Replacing Skim Milk Powder With White Sweet Lupin Flour For Ice Milk Manufacture

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ABSTRACT

Replacement of skim milk powder with white sweet lupin flour did not affect significantly (P>0.05) the total solids, while affected significantly total protein, fat ,ash, acidity and pH values of resultant ice milk. Viscosity, freezing point, whippability, overrun, melting resistance, both essential and nonessential amino acids, fibers and minerals content (Zn, Fe, Mn and Se) increased significantly by this replacement. Increasing the rate of replacement up to 25% did not affect the organoleptic properties (body and texture, melting properties and flavour). It could be recommended that, we can manufacture ice milk with high nutritional value and good physical and organoleptic properties by replacing up to 25% of skim milk powder with white lupin flour without any diverse effect during freeze storage for 8weeks.

Keywords: Sweet lupin, skim milk, ice milk, physical and organoleptic properties.

INTRODUCTION

The demand for functional foods is growing rapidly all over the world due to the increase awareness of the consumers on the impact of food health.(Stoon,2002).

The future promises changes in the composition and form of frozen dairy desserts, as frozen dairy desserts can carry health-promoting constituents, and the nutraceutical concept (Marshall & Goff, 2003).

The increasing demand for local agricultural sources that can supply our requirements for food and raw material stimulates the research to explore and evaluate the chemical potentialities of our agricultural resources.

Lupin is an economically and agriculturally valuable plant (Sujak *et al.* 2006*,* Gulewicz *et al.* 2008). Lupins (*Lupinus* spp.) belong to the *Genisteae* family, *Fabaceae or Leguminosae* (Uzun *et al.* 2007*,* Pastor-Cavada *et al.* 2009).

Kohajdova *et al.* (2011) reported that legume seeds are an abundant source of proteins and, among them, lupin is one of the richest. Lupin seed deserves great interest due to its chemical composition and augmented availability in many countries in recent years. The review reports on the current knowledge about nutritional characteristics (proteins, amino acids, starch, sugars, fiber, lipids, fatty acids, vitamins, anti nutritional compounds) and potential use of different lupin seed products (flour, kernel fiber, protein isolates and concentrates) for baking applications. The influence of lupin addition on the rheological properties of dough and quality of final products are also described. A separate part of the article is focused on the foaming and emulsifying properties of lupin proteins. Chemical composition of white lupin seeds*(Lupinus albus* L.)was 8.32% moisture, 32.2% crude protein, 16.2% crude fiber, 5.95% crude fat,2.65% ash and0.13% acidity (Erbas *et al.*, 2005). Pilvi (2006) found that lupin inclusion in the diet had a protective effect by normalizing vascular function of salt loaded rats. Australian sweet lupin foods reduce transit time, lower the colon pH (anti cancer) and act as a 'pre-biotic' therefore are potentially very beneficial for bowel health (Johnson *et al.,* 2006, Smith *et al.,* 2006).

In view of the aforementioned informations the objectives of the present study were to evaluate the possibility of making a good quality ice milk by using sweet lupin flour to substitute various levels of skim milk powder and studying their effects on physico-chemical properties of the mix and the resultant ice milk as well as the sensory properties of the resultant ice milk.

MATERIALS AND METHODS

Materials:

Dairy ingredients:

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

Skim milk powder (SMP) was obtained from United States of America by Obour land for food industry, EL Obour city, Cairo, Egypt. Cream was obtained by separating fresh whole buffaloes milk in the pilot plant of department of Dairy Science and Technology, Faculty of Agriculture, Minufiya University, Shibin El-kom, Egypt. The gross composition of the dairy ingredients used is given in Table (1).

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	16.9	7	4.18	0.91	4.81
Fresh skim milk	9.2	0.1	3.7	0.82	4.58
Skim milk powder	96	0.5	35.3	8.2	52
Cream	47.45	40	2.88	0.66	3.91

Non –dairy ingredients:

Commercial grade crystalline sucrose was obtained from the local market. Vanillin powder was obtained from the local market. Sweet white lupin flour (*Lupinus* ssp.) was obtained from the local performing market of Shebin El kom, Egypt.

