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EFFECT OF REPLACING SKIM MILK POWDER (SMP) WITH CHICKPEA FLOUR ON ICE MILK QUALITY

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ABSTRACT: *The main objectives of the present study wase to determine the combined effect of skim milk powder and chickpea on ice milk properties .five treatments of mixes T1 ,T2 , T3 ,T4 and T5 were prepared by substituting 10 ,25 ,50 ,75 ,and 100 %of skim milk powder with chickpea flour ,respectively .The specific gravity and weight per gallon of the resulted ice milk decreased significantly with increasing chickpea flour .The overrun increased significantly when chickpea flour increased up to 50 %while decreased significantly at level 75 and 100% replacing skim milk powder with chickpea flour caused a significant decrease in the rate of melting . Ice milk made by replacing 50 % of SMP with chickpea flour showed the highest content of both total and non- essential amino acids and total essential amino acids except lysine and isoleucine, valine, threonine and methionine. content was clearly increased . Increasing chickpea flour caused a remarkable increase in crude fibers and minerals (selenium, iron, manganese, potassium and zinc) .*

Substituting up to 50% of skim milk powder with chickpea flour would yield ice milk with the highest nutritional value and the best physical and organoleptic properties without adversely affecting during storage up to 4 weeks.

Key words: *Ice milk , skim milk powder, chickpea flour, ice milk quality.*

INTRODUCTION

Ice milk is a frozen dairy product that is widely consumed all the world. Ice milk is composed of a mixture of air, water, milk fat, milk solids not-fat, stabilizers, emulsifiers, sweeteners, and flavours. The demand for functional food is growing rapidly all over the world due to increasing awareness of the costumers on the impact of food health. The future promises changes in the composition and form of ice milk, as can carry health-promoting constituents, and the nutraceutical concept.

Chickpea (*Cicer arientum L.*) is considered the 5th valuble legume in trems of worldwide economical standpoint. Chickpea is considered a good source of proteins and carbohydrates. Like other legumes Chickpea seed contains (29%protein, 59% carbohydrate, 3% fiber, 5% oil and 4% ash. Chickpea is also a good source of absorbable Ca, P, Mg, Fe and K (Chavan *et al;* 1989 and Christodoulou 2005). Chickpea's globulins and albumins represent the two major fractions found in beans. In legumes, the globulins, represented mainly by legumin and vicinin, reach up to 60-80% out of the extractable proteins of the beans whereas the albumin fraction, less abundant, represents up to 15-25% out of the beans proteins(Singh *et al;* 2008). Albumins play an important role in chickpea beans since they contain most of the enzymes and proteins with metabolic significance. In addition, they display a higher nutritive value compared to the globulins due to their high content in lysine and sulfur aminoacids.

The chickpea proteins are better appreciated compared to the proteins from pigmelion peas, blackgram and greengram(Kaur and Singh2007) due to their high biological value, high biodisponibility, wellbalanced amino acids content and low content in antinutritional factors(Friedmen *et al;*1996). The low fat content combined with the special characteristics of chickpea beans justify the nowadays concerns for chickpea protein isolates and concentrates obtaining and their functional characterization. Sanchez-Vioque *et al*.(1999) investigated the protein recovery yield in different experimental conditions, functional properties and the composition of chickpea protein isolates in direct relations with the possibility of using these isolates in food industry. According to their findings, the protein isolates characterized by a high absorption capacity of water and oil are adequate for obtaining cheese, bakery and meat products. On the other hand, the isolates with a good emulsifying capacity can be successfully used for obtaining products such as frankfurter and cream-like products.

In view of the aforementioned the objectives of this study were to evaluate the possibility of making a good quality ice milk by using chickpea flour to substitute various levels of MSNF and studying their effects on physico-chemical properties of the mix and the resultant ice milk as well as the sensory evaluation of the resultant ice milk.

MATERIALS AND METHODS

Materials:

Raw milk:

Fresh buffaloes milk was obtained from the herd belonging to faculty of Agriculture, Minufiya University, Shibin El-kom, Egypt.

Skim milk powder (S.M.P)

Skim milk powder was obtained from United States of America. By Obourland for food industry , EL Obour city, Cairo, Egypt . The gross composition of the (S.M.P) used is given in Table (1).

Cream:

Cream was obtained by separating buffaloes milk in the pilot plant of department of dairy science and technology, faculty of Agriculture, Minufiya University, Shibin El-kom Egypt.

Chemical composition of the raw material of the Raw milk, Fresh skim milk, Skim milk powder (S.M.P) and Cream used in the manufacture of the ice milk (Table1).

Non –dairy ingredients:

Sucrose:

Commercial grade crystalline sucrose was obtained from the local market.

