Cairo, Egypt.

Emulsifying salt: Commercial emulsifying salt S9s was obtained from JOHA.BK Landenburg Corp, Gmbh, Landenburg, Germany.

Zinc acetate: Fluka chemie AG.CH-9470 Bruchs. Switzerland.

Iron chloride: BDH Laboratory Supplies, Poole, BH15 1TD, England.

Methods

Processing of chickpea: The method described by Nestares *et al.* (1996) was carried out. Dried raw seeds were soaked at room temperature (~30°C) for 9 hrs. in 0.1% citric acid solution (pH 2.6) at ratio 1:3 (w/vol). The soaking water was drained off and the seeds were cooked in distilled water for 35 min at ratio of 1:6 (w: vol). The cooking water was drained off. The seeds were hulled, crushed to fine granules then kept under freezing conditions (-18°C) until use.

Processed cheese manufacture: The ingredients which used for the manufacture of Spreadable Processed Cheese Analogue (SPCA) was calculated to fulfill the national legal standard specifications of the final product i.e., full fat (45%, fat/DM and 40% T.S). All ingredients were thoroughly mixed and adjusted for fat and moisture contents, with 2.5% emulsifying salt and 0.01% Potassium sorbate and were added consecutively in a laboratory style processing skettle (Awad, 1996). The mixture was cooked at 85-90°C using indirect steam at pressure 2:2.5 kg cm^{-2}. The melted SPCA was poured into glass cups (100 mL) with aluminum cover and stored at 5±1°C until analysis. The resultant cheese was analyzed when fresh and after 1, 2 and 3 months of cold storage (5±1°C). Three replicates of SPCA were carried out.

Experimental procedures: Preliminary experiments were carried out by replacing (w/w) the cheese base (Ras and cheddar) by different ratios of grounded cooked chickpea. The composition of different formulations used is shown in Table 1. The resultant SPCA made from these formulas was examined for their sensory and acceptability by a panel judges of the staff members of Dairy Laboratory in National Research Center. However, SPCA made with adding 20% of chickpea gained the highest acceptability.

Methods of analyses

Chemical analyses: Processed cheese samples were tested for Total Solids (TS) and soluble nitrogen (S.N.), fat, Titratable Acidity (TA) and ash contents as mentioned in AOAC (2007). Total Volatile Fatty Acids (TVFAs) values were determined according to Kosikowski (1982) and expressed as mL of 0.1 N NaOH/100 g. Total carbohydrate of cheese samples were measured by difference.

Physicochemical properties: Melting quality was determined as by the method of Savello *et al.* (1989). Oil separation index of spreadable processed cheese analogue SPCA was

Table 1: Formulation of different Spreadable Processed Cheese Analogue (SPCA) with different chick pea ratios

		Chick pea (%)		
Ingredients	Control	10	20	30
Ras cheese	24.50	22.05	19.60	17.15
Cheddar cheese	24.50	22.05	19.60	17.15
Butter oil	6.00	6.0	6.00	6.00
Zinc (g kg^{-1})	1.14	1.14	1.14	1.14
Iron (g kg^{-1})	0.70	0.7	0.70	0.70
Emulsifing salt	2.50	2.5	2.50	2.50
Cooked chick pea	-	5	10.00	15.00
Water	40.66	40.56	40.46	40.36

*330 mg zinc element (as zinc sulphate) was added, *200 mg iron element (as iron chloride) was added

Table 2: Average of chemical composition for row ingredients used in Spreadable Processed Cheese Analogue (SPCA)

	Percentage (%)					
Ingredients	Total solids	Fat	Total protein	Total carbohydrate	Ash	Total fiber
Ras cheese	64.63	35.32	24.22	0.51	3.93	-
Cheddar cheese	62.67	36.50	20.89	0.42	3.84	-
Cooked chick pea	55.74	6.33	23.96	20.38	0.93	3.62

*Total carbohydrate was calculated by differences, *Data represents average of 3 replicates

estimated according to Thomas *et al.* (1980). The diameter of spread oil was measured in mm and used as an oil separation index as following:

$$OSI = \frac{D2\text{-}D1}{D1}$$

Where:
OSI: Oil separation index
D_1: Diameter of cheese fat before heating
D_2: Diameter of cheese fat after heating

Color measurement: Color was measured using Hunter Colorimeter model D2s A-2 (Hunter, 1975). Tristimulus values of the color namely L, a and b were measured.