Sodium carboxy methyl cellulose(CMC) was obtained from Obour land for Food Industry ,EL Obour City, Cairo, Egypt.

Methods

Technological Methods:

Sweet white lupin flour :

Seeds were cleaned, separated from forgein matters, soaked in water (1-5 w/v) for 12 hr water was changed (2-3times) then, the seeds were cooked in water (1:5 w/v) on a hot plate until it become semi soft as felt between fingers, dried in an air oven at 55°C and then ground to obtain a flour of 60 mesh. The flour obtained was stored in tightly closed bag until the time of use.

Table 3: Mineral contents of sweet white lupin flour, (mg/100g on dry weight)

Component	Mn	Fe	Mg	K	Se	Zn
White lupin	28.23	16.3	200.30	96.700	0.196	16.01

Composition of sweet white lupin flour is shown in Table (2) and its mineral content is shown in Table (3).

Manufacture of ice milk mix:

Vanillia ice milk mix contained 6% fat, 13% milk solid not fat (SNF), 15% sugar, 0.4% stabilizer and the adequate of vanillin was added. Skim milk powder was used to supply the milk solid not fat in control mix , sweet white lupin flour was used to substitute 10, 25, 50, 75 and 100% of the amount of skim milk powder. All mixes were manufactured to ice milk as reported by Arbuckle (1986) using ice cream machine (Taylor, Model, 103, Italy). Each batch was about two kilograms (2Kg). The resultant ice milk was filled into polyvinyl chloride PVC cups (cap. 100 ml) covered and put in refrigerator for physical and sensory analysis and put in deep freezer for chemical analysis. Five replicates were done for every treatment.(Table 4).

Analytical Methods:

Chemical Analysis:

Total solids content were determined according to the AOAC (2000).

Acidity, pH values and milk fat were determined according to the methods described by Ling (1963).

Milk protein contents (total nitrogen × 6.38), white lupin (total nitrogen × 5.45) and ash contents were estimated as in the AOAC (2000).

Carbohydrate content was calculated by difference according to Guzman *et al.* (1999) as follows

Carbohydrate (%) =
total solids – (total protein + fat + ash)

Mineral contents were determined according

Table 2: Gross composition of sweet white lupin flour used for ice milk making (g/100g)

Component	Moisture	Crude fat	Crude protein	Total carbohydrate	Crude fiber	Ash	Energy value cal/100gm
White lupin	9.35	11.5	41.60	29.10	14.2	3.6	341.6

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

Raw materials g	Ice milk mixes*					
	C	T1	T2	T3	T4	T5
Fresh skim milk	1156	1156	1156	1156	1156	1156
Fresh cream	400	400	400	400	400	400
Skim milk powder	134	120.6	100.5	67	33.5	0
white lupin flour	0	13.4	33.5	67	100.5	134
Cane sugar (15%)	300	300	300	300	300	300
CMC	8	8	8	8	8	8
Vanilla	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 (SNF).

*T1, T2, T3, T4, and T5= ice milk samples made by substituting skim milk powder(SMP) with white lupin flour at the ratios of 10,25,50,75,100%, respectively.

to Shoale *et al.* (1997) and modified by Allen *et al,* 1997 .Fiber content was measured as described by AOAC(2000). Free amino acids were determined according to Ivana *et al.* (2009).

Physical Analysis:

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

The weight per gallon of ice milk was calculated in kilogram (Kg) according to Arbuckle (1977). Freezing point was measured as described in the FAO (1977) using an electronic thermometer (Wheatson 650 , typ-k , chromel-alvmel). Viscosity was determined as given by Morrison & Macjary (2001).

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

The overrun percent was calculated according to Arbuckle (1986) using the following equation:

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

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

Sensory Evaluation:

The organoliptic properties for the resultant ice milk were assessed by 30 panelists from the staff members of Dairy Science and Technology Department, Faculty of Agric., Minufiya Univ., Shebin El-kom, Egypt .

Statistical Analysis.

Factorial design 1 and 2 factors ,3 replicates was used to analyze all the data and student newman keuls test was followed to make the multiple comparisons (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Chemical composition of mixes:

The chemical composition of ice milk as affected by different replacement levels of skim milk powder with white lupin flour are demonstrated in Table (5).