Chickpea flour (*Cicer arientum L*).

Was obtained from the local per former market of Kafr El-sheikh, Egypt. Seeds were cleaned, separated from forgein matters, cooked in water (1:7 w/v) on a hot plate until it become soft as felt between fingers . the cooked seeds was dried in a hot air oven mainted at 55°C. According to the method of Jood *et al*.; (1988). and then ground to obtain a Fluor of about 60 mesh. The flour obtained was stored in tightly closed bag . until the time of use.

Chemical composition of chickpea flour (Table 2&3)

Table (1). The gross composition of raw dairy ingredients used for ice milk making (g-100g):

component	T. s%	Fat%	T. p%	Ash%	Lactose%
Buffaloe,s milk	16.90	7.00	4.18	0.91	4.81
Fresh skim milk	9.20	0.10	3.70	0.82	4.58
Skim milk powder	96.00	0.50	35.30	8.20	52.00
cream	47.45	40.00	2.88	0.66	3.91

Table (2). Gross composition of chickpea flour for ice milk making (g/100g).

Moisture	Crude fat	Crude protein	Crude carbohydrate	Crude fiber	Ash	Energy value cal/100gm
8.79	5.6	25.53	47.78	8.8	3.5	385.2

Table (3). Mineral contents of chickpea flour (mg/100g on dry weight).

Mn	Fe	Mg	K	Se	Zn
17.35	6.9	152.60	771.80	0.170	3.83

Carboxy methyl cellulose(C.M.C):

Sodium carboxy methyl cellulose (C.M.C) was obtained from Obourland for food industry , EL Obour city, Cairo, Egypt.

Vanilla :

Vanilla powder was obtained from the local market.

Methods:

Manufacture of ice milk mix:

Vanilla ice milk mix contained 6 %fat , 13 %milk solid not fat (M.S.N.F) ,15 %sugar , 0.4 %stabilizer and 0.1 %vanilla. Skim milk powder was used to supply the milk solid not fat in control mix , five batches were made replacing 10,25,50,75 ,and 100 %of skim milk powder used in the control mix with chickpea flour Treatments T1,T2,T3,T4 and T5 , respectively (Table 4).

In each treatment of the study, ingredients were mixed together, then sifted slowly to the standardized milk at 45 to 6o °C under vigorous agitation to prevent lumping according to the method of (Khader *et al*.,(1992).

All mixes were heat treated at 85°C for 10 min., then rapidly cooled to 5 °C, thereafter ,the mixes were aged at 6°C for 24 hours before freezing as reported by (Arbucklel (1986). Using hard ice cream machine (Taylor, Model, 103, Italy) the resultant ice milk was filled into PVC cups (cap.100ml) covered and put in refrigerator for physical analysis, and some samples put in deep freezer until chemical analysis have been done.

Chemical analysis:

Determination of total solids:

Total solids content were determined according to A.O.A.C (2000).

Determination of fat and oil contents:

Fat and oil contents were determinate according to A.O.A.C (2000). Determination of milk fat was according to the methods described by Ling (1963).

Determination of total protein and ash contents:

Milk protein contents (total nitrogen × 6.38), lupin, chick pea, white bean (total nitrogen × 6.25) and ash contents were estimated as in A.O.A.C (2000).

Determination of carbohydrate content:

Carbohydrate content was calculated according to Guzman *et al.,* (1999) by difference as following carbohydrate % = total solids – (total protein + fat + ash).

Determination of minerals contents:

Minerals content were determined according to Shoale *at al.;* (1997), using a known weight (0.5g) of the dried samples and wet digestion was conducted using a microwave oven (milestone mps 1200 mega). The conditions for wet ashing were as follows.

The sample was mixed with 6 ml. of concentrated nitric (65% v/v) and heated with microwaves generated from the oven moderat full power for 15 min. micronutrients content were determined in digested solution using indicative coupled plasma (600) emission spectrometery according to Allen *et al.;* (1997).

Table (4): Formula of ice milk mixes made by substitution of skim milk powder (SMP) with different levels of chickpea flour.

Raw materials	Ice milk mixes					
	C*	T1	T2	T3	T4	T5
Fresh skimmed milk(g)	1156	1156	1156	1156	1156	1156
Fresh cream(g)	400	400	400	400	400	400
Skim milk powder(g)	134	120.6	100.5	67	33.5	0
Chickpea flour(g)	0	13.4	33.5	67	100.5	134
Cane sugar (g)	300	300	300	300	300	300
CMC(g)	8	8	8	8	8	8
Vanilla(g)	2	2	2	2	2	2
Total (g)	2000	2000	2000	2000	2000	2000

C*= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with chickpea flour at the ratio of 10,25,50,75,100% respectively.

