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تأثير استبدال اللبن الفرز المجفف بالرتنتات على جودة المثلوج اللبنى

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الملخص العربي:

في هذا البحث تم تصنيع ٤ معاملات من المثلوج اللبنى حيث تم استبدال اللبن الفرز المجفف المستخدم فى صناعة المثلوج اللبنى بنسب ٥٠،٠ ، ٧٥ ، ١٠٠٪ من الرتنتات المجففة والتي تمتاز بارتفاع نسبة البروتين به حوالي ٧٤٪ كما يقل محتواها من اللاكتوز ١١.٩% بالإضافة إلى أنها ذات خواص وظيفية هامة فهي ترفع القدرة على الارتباط بالماء وتُحسن القابلية للخفق وترفع نسبة الريع في المنتج بالإضافة إلى أنها تُحسن من جودة خاصية الانصهار للآيس كريم وبذلك فإن استخدام الرتنتات المجفف يجعل هذا المنتج مناسب للأشخاص ذو الحساسية للاكتوز ولقد تمت الدراسة بغرض معرفة تأثير الاستبدال للبن الفرز المجفف بالرتنتات المجففة على جودة المثلوج اللبنى، وكانت أهم النتائج المتحصل عليها ما يلي :

١ – أدى استبدال اللبن الفرز المجفف بواسطة الرتنتات لعدم وجود فروق معنوية بين المعاملات بالنسبة للجوامد الكلية ، بينما أدى لزيادة في نسب الدهن والبروتين والرماد والحموضة في المخاليط والوزن النوعي والوزن بالجالون واللزوجة ونقطة التجمد وكانت الزيادة معنوية مع زيادة نسبة الاستبدال بالرتنتات. كما أدى الإستبدال أيضا لزيادة قابلية المخاليط للخفق والنسبة المئوية للريع والمقاومة للانصهار وأن هذه الزيادة تزيد بزيادة نسبة الإستبدال بالرتنتات حتى ١٠٠% استبدال ومن جهة أخرى حدث انخفاض لقيم الـ pH واللاكتوز.

٢- زادت نسبة اللاكتوز/الوسط المائي في العينة الكنترول عن المخاليط المحتوية على الرتنتات كذلك نسبة اللاكتوز/البروتين أخذت نفس الاتجاه.

٣- انخفض الوزن النوعي والوزن بالجالون والريع والمقاومة للانصهار للمثلوج اللبني الناتج مع زيادة نسبة الاستبدال بالرتنتات.

٤- كما لوحظ زيادة محتوى المثلوجات اللبنية المحتوية على ٧٥٪ رتنتات من الأحماض الأمينية الضرورية والأحماض الأمينية الغير ضرورية، وكذلك المحتوى من العناصر المعدنية وهى "الحديد والزنك والسلينيم والمنجنيز" ، بينما حدث انخفاض في عنصر البوتاسيوم بالمقارنة بالعينة الكنترول.

٥- ارتفعت درجات التحكيم للمثلوج اللبنى بزيادة نسبة الرتنتات حيث حصلت العينات المحتوية على ٧٥% رتنتات على أعلى درجات فى القوام والتركيب والمقاومة للانصهار بالمقارنة بالعينة الكنترول بينما انخفضت درجات اللون والنكهة خلال فترات التخزين التي استمرت لمدة ٨ أسابيع على درجة حرارة -١٨°م.

مما سبق يتضح أنه يُمكن إنتاج مثلوج لبنى مرتفع القيمة الغذائية والصحية وذو خواص وظيفية وحسية جيدة باستخدام الرتنتات المجففة بنسبة ٧٥% استبدال بدلا من اللبن الفرز المجفف وتخزين حتى ٨ أسابيع على درجة -١٨°م بدون تأثير غير مرغوب على النكهة أو خواص التركيب والقوام .