- **L:** value represents darkness from black (0) to white (100)
- **a:** value represents color ranging from red (+) to green (-)
- **b:** value represents yellow (+) to blue (-)

Sensory evaluation: A panel of 10 judges of the Dairy Department in National Research Center were evaluated the sensory attributes of SPCA samples. Scores were on a 5-point scale, where 1 = absence of the attribute and 5-exist extremely (Maifreni *et al.*, 2002).

Amino acid analysis: Protein hydrolyzed was prepared by treating 300 mg sample (for control sample and 20% chickpea preferable SPCA) with 6 N HCL in an evacuated test tube for 24 h at 105°C. After water evaporation, the dried residue were dissolved in citrate buffer (pH 2.2). Aliquots were analyzed in an LKB Biochrome automatic amino acid analyzer (model 4151, Hobart, U.K) using a buffer system as described by Zarkadas *et al.* (1993). Methionine and cystine+cysteine were analyzed separately after performic acid oxidation and subsequent hydrolysis with HCl (Khalil and Durani, 1990). Tryptophan was determined after alkali (NaOH) hydrolysis by a calorimetric method (Friedman and Finley, 1971).

Computation of nutritive value: Protein Efficiency Ratio (PER) based on the amino acid contents of for control sample and the preferable treatment of SPCA (supplemented by 20% chickpea) was calculated according to the recommendations of Alsmeyer *et al.* (1974) using the following equations:

- PER_1 = -0.684+0.456 (leucine)-0.047 (praline)..... (For adults)
- PER_2 = -0.468+0.454 (leucine)-0.105 (tyrosine)..... (For juveniles)
- PER_3 = -1.816+0.435 (methionine)+0.78 (leucine)+0.211 (histidine)-0.944 (tyrosine)..... (For children)

Biological Value (BV) and Net Protein Utilization (NPU) were calculated using the equations suggested by Block and Mitchell (1947).

- BV = 49.9+10.53 PER
- NPU = BV X Digestibility (protein, 95%)

Statistical analysis: Statistical analysis was performed according to the User's Guide given by SAS Institute (2004) using Least Significant Differences (LSD).

RESULTS AND DISCUSSION

Processing of chickpea: Table 2 illustrated the average chemical composition of prepared chickpea. It was cleared that chickpea contained a high levels of total carbohydrate, crude protein. In addition, chickpea contained (3.62%) of fibers. These results indicated that chickpea was an important source of available energy (Melo and Ribeiro, 1990). The results were in accordance of several investigators (Arab *et al.*, 2010; Nestares *et al.*, 1996; Bampidis *et al.*, 2009). Chickpea; like other legumes contain anti-nutritional factors (α-galactosides, trypsin, inhibitors, tanines... etc.) which may minimize their nutritive value of their proteins. These anti-nutritional factors can be eliminated or reduced by cooking (Nestares *et al.*, 1996). Therefore, soaking of chickpea and cooking in acid media was adapted to improve both nutritional and functional properties of chickpea.

Chemical composition of spreadable processed cheese analogue (SPCA): Table 3 revealed that the gross chemical composition of Spreadable Processed Cheese Analogue (SPCA) contained different amounts of cooked chickpea compared with control sample. It is clear that T.S., T.P. and ash contents of cheese with added chickpea was higher than control except for treatment with 10% chickpea which slightly lower in TS. This increase was parallel with increasing the level of chickpea in processed cheese analogue. However, these values were higher than control sample. Fat content of SPCA took an opposite trend. However, it is clear that addition of chickpea significantly affected the chemical composition of SPCA the spreadable processed cheese analogue SPCA compared with the control.