Fat and total solid (TS) contents:

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, 6.2, 6.4, 6.5,and 6.7% for treatments C,T1, T2, T3, T4 and T5, respectively (Table 5). Statistical analysis revealed that the control treatment was significantly lower ($P \leq 0.05$) than treatment T5, this result may be due to the higher fat content of white lupin than that of skim milk powder

Regarding the effect of replacing skim milk powder with white lupin flour on the total solid

Table 5: Chemical composition of ice milk mixes made with different replacement levels of skim milk powder with white lupin flour

Components	Treatments*					
	C	T1	T2	T3	T4	T5
Total solids%	34.51[d]	34.52[d]	34.5[cd]	34.47[bc]	34.45[ab]	34.42[a]
Fat %	6[a]	6.1[ab]	6.2[b]	6.4[c]	6.5[c]	6.7[d]
SNF %	13	13	13	13	13	13
Total protein %	4.84[a]	4.85[a]	4.89[b]	5.12[c]	5.25[d]	5.36[e]
Ash %	1.092[a]	1.09[ab]	1.087[b]	1.076[d]	1.068[c]	1.062[e]
Acidity %	0.2[e]	0.2[de]	0.201[d]	0.202[c]	0.206[b]	0.211[a]
pH value	6.62[a]	6.61[a]	6.6[b]	6.57[c]	6.53[d]	6.49[e]

* See Table (4) for details
For each effect the different letters in the same row means the multiple comparisons are significantly different from each other at 0.05% level

contents of mixes, the mean values were 34.51, 34.52, 34.50, 34.49, 34.47 and 34.41% for treatments C, T1, T2, T3, T4, and T5, respectively. It is obvious from Tables(4 & 5) that there were no 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 white lupin flour.

Protein content:

The protein content in white lupin flour mixes were 4.84, 4.85, 4.89, 5.12, 5.25 and 5.36 % for treatments C, T1, T2, T3, T4, and T5 respectively (Table 5). These results might be due to the little higher protein content of white lupin flour than that of skim milk powder (Tables 1 & 2) and (Fig. 1) .

The proportional replacement of skimmed milk powder with white sweet lupin flour caused a significant increase (P≤0.05) in the protein content of ice milk mixes (Table 5).There were no significant difference in protein content between control, and T2, T1. The difference in protein content was significant (P≤0.05) between both of control, T1,T3 and all other treatments.

Ash content:

Ash content of ice milk mixes made with either skim milk powder or white lupin flour are shown in (Table 5). Ash content of ice milk mixes were 1.092, 1.091, 1.087, 1.076, 1.068 and 1.062 % for treatments C, T1, T2, T3, T4, and T5, respectively.

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

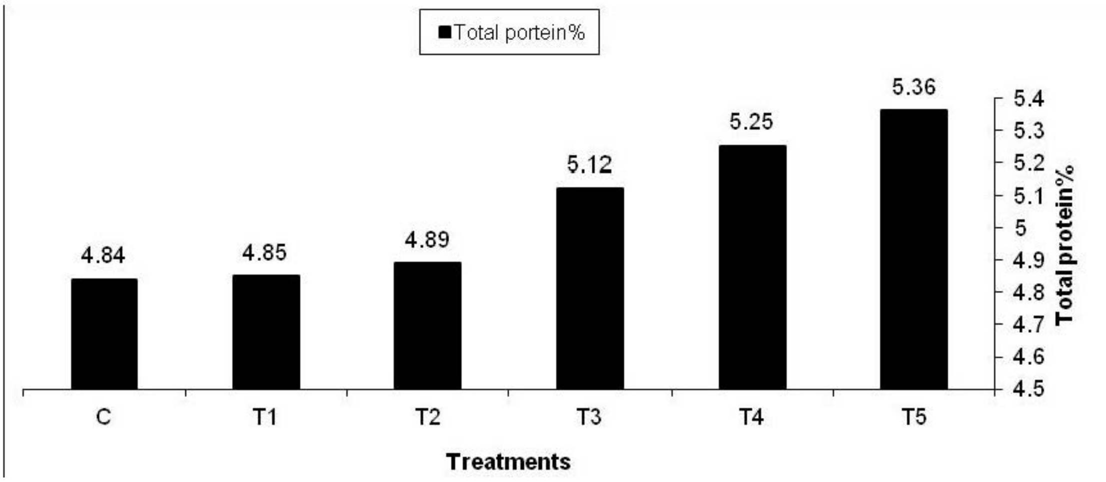

Fig. 1: Effect of replacing skim milk powder with lupin on total protein of ice milk.