EFFECT OF REPLACING SKIM MILK POWDER WITH DRIED RETENTATE ON THE QUALITY OF ICE MILK

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ABSTRACT: ***Four treatments of ice milk were prepared, i.e. control (C) in which skim milk powder (SMP) was used to supply the milk solids not fat and (T1, T2 and T3) treatments in which SMP was replaced with dried retentate (DR) (74% protein and 11.9% lactose) at the ratio of 50, 75 and 100%, respectively. Desserts made from mixes containing DR exhibite excellent melting qualities. No significant differences (P > 0.05) were found between the treatments in total solids contents, while fat, protein, ash contents, acidity, specific gravity, weight per gallon, viscosity and freezing point of the mix.., whipping ability, overrun and melting resistance were increased significantly (P ≤ 0.05) as the percent of DR increased. On the other hand, pH values and lactose content decreased (P ≤ 0.05) in control treatments with DR. The specific gravity, weight per gallon, overrun and melting resistance of the resultant ice milk were decreased significantly (P ≤ 0.05) with increasing DR. The resulting ice milk 75% DR showed the higher values in both essential and non essential amino acids and iron, zinc, selenium and manganese, but potassium decreased than control. Ice milk made with different levels of DR get higher scores for the body & texture and melting resistance than the control but scores for flavour and colour decreased. From this study it can be conclude that ice milk with high nutritional value and good sensory properties could be successfully made using DR as a source of SNF with percent up to 75% DR.***

Key words: ***Ice milk, skim milk powder, dried retentate.***

INTRODUCTION

Ice cream is composed of mixing of air, water, milk fat, skim milk powder (SMP), sweeteners, stabilizers, emulsifiers, and flavours. An ice milk mix is the unfrozen blend of the ingredients used to supply these constituents, except the air and flavoring materials. 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). Logical developments and changes in marketing, economic condition has encouraged the development of a wide range of ingredients that are available from numerous sources. Dairy products, the ingredients, which furnish the milk fat and SMP have essential roles in ice cream and related products.

Ultrafiltration (UF) technique can be used to alter the ratio of protein to lactose (Cheryan, 1986). Retentates have been used to replace SMP of the normal dry matter in frozen desserts. Ice cream made using UF-retentate received body and texture scores comparable with those of commercial ice cream. the high protein content of UF-frozen ice cream resulted in harder body, but smoothes texture than that traditional ice cream. High protein in the UF-ice cream increases the water binding capacity and could possibly reduce the amount of stabilizers needed. Also, UF-ice cream with low lactose content suggested as a commercial potential product for lactose intolerant people (Garcia *et al*., 1993).

The objectives of this study were to evaluate the possibility of making a good quality ice milk made by substituting SMP with dried retentate at levels of 50%, 75% and 100% and study their effect 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

Ingredients:

Cream (40% fat) and skim milk were separated at 35ºC from fresh buffaloe's milk, which was obtained from the herd of Faculty of Agric., Minufiya University, Shibin El-Kom, Skim Milk Powder was from Poland. The gross composition of raw dairy ingredients used for ice milk making is given in Table (1). Sucrose and vanilla were purchased from the local market. Sodium Carboxy methyl cellulose (CMC) was obtained from Mifad, Co., Egypt. Spray dried retentate was obtained from Australia.

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

Ingredients	T.S %	Fat %	T.P %	Ash %	Lactose %
Buffaloe's milk	16.80	7.00	4.15	0.41	4.84
Cream	47.43	40.00	2.88	0.65	3.90
Fresh skim milk	9.18	0.1	3.69	0.81	4.58
Skim milk powder	95.0	0.60	35.6	8.30	51.50
Dried retentate	96.1	1.4	74.0	8.80	11.90

Manufacture of ice milk:

Four vanilla ice milk mixes were prepared with the following composition, 6% fat, 12% skim milk powder (SMP), 16% sugar and 0.3% stabilizer. Skim milk powder was used to supply the milk solids not fat in the control. Skim milk powder was replaced in the other three ice milk batches with dried retentate (DR) at ratios of 50%, 75% and 100%, the ingredients were mixed together, then shifted slowly to the standardized milk at 45 to 60°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 and aged at 5°C overnight. Vanilla was added prior to freezing, then ice milk mix was frozen in a batch-type freezer (Taylor, Model, 103, Italy). The resultant ice milk treatments were packed into plastic cups (120 cm^3) covered and stored at -18°C in a harding room for eight weeks. Each batch was about two and half kilogram (Kg). Three replicates were done for every treatment. The formula of ice milk mixes is presented in Table (2).

Table (2): Formula of ice milk mixes made by replacing skim milk powder with different levels of dried retentate.