Table 3: Chemical composition of fresh Spreadable Processed Cheese Analogue (SPCA)

		Chick pea (%)		
Components (%)	Control	10	20	30
Total solids	43.56	43.22	43.83	44.69
Fat	25.53	24.66	24.32	24.11
Fat/DM	58.61	57.06	55.48	53.95
Total protein	10.92	11.42	12.12	12.62
Ash	1.44	1.62	1.81	1.83
Salt	4.81	4.78	4.71	4.65

*Data represents average of 3 replicates, *$LSD_{0.0188}$

Table 4: Titratable acidity* of Spreadable Processed Cheese Analogue (SPCA) during storage period at 5±1°C

		Chick pea (%)		
Storage period (month)	Control	10	20	30
Fresh	0.74	0.98	1.30	1.35
1	0.92	1.10	1.32	1.38
2	1.25	1.34	1.41	1.48
3	1.35	1.42	1.51	1.56

*Average of three replicates, *$LSD_{0.188}$

Table 5: Soluble nitrogen *(%) of spreadable processed cheese analogue (SPCA) during cold storage at 5±1°C

		Chick pea (%)		
Storage period (month)	Control	10	20	30
Fresh	1.332	1.441	1.523	1.663
1	1.499	1.595	1.617	1.775
2	1.616	1.725	1.812	1.828
3	1.852	1.915	1.982	2.066

*Average of three replicates, *$LSD_{0.118}$

Titratable acidity: Titratable Acidity (TA) values of the spreadable processed cheese analogue SPCA when fresh and after 1, 2 and 3 months of cold storage were presented in Table 4. The data indicated that control sample have the lowest acidity value than the processed cheese spread analogues either when fresh or during cold storage. TA increased gradually during storage period while a pronounced increase was observed after 3 months. The increased acidity of samples could be due to that chickpea gained higher acidity during preparation and processing with increasing chickpea levels. However, the increase of titratable acidity between samples was significant either when fresh or during cold storage period. Generally, the increase of titratable acidity of all samples during cold storage was attributed to the changes of emulsifying salt form, lactose and soluble nitrogen content. These data are agreed with findings of Aly *et al.* (1995), Abdel-Hamid *et al.* (2000). Contrary to our present results, Omar *et al.* (2012) indicated that T.A. of treated legumes samples was decreased during storage period than control.

Soluble nitrogen: Table 5 presented the Soluble Nitrogen (SN) content of the Spreadable Processed Cheese Analogues (SPCA) compared with control when fresh and after 1, 2 and 3 months of cold storage. The data indicated that (SPCA) had higher values than control sample. The increase of soluble nitrogen content of the treatment was announced with extending cold storage period and parallel to increasing chickpea level. These changes may be due to the partial hydrolysis of both milk and chickpea proteins. Nestares *et al.* (1996) indicated that row chickpea contained 3.83% total nitrogen, of which 8.81% was non protein nitrogen. The apparent increase in soluble nitrogen concentration was due to solubilization of carbohydrates soaking and cooking liquids. Furthermore, (Hassan *et al.*, 2007) claimed that the increase of soluble nitrogen with extending period may be due to the hydrolysis of polyphosphate present in emulsifying salts which cause more solublilization of proteins. However, the difference between soluble nitrogen of all treatments and control was highly significant either when fresh or during cold storage period.

Total volatile fatty acids (TVFAs): TVFAs in both control and SPCA treatments with different levels of chickpea were shown in Table 6. Data showed that control sample possessed the highest TVFAs values than the SPCA supplemented by chickpea. The differences in TVFAs among all treatments may be due to the percent of cheese base in the cheese. Increasing both ras and cheddar cheese ratio in the blend increased TVFAs in SPCA. From the data in Table 6 it could be concluded that TVFAs values increased during cold storage of either control or treated samples SPCA. It is clear that TVFAs decreased with increasing the chickpea levels. This increase was mainly attributed to the residual activity of heat resistant lipases in cheese formula. The changes in TVFAs during cold storage were highly significant between control and treatments when fresh and during cold storage period. However, cold storage period affect the development of TVFAs significantly in control and SPCA treatments. These findings were in accordance with (Hassan *et al.*, 2007).