* See Table (4) for detais

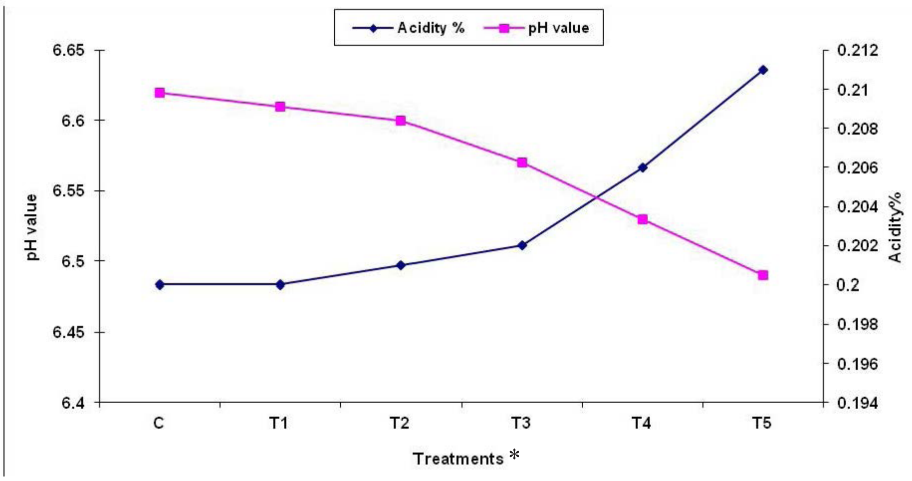

Figure (2). Effect of replacing skim milk powder with lupin on acidity and pH values of ice milk

*See Table (4) for details

Acidity and pH values

Data in Table (5) and (Fig 2) revealed that, the proportional replacement of skim milk powder by white lupin flour led to gradual increase in acidity content of ice milk mix. The pH value decreased in the white lupin flour mixes than the control. Increasing of acidity was proportional to the rate of replacement skim milk powder with white lupin flour, which means a positive relation between the acidity of ice milk and the rates of replacement.

The increase of acidity by increasing the rate replacement may be due to the white lupin flour protein, also due to the increase of protein content of white lupin flour than skim milk powder (Tables (1 & 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 1.073, 1.082, 1.097, 1.107, 1.115 and 1.121 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 white lupin flour increased. The mean values of weight per gallon in kilogram (kg) were 4.061, 4.095, 4.118, 4.147, 4.192 and 4.235 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 partial replacement of skim milk powder with white lupin flour in making ice milk caused a significant (P≤0.05) increase in the Specific gravity, weight / gallon. From Table (6) it could be seen that the control treatment was significantly lower (P≤0.05) than the other treatment

Viscosity:

The results in Table (6) indicated that the replacement of skim milk powder with white lupin flour affected significantly (P≤0.05) the viscosity of ice milk mix. Viscosity of control ice milk mix was 96 CP while those of treatments T1, T2, T3, T4, and T5 were 128, 280, 370, 700 and 960 CP, respectively. The viscosity of ice milk increased with increasing the level of added white lupin flour, which can be attributed to the effect of soluble fibers, which had exceptional water binding capacity and ability to enhance viscosity (Wang *et al.* 1998). Adapa *et al.* (2000) reported that the addition of protein-based and carbohydrate-based fat replacers might improve the viscosity of ice cream mix and frozen ice cream. El-Nagar & Kuri (2001) reported that the addition of inulin to frozen yoghurt mixes increased its viscosity, which they attributed to inulin acting as a stabilizer due to its high capacity to bind water.