Determination of fiber contents:

Fiber content was measured as described by A.O.A.C (2000). Samples were boiled in H2so4 acid (0.128 m) for 30 min., then washed several times with warm distilled water. The residue was then boiled with KoH solution of 0.223 m for 30 min ,and also washed several times with distilled water. The lipid in the residue was extracted with acetone before being dried at 100 C to constant weight and weighted (w1).

The samples were put in muffle furnace at 525 C complete ashing and weighted (w2) the crude fiber % was calculated as follows:

Crude fiber % = w1-w2/weight of sample ×100.

Determination of free amino acids contents :

Free amino acids were determined according to Biock *et al.;* (1958). Using automatic amino acid analyzer, AAA 400 , ingosltd. The dried grinded sample (100mg) was hydrolyzed with 6N HCL (10 mg) in a sealed tube at 110C in an oven for 24 hrs. the excess of HCL was then free from 1 ml. hydrolyzed under vacuum of 80 C with occasionally addition of distilled water, then evaporated to dryness. The HCL free residue was dissolved in exact (2 ml) of loading buffer (2.2 M. pH 2.2).

Acidity and pH value.

Titratable acidity and pH value were determined according to Ling (1963).

Physical analysis.

Determination of specific gravity:

Specific gravity of ice milk was determined according to Winton (1958); at 20 °C.

Determination of weight per gallon:

The weight per gallon of ice milk was calculated in kilogram (Kg) according to Burke (1947) and Arbuckle (1977) by multiplying the specific gravity of the mix by the factor (3.786) (The weight per gallon of water in Kg).

Measurement of freezing point:

Freezing point was measurement as described in FAO 1977 using an electronic thermometer (Wheatson 650 , typ-k , chromel-alvmel).

Measurement of viscosity:

It was determined as given by Tobias and Tracy (1950), and Morrison and Macjary (2001).

Determination of whipping ability:

For measurement of whipping ability. Samples were drawn (100 ml) from the freezer during freezing at 5 minutes intervals and the loss in weight per unit volume due to incorporation of air was recorded and percent overrun was calculated.

Overrun percent:

The overrun percent was calculated using the following equation Arbuckle (1986).

% overrun = weight of mix – weight of ice milk / weight of ice milk ×100

Determination of melting resistance.

The melting resistance of the resultant ice milk was determined according to Arbuckle (1986).

Organolipticscoring :

The organoliptic properties for resultant ice milk were assessed by 30 panelists from the staff members of dairy Sci.; food Sci.; and Tech., dept., Faculty of Agric., Minufiya Univ., Shibin El-_kom , Egypt .

Statistical analysis:

Factorial design was to analyze all the data and student newman keuls test was followed to make the multiple comparisons Steel and Torrie , (1980) using costate program . significant differences were calculated at p≤ 0.05 .

The prepared mixes were examined for chemical composition, acidity, pH value as well as freezing point, specific gravity, weight par gallon, viscosity and whipping ability. Resultant ice milk was tested for specific gravity, weight per gallon, overrun and melting resistance. Samples of ice milk were examined organoleptically for flavor (45 points), body & texture (35 points), as well as melting properties (10 points) and colour (10 points), treatments were repeated in triplicates and average values were tabulated. Statistical analysis of results was carried out.

RESULTS AND DISCUSSION

Chemical composition of mixes:

Fat and total solids (TS) contents:

The chemical composition of ice milk mixes as affected by replacement levels of skim milk powder with chickpea flour is demonstrated in (Table 5&11) . it could be observed that the mean values of fat content of ice milk mixes showed no remarkable changes and had values 6.0, 6.1, 6.1, 6.2, 6.2, and 6.3 for treatments C,T1,T2,T3,T4, and T5 statistical analysis revealed that the control treatment was significantly lower (p≤0.05) than treatment T5. this result might be due to the higher fat content of chickpea than that of skim milk powder (Table 3).

Regarding the effect of replacing skim milk powder with chickpea flour on the total solids contents of mixes, the mean values were 34.41, 34.40, 34.40, 34.37, 34.34 and 34.30% for treatments C, T1, T2, T3, T4, and T5. it is obvious from Tables (5&11) that there were significant (p>0.05) differences among all treatments in total solids contents as it was adjusted to be ≈ 34% either in control or the mixes containing chickpea flour.

Protein content:

The protein content in chickpea flour mixes were 4.84, 4.82, 4.79, 4.71, 4.63 and 4.56 % for treatments C,T1,T2,T3,T4,and T5 respectively (Table 5). These results might be due to the higher protein content of skim milk powder than that of chickpea flour (Tables 1& 2).