Meltability: Meltability of spreadable processed cheese analogues with different ratio of chick pea was recorded as cheese flow (mm) when fresh and during 3 months of cold storage were presented in Table 7. However, the control processed cheese spreads showed pronounced higher meltability values than the treated cheese when fresh and during cold storage. Increasing the percent ratio of chick pea of cheese blend lowered the meltability of the resultant cheese analogue. The increase

Table 6: Total volatile fatty acids* (TVFAs) of Spreadable Processed Cheese Analogue (SPCA) during cold storage at 5±1°C

		Chick pea (%)		
Storage period (month)	Control	10	20	30
Fresh	32.00	23.01	24.20	25.30
1	34.74	27.55	28.53	29.84
2	39.54	30.22	32.65	34.26
3	41.56	32.84	35.37	36.13

Total volatile fatty acids (1 mL 0.1 N NaOH 100^{-1} g cheese), *Average of three replicates, *$LSD_{1.88}$

Table 7: Meltability values (mm) of Spreadable Processed Cheese Analogue (SPCA) during cold storage at 5±1°C

		Chick pea (%)		
Storage period (month)	Control	10	20	30
Fresh	160	130	120	110
1	170	140	130	100
2	180	157	150	85
3	200	162	157	92

*Average of three replicates, *$LSD_{1.663}$ ($p< 0.05$)

Table 8: Oil separation index (mm) of Spreadable Processed Cheese Analogue (SPCA) during cold storage at 5±1°C

		Chick pea (%)		
Storage period (month)	Control	10	20	30
Fresh	58	78	79	82
1	61	83	86	94
2	74	96	98	105
3	82	108	115	120

*Average of three replicates, *$LSD_{1.6631}$ ($p< 0.05$)

of meltability during cold storage may be due to the increase of S. N. in all treatments. However, the differences in meltability between samples were significantly in fresh or during cold storage. These results were in agreement with Hassan *et al*. (2007).

Oil separation index: Results in Table 8 indicated that the control sample had the lowest oil separation than the treatments. Moreover, oil separation values increased with increasing chick-pea ratio (%). The differences in oil separation values among treatments are mainly due to the nature of protein in the blend or the emulsification degree of the product. The protein in Ras and cheddar cheese (mainly casein) produced a net work which able to contain fat and other components with the net work, while the protein of chick pea would be less able to do the same. The oil separation of SPCA increased during cold storage period, being slightly in control samples than treatments. However, a clear significant difference between control and treated samples during storage period was observed. Ahmed (2009) concluded that the higher oil separation during cold storage could be related to the increase in soluble nitrogen content (more decomposition of protein), which resulted in lower degree of emulsification and higher fat leakage.

Color parameters: Table 9 shows the color parameters of control and SPCA with different levels of chickpea during cold storage (5±1). However, the control sample had higher whiteness degree when fresh and during cold storage, while decreased with increasing the chickpea ratio. As the increase of chickpea incorporation in blend cheese, the color parameters (a and b) increased. The increase of parameter b (yellow) was highly pronounced in treated cheese than the parameter a (red). This increase may be due to the slightly yellow color of added chickpea. Further, these differences were slightly noticed. However, addition of iron salt showed a negligible effect on color of both control and cheese analogue. In agreeing with our results, Ahmed (2009) indicated that addition of whey protein concentrate or butter milk concentrate affect of the color of SPCA.