Raw materials (kg)	Ice milk mixes			
	C*	T_1	T_2	T_3
Fresh skim milk	1.574	1.574	1.574	1.574
Fresh cream	0.375	0.375	0.375	0.375
Skim milk powder	0.144	0.072	0.036	–
Dried retentate	–	0.071	0.106	0.142
Cane sugar	0.40	0.40	0.40	0.40
CMC	0.075	0.075	0.075	0.075
Vanilla	Traces	Traces	Traces	Traces
Total (kg)	2.558	2.567	2.566	2.566

C* = Control ice milk made with 3% skim milk powder as a source of milk solids not fat.
T_1, T_2, T_3 = Ice milk samples made by substitution skim milk powder with dried retentate at the rate of 50, 75 and 100%, respectively.

Chemical and physical analysis:

Total solids, milk protein (total nitrogen × 6.38) and ash contents were estimated as described in A.O.A.C (2000). Fat content, titratable acidity were determined according to Ling (1963), pH value was measured using laboratory pH meter (Jenway LTD., Felsted Dunmon, Essex, Uk) at room temperature. Carbohydrate content was calculated by the difference as follows: Lactose % = Total solids - (total protein + fat + ash) according to Guzman *et al.* (1999). Minerals contents were determined according to Shoale *et al*. (1997), using Atomic Absorption (Perken Elemer Emission Spectrophotometer, USA). The samples were hydrolyzed with 6N HCl according to Sotera and Stux (1979). Free amino acids were determined according to Weaver and Kroger (1978), using Amino Acid Analyzer (119 CL., Spinco Div., Beakman Instr., California). Specific gravity (Winton, 1958). Weight per gallon (Burke, 1947). Freezing point (FAO, 1997), using an electronic thermometer (Wheatson 650, Type-K, Chromel-Alvmel). Viscosity of ice milk was measured according to Morison and Macjary (2001), using coaxial cylinder viscometer (Bohlin 88, Sweden) attached to a work station loaded with software V88 viscometry programme. The system (C30) was filled with the ice milk sample at a refrigerator temperature (4-6°C) and measurement of shear stress and the viscosity was carried out in the up mode at shear rates 49 $^1/_s$. The whipping ability was carried out as given by

El-Neshawy *et al*. (1988). The overrun and melting resistance were determined according to Sommer (1951) and Arbuckle (1977), respectively.

Organoliptic properties:

Ice milk samples were sensory evaluated by 15 panelists from of the Dairy Sci. & Tech. Dept. staff, for flavour (50 points), body and texture (35 points), melting quality (10 points) and colour (5 points) when fresh and after 2, 4 and 8 weeks.

Statistical analysis:

Factorial design and completely randomized design were block used to analyze all the data and Newman Keuls test was followed to make the multiple comparisons (Steel and Torri, 1980) using Costat program. Significant differences were calculated at ($p \leq 0.05$).

RESULTS AND DISCUSSION

Mix. properties:

Total solids content of ice milk mix. were not significantly different ($p > 0.05$) among all treatments by substituting of skim milk powder (SMP) with dried retentate (DR) (Tables 3, 8), which could be attributed to the same total solids of both skim milk powder and dried retentate (Table 1).

Substitution of SMP with DR was slightly increased ($p \leq 0.05$) significantly the fat content of treatment T_3 than the control treatment. These results may be due to the higher fat content of dried retentate than skim milk powder (Table 1).

Protein content of ice milk mix was significantly ($p \leq 0.05$) different among all treatments by replacing of SMP with DR (Tables 3, 8), this may be due to using different levels of dried retentate containing high protein contents. Similar trends in the protein content in frozen dessert mixes making were reported by Masters and Kosikowski (1986), Grow *et al.* (1989), Mohamed (1997), Sallam (1998) and Shenana *et al.* (2007).

Ash content of ice milk mixes was increased significantly ($p \leq 0.05$) with the proportional increase of DR in the mixes (Tables 3, 8). This increase may be due to the high protein content in these treatments as the minerals are bound with casein leading to higher ash content than that of skim milk powder. This was explained by Masters and Kosikowski (1986) who revealed that increasing the protein content by membrane technique caused an increase in the ash contents of the retentates, and hence the contents of the total ash of the ice cream mix. Similar results were reported by Mohamed (1997) and Shenana *et al.* (2007).

Lactose content and lactose / water phase and lactose of ice milk fortified with either SMP or DR are shown in (Table 3). There were decreased significantly ($p \leq 0.05$) with replacing SMP with DR among all treatments due to

the low lactose content of retentate (Tables 3, 8). These results are in agreement with those reported by Hofi (1989), Lee and White (1991), Sallam (1998) and Shenana *et al.* (2007).