The proportional replacement of skimmed milk powder with chickpea flour caused significant decrease (p≤0.05) in the protein content of ice milk mixes (Table 11).

Table (5). Chemical composition and PH value of ice milk mixes made with different replacement levels of skim milk powder with chickpea flour.

Componens	*Treatments					
	C	T1	T2	T3	T4	T5
Total solids%	34.41	34.40	34.40	34.37	34.34	34.30
Fat%	6.0	6.0	6.1	6.2	6.2	6.3
MSNF%	13.0	13.0	13.0	13.0	13.0	13.0
Total protein%	4.84	4.82	4.79	4.71	4.63	4.56
Ash%	1.087	1.082	1.075	1.069	1.060	1.058
Acidity%	0.205	0.200	0.198	0.197	0.192	0.189
pH value	6.59	6.62	6.66	6.71	6.79	6.85

C*= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with chickpea flour at the ratio of 10,25,50,75,100% respectively.

Ash content:

Ash content of ice milk mixes made with either skim milk powder or chickpea flour are shown in (Table 5). Ash content of ice milk mixes were 1.087, 1.082, 1.075, 1.069, 1.060 and 1.058 % for treatments C, T1, T2, T3, T4, and T5 respectively.

Ash content showed slight decrease with the proportional increase of chickpea flour in the mixes (Table 5& 11). This may be attributed to the high ash content in skim milk powder than chickpea flour (Table 1,2) leading to higher ash content in control than treatments C,T1,T2,T3,T4,and T5.

Acidity and pH value:

Data in (Tables 5& 11) revealed that, the proportional replacement of skim milk powder by chickpea flour led to gradual decrease in acidity content of ice milk mix. The pH value increased in the chickpea flour mixes than the control. The decrease of acidity was proportional to the rate of replacement skim milk powder with chickpea flour, which means a negative relation between the acidity of ice milk and the rates of replacement. The decrease of acidity by increasing the rate replacement may be duo to the chickpea flour protein. Also duo to the increase of protein and ash content of skim milk powder than chickpea flour (Tables1&2), as these components contribute in the natural acidity of milk and its products.

Physical properties of mixes:

Specific gravity (Sp. gr) and weight per gallon (wt. /gal):

Specific gravity, weight / gallon, viscosity, freezing point and whipping ability in different treatments of ice milk mixes are illustrated in Table (6). The mean values of specific gravity were 1.071, 1.078, 1.085, 1.103, 1.109 and 1.117 for treatments C, T1,T2,T3,T4, and T5 respectively. From these results, it could be seen that the specific gravity of mixes increased as the percentage of chickpea flour increased. The mean values of weight per gallon in kilogram (kg) were 4.056, 4.079, 4.109, 4.159, 4.196 and 4.218 kg for the same treatments in order. Weight per gallon of the mixes were closely related to the specific gravity of the corresponding mixes. From these data, it could be seen that proportional replacement of skim milk powder with chickpea flour in making ice milk caused a significant ($p \leq 0.05$) increase in the Specific gravity, weight / gallon. From Table (11) it could be seen that the control treatment was significantly lower ($p \leq 0.05$) than other treatment.

Table (6). Effect of replacing of skim milk powder with chickpea flour on ice milk mixes properties.

Properties	Treatments*					
	C	T1	T2	T3	T4	T5
Specific gravity(g/cm3)	1.071	1.078	1.085	1.103	1.109	1.117
Weight/gallon (Kg)	4.056	4.079	4.109	4.159	4.196	4.218
Viscosity (Cp)	96	120	273	350	667	897
Freezing point (°C)	-2.3	2.20-	2.00-	-1.9	-1.7	-1.4
Whipping ability (as overrun %) After						
5 min	13.6	13.9	19.8	22.1	13.23	10.22
10 min	35	36.1	39	40.33	34.1	32.43
15 min	45.3	46.5	49.8	57.2	42.15	39.56
20 min	44.2	46.2	48.95	56.3	41.95	38.14

C*= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with chickpea flour at the ratio of 10,25,50,75,100% respectively.

Viscosity:

The viscosity of the control mix was 96 Cp, while those of treatments T1, T2, T3, T4 and T5 were 120, 273, 350, 667and 897 Cp, respectively (Table 6) . Replacing of chickpea flour in the mixes tended to increase significantly ($p \leq 0.05$) the viscosity of the mix as the skim milk powder substitution level with chickpea flour increased (Table 11).Tasneem *et al*.; (1982) reported that functional properties cannot be attributed solely to the protein portion of concentrates. Other components, such as carbohydrate and lipids, contribute appreciably though protein- carbohydrate and protein- lipid interactions.