Table 6: Effect of replacing of skim milk powder with white lupin flour on ice milk mixes properties

Properties	Treatments*					
	C	T1	T2	T3	T4	T5
Specific gravity(g/cm3)	1.073[a]	1.082[b]	1.097[c]	1.107[d]	1.115[e]	1.121[f]
Weight/gallon (Kg)	4.061[a]	4.095[b]	4.118[c]	4.147[d]	4.192[e]	4.235[f]
Viscosity (Cp)**	96[a]	128[b]	280[c]	370[d]	700[e]	960[f]
Freezing point (°C)	-2.3[a]	-2.1[b]	-1.9[ab]	-1.7[c]	-1.4[d]	-1.1[e]
Whipping ability (as overrun %)						
After 5 min	13.6[c]	14.1[d]	20.2[e]	21.9[f]	12.5[b]	9.6[a]
10 min	35[c]	36.3	39.7[f]	39.45[e]	32.6[b]	31.1[a]
15 min	45.3[c]	47[d]	50.8[e]	55.9[f]	40.2[b]	38.15[a]
20 min	44.2[c]	46.5[d]	49.6[e]	55.2[f]	38.75[b]	37.3[a]

* See Table (4) for details

For each effect the different letters in the same row means the multiple comparisons are significantly different from each other, at 0.05% level.

Freezing point (°C):

The freezing point of ice milk mixes increased by using white lupin flour (Table 6). Freezing point of ice milk were -2.3, -2.1, -1.9, -1.7, -1.4 and -1.1°C for treatments C, T1, T2, T3, T4 and T5, respectively. This is probably due to the lower lactose content in treatments made with white lupin flour compared to the control. Omar (1983) mentioned that the freezing point of ice cream was lowered by increasing the percentage of MSNF which contained lactose and minerals, as freezing point of ice cream is dependent on soluble constituent in mix (Arbuckle, 1986). The differences among ice milk mixes in freezing point were significant (P≤0.05) .

Whippability:

The whippability of ice milk mix increased by replacing up to 50% of skim milk powder with white sweet lupin flour (Table 6). This could be attributed to the high soluble fiber , protein , and carbohydrates content of the white lupin flour which act as a stabilizer. El-Nagar & Kuri (2001) indicated that increased additions of inulin to frozen yoghurt mixes probably formed stable gel networks reducing its melting rates. Also, Blomsma (1997) reported that inulin had the ability to stabilize the structure of aqueous phase.

Physical properties of the resultant ice milk:

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

Specific gravity is one of the important physical properties of ice milk. It gives some information about the incorporated air and melting quality of ice milk. As the specific gravity decreased, the weight per gallon decreased (Table 7). It could be also seen that the weight per gallon kg of ice milk are closely related to their specific gravities. Specific gravity and weight per gallon of resultant ice milk decreased gradually when the substituting rates of skim milk powder were 10, 25, and 50% with white lupin flour. Specific gravity decreased from 0.741 for the control treatment to 0.738, 0.732 and 0.725 for treatments T1, T2 and T3, respectively. This might be due to the increase of overrun. The increase in specific gravity and weight per gallon increased by increasing the replacement ratio of skim milk powder with white lupin flour to 75% which could be attributed to the higher viscosity of ice milk mix and the decrease of overrun. The differences among ice milk treatment were significant ($P \leq 0.05$). Mahran *et al.* (1984) stated that the specific gravity of ice milk is inversely related to changes in the overrun, which in agreement with the present results.

Table 7: Effect of replacing of skim milk powder with white lupin flour on properties of the resultant ice milk

Properties	Treatments					
	C	T1	T2	T3	T4	T5
Specific gravity(g/cm3)	0.741[d]	0.738[c]	0.732[b]	0.725[a]	0.792[e]	0.821[f]
Weight/gallon (Kg)	2.776[d]	2.771[c]	2.621[b]	2.554[a]	2.916[e]	3.107[f]
Overrun %	45.86[c]	46.24[d]	48.73[e]	52.75[f]	44.61[b]	43.52[a]
Melting resistance loss %						
At 25 °C after 15 min	0.0	0.0	0.0	0.0	0.0	0.0
45 min	10.3[f]	8.1[e]	7.5[d]	7[c]	6.8[b]	6.5[a]
75 min	40.2[f]	38.4[e]	38.1[d]	37.1c	35.3[b]	33.6[a]
90 min	100[f]	91.6[e]	89.5[d]	88.1[c]	87.9[b]	87.2[a]

See Table (4) for details.