Table (3): Chemical composition of ice milk mixes made with different replacement levels of skim milk powder with dried retentate.

Components (%)	Treatment			
	C*	T_1	T_2	T_3
Total solids	34.0	34.2	34.1	34.3
Fat	6.0	6.1	6.2	6.3
Total protein	4.87	6.86	7.92	8.52
Ash	1.08	1.09	1.14	1.19
Lactose	6.05	4.15	2.84	2.29
Lactose/water phase	9.17	6.31	4.31	3.49
Acidity	0.200	0.215	0.221	0.226

* See Table (2) for details.

Acidity of ice milk mix. was increased ($p \leq 0.05$) significantly by substituting SMP with DR (Tables 3, 8). This increase of acidity was proportional due to the high protein content of DR than SMP (Table 1). Similar observation were reported by Hofi (1989), Mohamed (1997) and Shenana *et al.* (2007).

Specific gravity and weight per gallon of the ice milk mix. were increased significantly ($p \leq 0.05$) as the percentage of DR in combinations increased (Tables 3, 8). These results are in agreement with those reported by Hofi (1989), Mohamed (1997) and Shenana *et al.* (2007).

Viscosity of ice milk mix. was increased ($p \leq 0.05$) significantly by replacing of SMP with DR (Tables 3, 8). Viscosity of ice milk was increased with increasing level of added DR. This may be due to the high protein and ash contents of the retentate and the hydration properties of these proteins. The results agree with those given by Arbuckle (1986), Lee and White (1991), Sallam (1998) and Shenana *et al.* (2007).

The freezing point of ice milk mixes was gradually increased ($p \leq 0.05$) by increasing the DR in the mix formula instead of SMP (Tables 3, 8). These results are in accordance with those given by Hofi (1989), Mohamed (1997) and Shenana *et al.* (2007).

Whipping ability of ice milk mixes gradually increased ($p \leq 0.05$) by increasing the DR in the mix formula instead of skim milk powder up to 100% (Tables 4, 8), which could be attributed to the relatively higher protein content of dried retentate (74.0%) compared with that of skim milk powder (35.60%). The protein content of DR was about two times as that of skim milk powder. Also due to the higher whey protein content of DR in which has a role in giving excellent whipping ability. These results are in accordance with those given by Khader *et al.* (1992).

Table (4): Effect of replacing of skim milk powder with dried retentate on ice milk mixes properties.

Properties	C*	T_1	T_2	T_3
Specific gravity (g/cm^3)	1.074	1.115	1.135	1.164
Weight/gallon (kg)	4.066	4.221	4.300	4.407
Viscosity (cp)•	81.0	93.0	115.0	116.0
Freezing point (°C)	-2.20	-2.00	-1.95	-1.89
Whipping ability (%)				
After: 5 min	15.01	21.45	25.60	26.21
10 min	35.80	39.50	45.65	46.99
15 min	45.89	58.82	66.66	79.32
20 min	44.90	52.26	56.18	64.68

* See Table (2) for details.
• Shear rate (49 1/s).

Ice milk properties:

It is clear from Tables (5, 9) that specific gravity and weight per gallon of the resultant ice milk were gradually decreased ($p \leq 0.05$) by replacing of SMP with DR up to 100% replacement. This decrease may be due to the increase of overrun.

The overrun percentage of the resultant ice milk was increased ($p \leq 0.05$) significantly by increasing the replacements of SMP by DR up to 100% (Tables 5, 9). There were positive correlation between the overrun and the rate of replacing SMP with DR which means that the overrun increased by increasing the rate of replacing skim milk powder with dried retentate (Tables 5, 9). These results could be attributed to the higher whey proteins in dried retentate which subsequently increase the incorporation of air in the ice milk. These results are in agreement with those reported by Khader *et al.* (1992) and Magdoub *et al.* (1992).

Table (5): Effect of substitution of skim milk powder with dried retentate on some properties of the resultant ice milk.

Properties		Treatments			
		C*	T_1	T_2	T_3
Specific gravity (g/cm^3)		0.736	0.702	0.681	0.648
Weight/gallon (kg)		2.800	2.660	2.580	2.457
Overrun (%)		45.89	58.82	66.66	79.32
Melting resistance loss%					
At 25°C after:	15 min	–	–	–	–
	30 min	5.77	4.78	3.80	3.22
	45 min	10.23	9.31	8.48	8.12
	75 min	35.30	34.77	33.67	33.00

* See Table (2) for details.