The data given in Table 6 indicate that the freezing point of skim milk powder and chickpea flour combination were -2.30, -2.20, -2.00, -1.90, -1.70 and -1.40 For treatments C ,T1, T2, T3, T4 and T5. These data revealed that the lowest freezing point were found in (control treatment) and increased gradually upon increasing the chickpea ratio in mix. The differences may be due to relatively lower lactose content in the treatment made with chickpea flour compared to the control. Omer (1983) mentioned that the freezing point of ice cream was lowered by increasing the percentage of MSNF which contained lactose and minerals, as the freezing point of ice milk is dependent on soluble constituents in mix Arbuckle, (1986). Statistical analysis, revealed that the control and T1 treatments were significantly lower ($p \leq 0.05$) than T1, T3, T4, and T5 treatments (Table 6&11) and there were no significant ($p > 0.05$) differences between control and T1 also between other treatments.

Whipping ability:

It is clear from data in Table (6) that the whipping ability of ice milk mix increased by replacing up to 50% skim milk powder with chickpea , which could be attributed to the high albumin content of chickpea. Chickpea contains about 26% protein which characterized by its high nitrogen solubility, favourable emulsifying properties, foaming capacity, hydrophobicity and high water hydration capacity of carbohydrates.

Treatment T5 (100% chickpea) had the lowest whipping ability in 5, 10, 15, and 20 minutes and treatment T3 was the highest. This may be due to higher viscosity of the mix (897 CP) (Table 6). Statistical analysis (Table 11) revealed that there were significant ($p \leq 0.05$) difference among ice mixes treatment. However, the differences were significantly different between all treatments ($p \leq 0.05$).

Physical properties of the resultant ice milk:

Specific gravity (Sp.gr) and weight per gallon (Wt./gal):

Table (7) shows that specific gravity and weight per gallon of the resultant ice milk were closely related. These results indicated that the mean values of specific gravity of ice milk were 0.736, 0.732, 0.725, 0.718, 0.758, and 0.781 for treatments C, T1, T2, T3, T4 and T5. the corresponding values of weight per gallon were 2.774, 2.772, 2.665, 2.583, 2.816, and 2.942. Specific gravity and weight per gallon of ice milk decreased with proportional increase of chickpea level in the mix up to 50%, this might be due to the increase of overrun. This high overrun could be due to the increase of viscosity and high whipping ability of treatments T1, T2, and T3 which were made by substituting 10, 25, and 50% of skim milk powder with chickpea. Mahran *et al*.; (1984) stated that the specific gravity of ice milk is inversely related to changes in the overrun.

Overrun:

The effect of replacing skim milk powder with chickpea on the overrun of the resultant ice milk was presented in Table (7). Replacement of skim milk powder with chickpea up to 50% caused a pronounced increase in the overrun of ice milk (Table 7). Overrun values of ice milk were 46.32, 46.98, 52.19, 56.22, 45.21 and 44.17 % for treatments C, T1, T2, T3, T4 and T5, respectively. The differences among these means were significant ($p \leq 0.05$) as shown in Table (12).

Table (7). Effect of replacing of skim milk powder with chickpea flour on properties of the resultant ice milk.

properties	Treatments*					
	C	T1	T2	T3	T4	T5
Specific gravity(g/cm3)	0.736	0.732	0.725	0.718	0.758	0.781
Weight/gallon (Kg)	2.774	2.772	2.665	2.583	2.816	2.942
Overrun %	46.32	46.98	52.19	56.22	45.21	44.17
Melting resistance loss %						
At 25C after 15 min	0	0	0	0	0	0
45 min	10.3	8.7	8.6	8.4	8.1	8
75 min	40.2	39.6	38.7	38.5	38	37.5
9o min	100	95.2	92.1	91.2	90	88.9

C= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with chickpea flour at the ratio of 10,25,50,75,100% respectively.

There were positive relation between the overrun and the rate of replacing skim milk powder with chickpea which means that the overrun increased by increasing the rate of replacing skim milk powder with chickpea up to 50%. This increase in overrun at replacing ratio of 10, 25, and 50% with chickpea might be due to the better functional properties (whipping and foam ability) of chickpea proteins. Increasing the replacement rate above 50% caused a reduction in overrun (Table 7). The decrease in overrun could be attributed to the higher increasing of mix viscosity (Table 6).