Sensory evaluation: The sensory evaluation of both control and processed cheese analogues during cold storage for 3 months were presented in table 10. The control samples gained the highest score for color, while SPCA gained lower score. This decrease of color parameter conversely collorlated with the addition percent of chickpea. Cold storage showed no difference of color. The control cheese gained the highest task followed by 20% SPCA. Cheese with 10 and 30% chickpea had slight low score when fresh. During cold storage the cheese with 20% chick pea increased clearly to reach approximate score of the control. SPCA with 30% chick pea had low taste score. Odor scores (Table 10) indicated that control cheese gained the highest score followed by cheese analogues with 20% chick pea, while the analogues with 10 and 30% showed low scores. However, the odor increased gradually during cold storage for 1 and 2 months. While a slight decrease was observed at the 3rd month. Addition of zinc or iron salts did not affect odor neither control nor

Table 9: Color parameters of Spreadable Processed Cheese Analogue (SPCA) during cold storage at 5±1°C

Sample (cooked chick pea)	L	a	b
Fresh			
Control	80.17	-3.21	30.97
10%	79.16	-3.68	31.18
20%	79.77	-4.15	32.37
30%	78.72	-4.17	32.51
1 month			
Control	80.83	-3.46	31.66
10%	78.81	-3.12	31.70
20%	78.02	-3.01	31.76
30%	77.62	-2.96	31.72
2 months			
Control	78.17	-2.99	31.14
10%	78.10	-3.41	31.92
20%	77.03	-3.35	31.78
30%	76.46	-3.27	31.52
3 months			
Control	65.26	-4.02	23.21
10%	72.54	-4.18	23.71
20%	72.14	-4.02	23.45
30%	71.82	-3.68	23.24

L: Values represent darkness black (0) to white (100), a: Values represent color ranging from red (+) to green (-), b: Values represent yellow (+) to blue (-)

Table 10: Sensory evaluation of Spreadable Processed Cheese Analogue (SPCA) during cold storage at 5±1°C

	Cooked chick pea (%)			
Storage (month)	Control	10	20	30
Color				
Fresh				
1	4.0	3.9	3.6	3.0
2	4.0	3.8	3.7	3.1
3	4.0	3.8	3.8	3.0
Taste				
Fresh	4.2	3.9	3.8	3.0
1	4.9	3.4	3.7	2.8
2	4.01	3.5	3.7	2.8
3	4.2	3.7	4.5	2.5
Odor				
Fresh	4.2	3.8	4.2	2.5
1	3.6	4.1	3.4	4.1
2	3.8	4.3	4.2	3.6
3	4.3	4.2	4.2	3.7
Smoothness				
Fresh	4.2	4.1	4.1	3.5
1	4.4	4.2	3.8	4.1
2	4.4	4.2	4.1	3.8
3	4.3	4.0	4.1	3.6
Spreadability				
Fresh	4.2	4.0	3.9	3.6
1	4.1	4.0	3.2	4.0

Table 10: Continue

	Cooked chickpea (%)			
Storage (month)	Control	10	20	30
2	4.2	3.9	4.2	3.4
3	4.3	4.0	4.3	3.5
Overall acceptability				
Fresh	4.4	4.0	4.1	3.3
1	4.1	3.9	3.9	4.1
2	4.3	4.0	4.3	3.5
3	4.2	3.9	4.5	3.0
Mean	4.6	3.9	4.6	3.6

cheese analogue. Smoothness of cheese analogues with 10 and 20% chick pea was higher than control and 30% cheese, when fresh. However, a slight gradual decrease was observed during the cold storage period. The increase of spreadability was pronounced of both control and 20% SPCA, while a negligible increase was observed for 10% followed by 30% SPCA during cold storage. For the overall acceptability the cheese analogue with 20% chickpea gained similar scores liked the control. SPCA with 10% chickpea had slight low scores, while SPCA with 30% had low score. From these results it could be assumed that cheese analogues with 20% chickpea had high acceptability like control cheese.

Amino acid profile: Amino acid profile of both control and SPCA with 20% chickpea was illustrated in Table 11. It is clear that total amino acids in control cheese was 728.4 mg 1 g^{-1} protein increased to 886.30 mg 1 g^{-1} protein in the preferable cheese analogue sample (20%). Total essential amino acids in control was 406.34 increased to 485.10 mg g^{-1}, while the ratio of essential amino acids/total amino acid in control was 56.04 and 54.78% in cheese analogue. However, sulfur containing amino acids decreased in cheese analogue, while a considerable increase of other amino acids was observed. The increased amino acids were arginine, histidine, isoleucine, leucine, lysine, alanine, aspartic acids, glutamic acids and proline were observed, while sulfur amino acids and valine slightly decreased.