Increasing the substitution level of DR in the resultant of ice milk improved the melting resistance. Grow *et al.* (1989) reported that, desserts made from retentates exhibited excellent melting qualities. These results

agree with those reported by Arbuckle (1986), Hofi (1989), Geilman and Schmidt (1992), Sallam (1998) and Shenana *et al.* (2007) who stated that soft ice cream manufactured by UF-technique had more melting resistance than that made from reconstituted skimmed milk powder. Moreover, the results clear that the melt down time was directly proportional to viscosity of the mix. The decrease in melting with raising the level of dried retentate may be due to their higher freezing point as it was reported by Arbuckle (1986), Mohamed (1997), Sallam (1998) and Shenana *et al.* (2007). Also, the high protein and low lactose content in dried retentate ice milk has role in giving excellent melting quality.

Data presented in Table (6) show the effect of substituting 75% of skim milk powder with dried retentate on the essential and non-essential amino acids. It is clear that ice milk made with dried retentate had higher content both total non-essential amino acids and total essential amino acids. The essential amino acids content in treatment T_2 was about two times as that of control, while the non-essential amino acid was about 35%. That could be attributed to the relatively higher protein content of dried retentate compared with that skim milk powder as before mentioned in Table (1).

Table (6): Effect of replacing skim milk powder with dried retentate on amino acids.

Amino acids [1]	Control	T_2
Essential amino acid (E.A.A):		
Luc	1.442	2.565
Iluc	0.637	1.1419
Lys	0.686	1.062
Met	0.183	0.302
Phe	0.477	0.750
Thr	0.649	1.1457
Trp	ND	ND
Val	0.746	1.3167
Total E.A.A	4.82[b]	8.2833[a]
Non essential amino acid (N.E.A.A.):		
Ala	0.54	0.9538
Asp	1.276	2.255
Glu	2.738	2.876
Gly	0.321	0.568
His	0.361	0.642
Pro	0.267	0.4712
Ser	0.804	1.419
Tyr	0.433	0.7657
Arg	0.258	0.454
Total N.E.A.A	6.998[b]	10.4047[a]

[1] g/100 g of ice milk on dry matter.
T_2 = Ice milk made with 75% substitution of skim milk powder with dried retentate.
ND = Not determined.

Table (7) shows the changes in some mineral content of ice milk. A remarkable increase in minerals (Iron, zinc, selenium and manganese) was

observed in ice milk made with 75% substitution of SMP with DR but potassium was decreased may be due to the majority of potassium losses in permeat during ultrafiltration "UF technique". These increase could be attributed to dried retentate added, which contains high content of protein (74%) compared with skim milk powder (35%) (Table 1) as the minerals are bound with coasein leading to higher ash content than that of skim milk powder itself. This was explained by Masters and Kosikowski (1986) who revealed that, increasing the protein content by membrane techniques caused an increase in the mineral contents of the retentate, and hence the contents of the total ash of ice cream mix.

Table (7): Concentration of some mineral elements (mg/100 g) of ice milk mixes (on dry weight basis).

Constituents (mg /100g)	Treatments	
	Control	T_2
K	559.9	531.08
Zn	3.014	4.840
Fe	12.452	15.290
Se	0.140	0.161
Mn	0.418	0.422

*** See Table (2) for details.**
T_2 = Ice milk made with 75% substitution of skim milk powder with dried retentate.

Table (8): Statistical analysis of chemical composition and physical properties of ice milk mixes made with different replacement levels of skim milk powder with dried retentate.

Ice milk mix Properties	Effect of treatments				
	Multiple comparisons•				
	Mean squares	C♦	T_1	T_2	T_3
Total solids %	0.050	A	A	A	A
Fat %	0.050	B	AB	AB	A
Protein %	3.701*	D	C	B	A
Ash %	0.018*	C	C	B	A
Lactose	7.8606*	A	B	C	D
Lactose/water phase	16.77*	A	B	C	C
Acidity %	0.037*	C	B	A	A
Specific gravity	0.043*	D	C	B	A
Weight/gallon	0.062*	D	C	B	A
Viscosity	884.75*	C	B	A	A
Freezing point	0.196*	D	C	B	A
Whipping ability After : 5 min	79.828*	C	B	A	A
10 min	82.912*	D	C	B	A
15 min	589.410*	D	C	B	A
20 min	203.642*	D	C	B	A

♦ See Table (2). *** 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.