Melting resistance :

Melting resistance of the resultant ice milk is determined as the loss in weight percent of the initial weight. From the data presented in Table (7), it could be seen that the melted portions after 15min were 0.0% for all treatments, after 45 min were 10.3, 8.7, 8.6, 8.4, 8.1, and 8.0% for treatments C, T1, T2, T3, T4 and T5, respectively. The corresponding portions were 40.2, 39.6, 38.7, 38.5, 38.0, and 37.5% after 75 minutes and 100.0, 95.2, 92.1, 91.2, 90.0, and 88.9% after 90 minutes. Replacing skim milk powder with chickpea caused an-obvious decrease in the rate of melting. The increase of melting resistance of ice milk was proportional to the amount of chickpea used. This increase could be attributed to higher water hydration capacity of chickpea. The control ice milk showed lower melting resistance than the rest of ice milk treatments made with replacement of skim milk powder. This may be due to its lower freezing point compared with other treatments supplemented with chickpea. These results are accordance with Arbuckle (1986), he found that using low lactose products in ice cream making caused some influence on the rate of melting.

The statistical analysis for melting resistances results of the ice milk are shown in Table (12). Values in this Table indicated that the differences between treatments at 15, 45, 75, and 90 minutes were decreased significantly ($p \leq 0.05$) between all treatments.

Amino acids contents

Data presented in Table (8) show the effect of substituting 50% of skim milk powder with chickpea on the essential and non-essential amino acids. From the obtained data, it is clear that ice milk made chickpea had higher content from both total and non-essential amino acids and total essential amino acids except isoleucine, valine, threonine, and methionine, compared with ice milk made without chickpea (control). Amino acid analysis showed a high content of lysine , Glutamic, and Leucine in treatment T3 than these in control. This might be because a high content of proteins chickpea with this acids. Therefore, it can be seen that substitution of ice milk powder in ice milk mixes with chickpea was more effective in increasing some essential and non-essential amino acids than that of control treatment.

Concentration of fibers and some minerals:

Table (9) shows a remarkable increase in crude fibers and minerals (selenium, iron, manganese, potassium and zinc) in ice milk made with 50% substitution of SMP with chickpea. This increase could be attributed to chickpea added which content high content of fibers and minerals [8.8 fibers, Se (0.170mg/g), Fe (6.9 mg/g), Mn (17.35mg/g), k (771.8 mg/g) and Zn (3.83 mg/g) (Table 2&3).

Organoleptic quality of the resultant ice milk:

The effect of chickpea on flavour, body and texture of fresh ice milk and during 2,4,6 and 8 weeks of storage periods at -15°C is shown in Table (10). It was found that the addition of chickpea to replace SMP in the ice milk increased the scores of body and texture and melting properties of the obtained up to 4 weeks after 8 weeks of storage period these declined than control.

Table (8). Effect of replacing of skim milk powder with chickpea flour on amino acids.

Type	Amino acids*(g/100g)	C	T3
Essential amino acid	Lysine	0.686	0.452
	Isoleucine	0.635	0.610
	Leucine	1.436	1.579
	Phenylalanine	0.465	0.834
	Tyrosine	0.429	0.579
	Histidine	0.365	0.590
	Valine	0.752	0.616
	Threonine	0.643	0.636
	Methionine	0.185	0.139
Non-Essential amino acid	Aspartic	1.273	1.681
	Glutamic	2.742	3.162
	Serine	0.809	0.903
	Proline	0.267	0.336
	Glycine	0.319	0.364
	Alanine	0.53	0.714
	Arginine	0.261	0.366
Total Essential amino acid		5.939	6.269
Total Non-Essential amino acid		6.201	7.526

C= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T3= ice milk made with 50% substitution of skim milk powder with chickpea.

Table (9). Concentration of crude fibers (%) and some minerals (mg/100g) of ice milk " on dry weight basis ".

Constituents	treatments*	
	C	T3
Fibers (%)	0	0.26
Se (mg/100g)	0.103	0.107
Fe (mg/100g)	11.983	19.493
Mn (mg/100g)	0.347	3.622
K (mg/100g)	543.178	568.795
Zn (mg/100g)	4.428	6.983

C= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T3= ice milk made with 50% substitution of skim milk powder with chickpea.

Table (10). Effect of replacing skim milk powder with chickpea flour on the organoleptic properties of ice milk stored for 8 weeks at -18°C ±2.