For each effect the different letters in the same row means the multiple comparisons are significantly different from each other at 0.05% level.

Overrun:

The effect of replacing skim milk powder with white lupin flour on the overrun of the resultant ice milk was presented in Table(7). Replacement of skim milk powder with white lupin flour up to 50% caused a pronounced increase in the overrun of ice milk (Table7). Overrun values of ice milk were 45.86, 46.24, 48.73, 52.75, 44.61 and 43.52 for treatments C, T1, T2, T3, T4 and T5, respectively. The differences among these means were significant ($P \leq 0.05$)

There were positive relation between the overrun and the rate of replacing skim milk powder with white lupin flour which means that the overrun increased by increasing the rate of replacing skim milk powder with white lupin flour up to 50%. This increase in overrun at replacing ratio of 10, 25, and 50% with white lupin might be due to the better functional properties (whipping and foam ability) of flour proteins. Increasing the replacement rate above 50% caused a reduction in overrun (Table 7). The decrease in overrun could be attributed to the more 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, 8.1, 7.5, 7.0, 6.8, and 6.5% for treatments C, T1, T2, T3, T4 and T5, respectively. The corresponding portion were 40.2, `38.4, 38.1, 37.1, 35.3, and 33.6% after 75 minutes and 100.0, 91.6, 89.5, 88.1, 87.9, and 87.2% after 90 minutes.

Replacing skim milk powder with white lupin flour caused an-obvious decrease in the rate of melting. The increase of melting resistance of ice milk was proportional to the amount of white lupin flour used. This increase could be attributed to higher water hydration capacity of white lupin flour. 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 white lupin flour. These results are in accordance with Arbuckle (1986),who 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 indicated that the differences between treatments at 15, 45, 75, and 90 minutes were decreased significantly ($p \leq 0.05$) different between all treatments.

Amino acid contents:

The data in Table (8) show that the effect of substituting 25% of skim milk powder with white lupin flour on the essential and non-essential amino acids. A pronounced increase in both total non-essential amino acids and total essential amino acids content in ice milk made with white lupin flour, compared with ice milk made without white lupin flour (control). This might be due to a high content of proteins white lupin flour with this acids. Therefore, it can be seen that substitution of ice milk powder in ice milk mixes with white lupin was more effective in increasing some essential and non-essential amino acids than that of control treatment.

Concentration of fibers and some minerals:

The results in Table (9) indicated a remarkable increase in fibers and minerals (selenium, iron, zinc, and manganese) in ice milk made with 25% substitution of skim milk powder with white lupin flour. This increase could be attributed to higher content of fibers (14.2%) and minerals (3.6%) in white lupin flour than those of skim milk powder (Tables 2 & 3).

Organoleptic quality of the resultant ice milk:

The effect of white lupin flour 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) and (Fig 3).

Table 8: Effect of replacing of skim milk powder with white lupin flour on amino acids (g/ 100g of ice milk, on dry weight basis)

Type	Amino acids	C*	T2*
Essential amino acid	Lysine	0.686	0.942
	Isoleucine	0.635	0.884
	Leucine	1.436	2.15
	Phenylalanine	0.465	0.86
	Tyrosine	0.429	0.761
	Histidine	0.365	0.804
	Valine	0.752	0.91
	Threonine	0.643	0.853
	Methionine	0.185	0.212
Non-Essential amino acid	Aspartic	1.273	1.861
	Glutamic	2.742	3.25
	Serine	0.809	1.167
	Proline	0.267	0.46
	Glycine	0.319	0.505
	Alanine	0.53	0.839
	Arginine	0.261	0.38
Total Essential amino acid		5.596	8.376
Total Non-Essential amino acids		6.201	8.462

*See Table 4 for details.