Total scores of organoleptic properties of the resultant ice milk as affected by SMP replacement with different levels of dried retentate are illustrated in Fig. 1. It could be observed that the total scores of organoleptic properties was gradually decreased ($p \leq 0.05$) during 8 weeks of storage period at -18ºC (Fig. 1 and Table 9). All the treated samples were found to have a bright white colour and gained higher colour scores due to added dried retentate. With regard to the total scores, products made with dried retentate had higher flavour, higher body and texture scores and excellent melting quality and bright white colour. These observations are in agreement with those observed by Hofi (1989) and Shenana *et al.* (2007).

Table (9): Statistical analysis of physical and organoleptic properties of the resultant ice milk made with different replacement levels of skim milk powder with dried retentate.

Ice milk Properties	Effect of treatments					Effect of storage period (weeks)				
	Multiple comparisons•					Multiple comparisons•				
	Mean squares	C♦	T_1	T_2	T_3	Mean squares	0	2	4	8
Specific gravity	0.041*	A	B	C	D					
Weight/gallon	0.062*	A	B	B	C					
Overrun	589.410*	D	C	B	A					
Melting resistance after:										
30 min	3.773*	C	C	B	A					
45 min	2.649*	C	C	B	A					
75 min	3.255*	C	C	B	A					
Total organoleptic scores	53.672*	B	A	A	A	183.797*	A	A	A	A

See Table (3). * 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, increasing the rate of replacement up to 75% improved the total scores of organoleptic properties, without any adverse effect on its flavour, therefore it is possibly to make a good quality ice milk with replacing up to 75% SMP with DR and can store the ice milk at -18°C in a harding room for 8 weeks without adversely affecting.

Fig. (1)

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تأثير استبدال اللبن الفرز المجفف بالرتنتات على جودة المثلوج اللبنى

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الملخص العربي:

في هذا البحث تم تصنيع ٤ معاملات من المثلوج اللبنى حيث تم استبدال اللبن الفرز المجفف المستخدم فى صناعة المثلوج اللبنى بنسب ٥٠،٠ ، ٧٥ ، ١٠٠٪ من الرتنتات المجففة والتي تمتاز بارتفاع نسبة البروتين به حوالي ٧٤٪ كما يقل محتواها من اللاكتوز ١١.٩% بالإضافة إلى أنها ذات خواص وظيفية هامة فهي ترفع القدرة على الارتباط بالماء وتُحسن القابلية للخفق وترفع نسبة الريع في المنتج بالإضافة إلى أنها تُحسن من جودة خاصية الانصهار للآيس كريم وبذلك فإن استخدام الرتنتات المجفف يجعل هذا المنتج مناسب للأشخاص ذو الحساسية للاكتوز ولقد تمت الدراسة بغرض معرفة تأثير الاستبدال للبن الفرز المجفف بالرتنتات المجففة على جودة المثلوج اللبنى، وكانت أهم النتائج المتحصل عليها ما يلي :

٦- أدى استبدال اللبن الفرز المجفف بواسطة الرتنتات لعدم وجود فروق معنوية بين المعاملات بالنسبة للجوامد الكلية ، بينما أدى لزيادة في نسب الدهن والبروتين والرماد والحموضة في المخاليط والوزن النوعي والوزن بالجالون واللزوجة ونقطة التجمد وكانت الزيادة معنوية مع زيادة نسبة الاستبدال بالرتنتات. كما أدى الإستبدال أيضا لزيادة قابلية المخاليط للخفق والنسبة المئوية للريع والمقاومة للانصهار وأن هذه الزيادة تزيد بزيادة نسبة الإستبدال بالرتنتات حتى ١٠٠% استبدال ومن جهة أخرى حدث انخفاض لقيم الـ pH واللاكتوز.

٧- زادت نسبة اللاكتوز/الوسط المائي في العينة الكنترول عن المخاليط المحتوية على الرتنتات كذلك نسبة اللاكتوز/البروتين أخذت نفس الاتجاه.

٨- انخفض الوزن النوعي والوزن بالجالون والريع والمقاومة للانصهار للمثلوج اللبني الناتج مع زيادة نسبة الاستبدال بالرتنتات.