Treatment	StoragePeriod (weeks)																								
	Flavour (45)					Body and texture (35)					Melting properties (10)					Colour (10)					Total scores(100)				
	0	2	4	6	8	0	2	4	6	8	0	2	4	6	8	0	2	4	6	8	0	2	4	6	8
C	42	42	42	41	41	32	32	32	31	31	8	8	7	7	7	9	9	8	8	8	91	91	89	88	88
T1	41	42	42	40	40	32	32	32	31	31	8	8	8	8	7	8	8	8	8	8	91	90	90	87	86
T2	41	41	41	40	40	32	32	32	31	30	8	9	9	8	8	8	8	7	7	7	90	90	89	86	85
T3	41	41	40	40	40	32	32	32	32	31	8	9	9	9	8	8	7	7	6	6	90	89	88	86	85
T4	41	39	36	34	32	31	31	29	27	25	8	8	7	6	7	6	7	6	5	5	88	85	77	72	70
T5	41	39	36	32	32	31	31	25	23	22	8	8	7	7	6	6	7	6	6	5	88	85	75	70	65

C= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with chickpea flour at the ratio of 10,25,50,75,100% respectively.

The scoring of flavour and colour decreased during the storage period by increasing the replacement ratio above 50%. This is may be due to the negative effect of that high concentration of chickpea on taste and colour of final products. Although.

All ice milk samples were accepted by the panelists up to 4 weeks, ice milk samples made by replacing 10, 25 and 50%.

After 8 weeks of storage period the average values of each flavour, colour, melting quality, body and texture decreased slightly in control, T1, T2, and T3 while in treatments T4 and T5 decreased markedly (Table 10). These results might be because a negative effect of that high concentration of chickpea concentration on the taste and colour of final products.

The importance of using chickpea in ice milk not only for protein and fibers contents but also for improving various characteristics. It could be recommended that, we can manufacture ice milk with high nutritional value and good physical and organoleptic properties by replacing up to 50% of skim milk powder with chickpea without adversely affect during storage 4 weeks.

Table (11). Statistical analysis of chemical composition and physical properties of ice milk mixes made with different replacement levels of skim milk powder with chickpea flour.

Ice milk mix properties	Effect of treatments multiple comparisons						
	Mean Square	C*	T1	T2	T3	T4	T5
Total solid %	0.013*	A	AB	AB	B	B	C
Fat %	0.035*	D	CD	BC	AB	AB	A
Protein %	0.038*	A	AB	B	C	D	E
Ash %	0	A	AB	B	C	D	D
Acidity %	0	A	B	C	C	D	DE
pH value	0.025*	E	E	D	C	B	A
Specific gravity(g/cm3)	0.001*	F	E	D	C	B	A
Weight/gallon (Kg)	0.008*	F	E	D	C	B	A
Viscosity (cp)	304644.9*	F	E	D	C	B	A
Freezing point(Cº)	0.546*	F	E	D	C	B	A
Whipping ability (as overrun %) After 5 min	60.749*	D	C	B	A	E	F
10 min	26.999*	D	C	B	A	E	F
15 min	116.116*	D	C	B	A	E	F
20 min	117.907*	D	C	B	A	E	F

C= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with chickpea flour at the ratio of 10,25,50,75,100% respectively. * Significant at 0.05% level.
* For each effect the different letters in the same row means the multiple comparisons are different from each other. Letter A is the highest mean followed by B, C, …. Etc.

Table (12). Statistical analysis of physical and organoleptic properties of the resultant ice milk made with different replacement levels of skim milk powder with chickpea flour.

Ice milk properties	Effect of treatments multiple comparisons						
	Mean Square	C*	T1	T2	T3	T4	T5
Specific gravity(g/cm3)	0.002*	C	D	E	F	B	A
Weight/gallon (Kg)	0.046*	C	D	E	F	B	A
Overrun%	18.539*	D	C	B	A	E	F
Melting resistance loss %) After							
45 min	2.105*	A	B	C	D	E	F
75 min	3.009*	A	B	C	D	E	F
90 min	46.664*	A	B	C	D	E	F

C= control ice milk made with 4% skim milk powder (SMP) as a source of milk solids not fat (MSNF).
T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with chickpea flour at the ratio of 10,25,50,75,100% respectively. * Significant at 0.05% level.
* For each effect the different letters in the same row means the multiple comparisons are different from each other. Letter A is the highest mean followed by B, C, …. Etc.

It could be concluded that, replacement of skim milk powder with chickpea did not affect significantly the total solids, ash content, acidity and pH values of the resultant ice milk samples. Also, the overrun, melting resistance, crude fiber, total essential amino acids and non-essential amino acids.

It is possible to make a good quality ice milk with replacing up to 50% skim milk powder with chickpea and can store the ice milk at -18 °C in a deep freezer up 4 weeks without adversely affect.

REFERENCES

Arbuckle, W. S. (1986). Ice cram. 14th Ed., the AVI punlishing Co. INC. West port. Connecticut, U.S.A.

Chavan, J.K., S.S. Kadam and D.K. Salunke (1989). Biochemistry and technology of chickpea (*C. arietinum*) seeds. CRC Crit. Rev. Food Sci. Nutr. 25: 107-132.