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

Constituents	Treatments*	
	C	T2
Fibers (%)	0	0.404
Se (mg/100g)	0.103	0.112
Fe (mg/100g)	11.983	17.349
Mn (mg/100g)	0.347	3.103
K (mg/100g)	543.178	550.441
Zn (mg/100g)	4.428	5.524

*See Table (4) for details

It was found that the addition of white lupin flour to replace SMP in the ice milk increased the scores of body and texture and melting properties

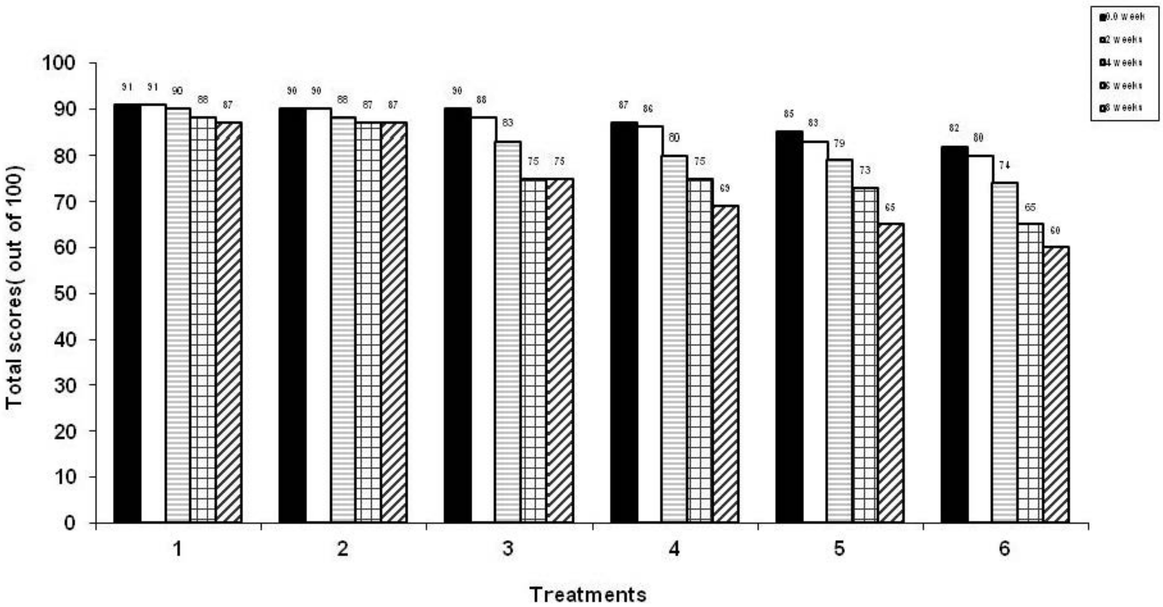

Figure (3). Effect of replacing skim milk powder with lupin on the organolepties of ice milk stored for 8 weeks at -18°C ±2.

*See Table (4) for details

of the obtained product up to 4 weeks but after 8 weeks of storage period these declined than control.

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 high concentration of white lupin flour on taste and colour of final products. Although all ice milk samples were accepted by the panelists up to 4 weeks. After 8 weeks of storage 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 due to a negative effect of high concentration of white lupin flour on the taste and colour of final products.