٩- كما لوحظ زيادة محتوى المثلوجات اللبنية المحتوية على ٧٥٪ رتنتات من الأحماض الأمينية الضرورية والأحماض الأمينية الغير ضرورية، وكذلك المحتوى من العناصر المعدنية وهى "الحديد والزنك والسلينيم والمنجنيز" ، بينما حدث انخفاض في عنصر البوتاسيوم بالمقارنة بالعينة الكنترول.

١٠- ارتفعت درجات التحكيم للمثلوج اللبنى بزيادة نسبة الرتنتات حيث حصلت العينات المحتوية على ٧٥% رتنتات على أعلى درجات فى القوام والتركيب والمقاومة للانصهار بالمقارنة بالعينة الكنترول بينما انخفضت درجات اللون والنكهة خلال فترات التخزين التي استمرت لمدة ٨ أسابيع على درجة حرارة -١٨°م.

مما سبق يتضح أنه يُمكن إنتاج مثلوج لبنى مرتفع القيمة الغذائية والصحية وذو خواص وظيفية وحسية جيدة باستخدام الرتنتات المجففة بنسبة ٧٥% استبدال بدلا من اللبن الفرز المجفف وتخزين حتى ٨ أسابيع على درجة -١٨°م بدون تأثير غير مرغوب على النكهة أو خواص التركيب والقوام .

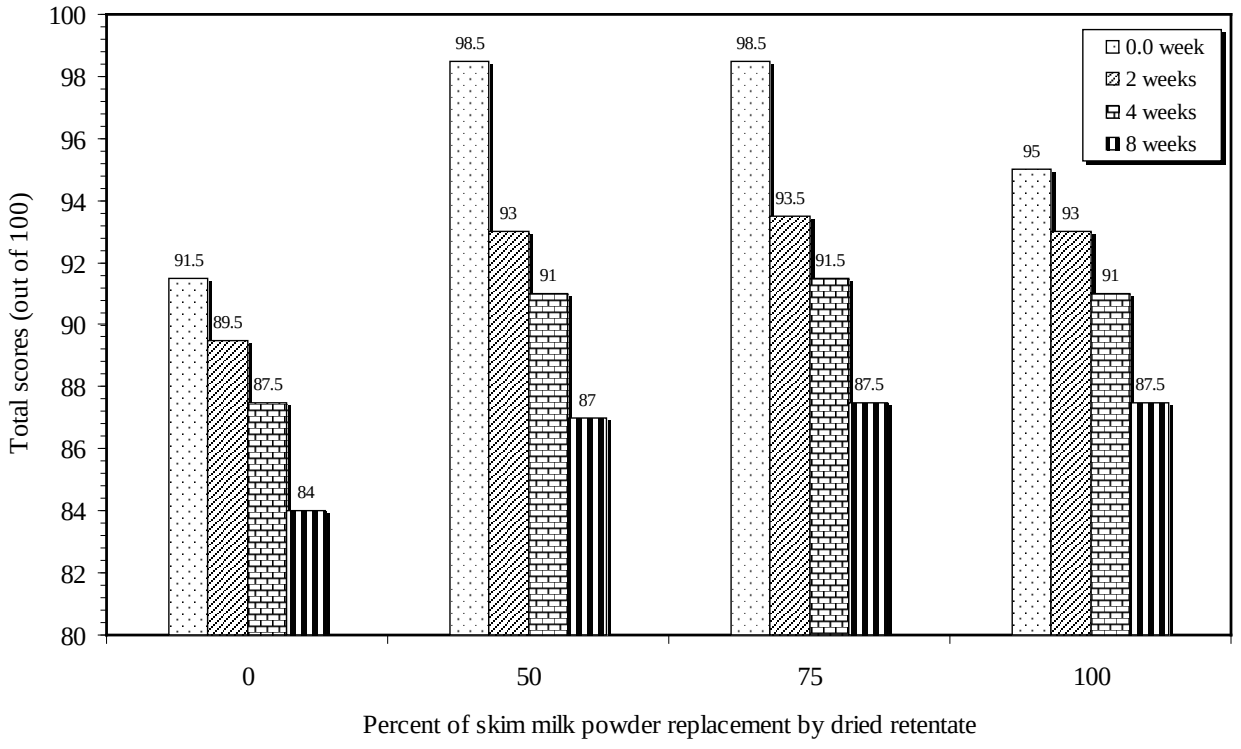

Fig.(1). Effect of replacing skim milk powder with dried retentate on the total scores of orgaoleptic properties on ice milk stored at -18°C for 8 weeks.