Christodoulou, V., V.A. Bampidis, B. Hucko, K. Ploumi, C. Iliadis, P.H. Robinson and Z. Mudrik (2005). Nutritional value of chickpeas in rations of lactating ewes and growing lambs. Anim. Feed Sci Technol. 118: 229-241.

Friedman, M. (1996). Nutritional value of proteins from different food sources. A review. J. Agricultural and Food Chemistry, 44: 6 – 29.

Jood, S., B. M. Chauhan and A. C. Kapoor (1988). Contents and digestibility of carbohydrates of chickpea and black gram as affected by domestic processing and cooking. Food Chem.,30(2):113-127.

Kaur, M. and N. Singh (2007). Characterization of protein isolates from different Indian chickpea (*Cicer arietinum L)*. cultivars. *Food Chemistry*, 102: 366 - 374.

Khader, A. F., S. I. Farag, A. M. Moussa and A. M. El-Batawy (1992). The use of whey protein concentrate in ice cream mixes. Minufiya J. Agric. Res., 17: 637- 647.

Mahran, G. A., M. A. El-Ghandour, E. H. El-Bagoury and A.F. Sayed (1984). Effect of skim milk powder storage on ice cream quality. Egyptian J.Dairy Sci., 12:267.

Omar, R. H. (1983). Studies on the manufacture of frozen yoghurts. M. SC. Thesis Fac. Agric., Ain Shams Univ., Cairo Egypt.

Sánchez-Vioque, R., A. Clemente, J. Vioque, J. Bautista and F. Millán (1999). Protein isolates from chickpea (Cicer arietinum L.): chemical composition, functional properties and protein characterization. Food Chemistry, 64: 237-243.

Singh, D.G., A.W. Abas, D. Kaur and D.S. Sogi, Singh (1991). Characterisation and functional properties of proteins of some Indian chickpea (*Cicer arietinum*) cultivars. *Journal of the Science of Food and Agriculture*, 88(5): 778 - 786 .

Soukulis, C. and E. Rontogianni (2009). Exploiting the functionality of dietary fiber in ice cream systems and predicting their consumers acceptability using PLSR. Delegate Manual 6th Nizo Dairy Conference { p.58 } Papendal, the Netherlands.

Tasneem, R., S. Ramamani and N. Subramanian (1982). Functional properties of guar seed. (*cyamopsis tetragonoloba*) meal dexoxified by different methods. J. Food Sci., 47: 1323-1328.

Wang, N., D. W. Hatcher, R. T. Tyler, R. Toews and E.J. Gawalko (2010). Effect of cooking on the composition of beans (*Phaseolus vulgaris L.*) and chickpeas (*Cicer arietinum L.*). Food Research International 43: 589-594.

تأثير استبدال اللبن الفرز المجفف بدقيق الحمص علي جودة المثلوج اللبني

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الملخص العربى

الهدف الاساسى لهذا البحث هو دراسة تأثير إستبدال جزء من اللبن الفرز المجفف المستخدم فى تكوين مخلوط المثلوج اللبني بدقيق الحمص وذلك على صفات المثلوج اللبني الناتج .وقد تم تصنيع خمس معاملات لمخلوط المثلوج اللبني تم فيها إستبدال 10و25و 50و75و100%من كميةاللبن الفرز المجفف بدقيق الحمص. وقد أظهرت النتائج حدوث إنخفاض معنوي وجوهري في الوزن النوعي والوزن بالجالون ومعدل الإنصهار بزيادة كمية الحمص بينما حدثت زيادة جوهريه في معدل السريان بزيادة كمية الحمص حتي نسبة إستبدال 50%,وقد أظهر المثلوج اللبني المصنع من الاستبدال بالحمص بنسبة 50% اعلى نسبة من الحماض الامينية الكلية الاساسية والغير اساسية . وزيادة كمية الحمص نتج عنها زيادة جوهريه في كلا من الالياف الخام والمعادن مثل السيلينيوم والحديد والمنجنيز والبوتاسيوم والزنك في المثلوج اللبني ولاكن لم يكن هناك تغير جوهري في الجوامد الصلبه الكليه وكان هناك انخفاض جوهري في نسبه البروتين والرماد وكان الناتج النهائي يمتاز بالقوام الجيد والنكهه المقبوله وتحسنت كذلك قدره المثلوج اللبني علي الاحتفاظ بخواصه الجيده اثناء فتره التخزين .ومن النتائج المتحصل عليها يمكننا استخدام دقيق الحمص كبديل للبن الفرز المجفف حتي نسبة 50% في صناعة المثلوجات اللبنيه .