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

Treatment*	Flavour (45)					Body and texture (35)					Melting properties (10)					Colour (10)					Total scores(100)				
	Storage Period (weeks)					Storage Period (weeks)					Storage Period (weeks)					Storage Period (weeks)					Storage Period (weeks)				
	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	41^{a}	42^{a}	42^{a}	41^{a}	41^{a}	31^{a}	32^{a}	32^{a}	31^{a}	31^{a}	7^{a}	8^{a}	8^{a}	8	7^{a}	9^{a}	9^{a}	8^{a}	8^{a}	8^{a}	88^{a}	91^{a}	90^{a}	88^{a}	87^{a}
T1	41^{a}	42^{a}	41^{a}	41^{a}	41^{a}	31^{a}	31^{a}	31^{a}	31^{a}	31^{a}	7^{a}	8^{a}	8^{a}	8	8^{b}	9^{a}	9^{a}	8^{a}	7^{a}	7^{a}	88^{a}	90^{a}	88^{a}	87^{a}	87^{a}
T2	41^{a}	41^{a}	41^{a}	40^{a}	40^{a}	31^{a}	32^{a}	32^{a}	32^{a}	31^{a}	7^{a}	9^{b}	8^{a}	8	8^{b}	8^{b}	8^{b}	8^{a}	7^{a}	7^{a}	87^{a}	90^{a}	89^{a}	87^{a}	86^{a}
T3	40^{b}	40^{b}	38^{b}	37^{b}	36^{b}	31^{a}	32^{a}	31^{a}	29^{b}	27^{b}	8^{b}	9^{b}	8	6^{b}	6^{c}	7^{c}	6^{c}	6^{b}	5^{b}	5^{b}	86^{a}	87^{b}	83^{b}	77^{b}	74^{b}
T4	40^{b}	38^{c}	37^{b}	34^{c}	31^{c}	31^{a}	31^{a}	31^{a}	28^{b}	28^{b}	8^{b}	8^{b}	8	6^{b}	6^{c}	6^{d}	6^{c}	5^{b}	5^{b}	4^{b}	85^{ab}	83^{c}	81^{b}	73^{c}	69^{c}
T5	8^{c}	36^{d}	33^{c}	29^{d}	28^{d}	31^{a}	31^{a}	30^{b}	27^{bc}	27^{bc}	8^{b}	8^{b}	7	6^{b}	5^{d}	5e	5^{d}	4^{bc}	3^{c}	3^{bc}	82^{b}	80^{d}	74^{c}	65^{d}	60^{d}

*See Table (4) for details

For each effect the different letters in the same column means the multiple comparisons are Significantly different from each other at 0.05% level.

The importance of using white lupin flour 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 25% of skim milk powder with white lupin flour without adverse affect during storage for 4 weeks.

It could be concluded that, replacement of skim milk powder with white lupin flour did not affect significantly (P>0.05) the total solids, while affect significantly total protein, fat and ash content, acidity and pH values of resultant ice milk samples, while increased significantly viscosity, freezing point, whipping ability, overrun, melting resistance, both essential and non-essential amino acids, fibers and minerals content (Zn, Fe, Mn and Se). Increasing the rate of replacement up to 25% did not affect the organoleptic properties (body and texture, melting properties and flavour). It is possible to make a good quality ice milk with replacing up to 25% skim milk powder with white lupin flour and can store the ice milk at -18 °C up to 4 weeks without adverse affect.

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الاستبدال الجزئى للبن الفرز المجفف بمسحوق الترمس الأبيض الحلو في صناعة المثلوج اللبنى

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الهدف الاساسى لهذا البحث هو دراسة تأثير استبدال جزء من اللبن الفرز المجفف المستخدم في تكوين مخلوط المثلوج اللبني بمسحوق الترمس الحلو وذلك على صفات المثلوج اللبنى الناتج .وقد تم تصنيع خمس معاملات لمخلوط المثلوج اللبنى تم فيها إستبدال ١٠ و٢٥ و٥٠ و٧٥ و١٠٠٪من كمية اللبن الفرز المجفف بمسحوق الترمس. وقد أظهرت النتائج عدم تأثر الجوامد الكلية بينما تأثر معنويا كل من نسبة البروتين الكلى والدهن والرماد والحموضة وقد زاد بفروق معنوية كل من اللزوجة ونقطة التجمد والقدرة على الخفق و معدل السريان والمقاومة للانصهار والاحماض الأمينية الأساسية وغير الأساسية والألياف الخام والمعادن مثل السيلينيوم والحديد والمنجنيز والبوتاسيوم والزنك بزيادة كمية مسحوق الترمس في المثلوج اللبنى. ولم تتأثر الخواص الحسية عكسيا بزيادة كمية مسحوق الترمس حتي نسبة استبدال ٢٥٪ . ولذلك فإنه يمكن صناعة مثلوج لبنى جيد حتى نسبة استبدال ٢٥ ٪ و تخزينه على -١٨°م لمدة أربعة أسابيع دون حدوث تأثيرات عكسية علي جودة المنتج.