These results were in accordance of the results of Arab *et al.* (2010) and Angulo-Bejarano *et al.* (2008). They indicated that cooked chick pea flour contained less sulfur amino acids and higher glutamine and proline. However, total and non essential amino acids indicated the same trend. Also Bampidis *et al.* (2009) claimed that the sulfur amino acids were the first limiting factor followed by valine, therionine.

Results in Table 11 revealed that both control and cheese analogue with 20% chickpea highly provide both pre-school and school children with their needed of E.A.A. However, it can be assumed that 20g of cheese was enough to provide the suggested daily intake of A.A.

The FAO/WHO/UNU (1985) suggested that the arginine is very essential for pre-school and school children. Therefore, from our results it is clear that addition of 20% chickpea to cheese analogue and provide the daily intake of children (Arab *et al.*, 2010).

Nutritive value: The nutritive values of both control and cheese analogues were shown in Table 12. A biological evaluation of chickpea protein was essential because chemical analysis do not always reveal how much of protein was biologically available and utilized. Both Protein Efficiency Ratio (PER) and biological value (B.V.) were recommended this purpose (Bampidis *et al.*, 2009).

Table 11: Amino acids profile (mg g^{-1} protein) of control and preferable 20% chick pea (SPCA) compared by the recommended daily intake (FAO/WHO/UNU, 1985)

Amino acids	Control	20% chick pea SPCA	Recommended daily intake (FAO/WHO/UNU, 1985)	
			Pre school child 2-5 years	School child 12 years
Arginine	26.2	38.1	19	19
Histidine	21.3	31.2	19	19
Isoleucine	36.2	54.1	28	28
Leucine	88.4	94.4	66	44
Lysine	46.6	66.1	58	44
Methionine	23.2	21.2	25	22
Cystine	18.4	17.3		22
Phenylalanine	23.3	32.2	63	22
Tyrosine	49.2	59.8		22
Threonine	27.1	26.9	34	28
Tryptophane	16.14	16.5	11	9
Valine	30.3	29.3	35	25
Total	406.34	485.1		
Alanine	39.5	51.2		
Aspartic acid	28.3	40.2		
Glutamic acid	121.5	139.1		
Glycine	45.1	48.7		
Proline	54.0	82.2		
Serine	30.4	39.8		

Nutritive value of control and preferable 20% chickpea (SPCA)

Table 12: Nutritive values of control and the preferable sample (SPCA) 20% chickpea

Items	Control	SPCA (20%) chickpea
Protein efficiency ratio (PER)		
1	3.70884	30.98244
2	3.44996	30.611
3	3.52775	30.328
Biological value (BV)		
1	88.954	91.835
2	86.228	87.924
3	87.047	84.944
Net protein utilization (NPU)		
1	84.5	87.243
2	81.92	83.53
3	82.69	80.70

Chickpea like other legumes contains variety of anti-nutritional factors, which impair nutrient absorption from the gastrointestinal tract (Singh, 1988). However, many anti-nutritional factors in chickpea are inactivated by heat treatment therefore soaking in acid media and cooking of chickpea was adapted to improve the nutritional values of cooked chickpea (Bampidis *et al.*, 2009; Arab *et al.*, 2010).

However, it is clear that supplementation with 20% cooked chickpea increases the magor nutritive parameters of cheese analogue. Furthermore, the net protein utilization slightly increased in cheese analogue.

CONCLUSION

It is clear that addition of chickpea significantly affect the chemical composition of SPCA compared with control.

However, while these studies are being conducted, the products can be used in programs, provided that they are acceptable to the target population and are expected to perform better than the products they replace.

Specialized products SPCA with chickpea, zinc and iron have special purposes to offer healthy foods for pre-school and school children. Cheese analogue with 20% cooked chickpea was more accepted by panelists. Further, 20 g from SPCA 20% provide the need of recommended daily intake for both pre-school and school children. It is suggested that further experiment should be done to investigate the role and the effect of zinc and iron.

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