UTILIZATION OF UF- AND RO-RETENTATES IN ICE CREAM MAKING

By

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ABSTRACT

Possibility of producing Ice cream using some effective techniques mainly the ultrafiltration (UF) and reverse osmosis (RO) to incorporate the obtained concentrated milk as a substituting ingredient of MSNF with a level of 50, 75 and 100% and the resultant ice cream was evaluated. Replacing of MSNF by UFR or ROR did not affect significantly the total solids (TS) and fat content in ice cream mixes. The results revealed that the levels of total protein, ash, specific gravity, freezing point, viscosity, and weight per gallon increased as the portion of UFR or ROR in ice cream mix increased. Whereas, the overrun, and melting resistance of the produced ice cream decreased by increasing the UFSR or ROSR levels. Lactose content decreased in the mixes with increasing replecement of MSNF of both concentrates UFR or ROR. Specific gravity, melting resistance and overrun of resultant ice cream increased with increasing of replecement MSNF of both UFR or ROR. Sensory evaluation of resultant ice cream showed that all treatments were acceptable for flavour, body & texture and melting quality. On the other hand, ice cream with 100 % replecement of MSNF by ROR had a slight sandness and it was more sweet than other treatments.

In a conclusion, the sensory assessment and physical properties, cleared that the best treatment was that made from 100 % replecement of UFR, then the 75 % of ROR. Looking at the resultant ice cream made with 100 % in replecement of UFR and 75 % of ROR gave the best sensory quality and melting resistance.

Key words: Ultrafiltration (UF), reverse osmosis (RO), Ice cream, milk solids not fat (MSNF), Melting, Physical properties.

INTRODUCTION

During the manufacture of ice cream the variation and quality of milk solids not fat (MSNF) source have an important effect on the physico-chemical properties of ice cream mixes and the resultant products. The variations in the quality of MSNF have an important influence on mixture wipping ability (Arbuckle, 1986).

Ultrafiltration (UF) technique can be used to alter the ratios of protein to lactose (Cheryan, 1986), however, use of reverse osmosis technique (RO) did not change the proportions of milk components as the various constituents in RO- retentate which increased by the same amounts as the concentration factor.

Retentates have been used to replace MSNF of the normal dry matter in frozen desserts. Ice cream made using UF-retentates received body and texture scores comparable with those of the commercial ice cream. The high protein content of UF-frozen ice cream resulted in harder body, but smoother texture than that of traditional ice cream. High protein in the UF-ice cream and partly in RO-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*., 1993a & b).

So, the purpose of this work was to produce, evaluate and compare the ice cream made by using UF-retentate or RO-retentate as substituting various levels of MSNF and study their effect on physico-chemical properties of the mix and the resultant ice cream as well as the sensory evaluation of the resultant ice ceram.

MATERIALS AND METHODS

Materials:

Fresh Buffaloes' and cows' milk were obtained from EL-Gemmeza Animal Production Research Station herd (Gharbiea Governorate), Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt, Skimmed milk powder was purchased from local market which was imported by El–Sayed Awad El-Amerity from Holland. Commercial grade of granulated sugar cane was obtained from the local Egyptian market which produced by Egyptian Sugar and Distillation Company at Hawmdia, Egypt. Vanilla was obtained from the local market (chem. rein 100 %), which imported by El–Sayed Awad El-Amerity and produced by Boehringer Monnheim, Germany. CMC was obtained from the Pharmaceutical Chemicals Nasr Co., Abo- Zaabel, Kalubia, Egypt.

Methods:

Preparation of the Concentrates for Ice Cream Making:

The milk was separated to produce 40 % fat cream. The resultant skimmed milk was divided into two equal parts:

A- The first part was concentrated by ultrafiltration technique to produce UFR using Carbo-sep, The Tech. Sep UF was fitted with 2_s 151 (Model Tubular), membrane type: mineral (Zerconium Oxid), support: with a membrane surface area of 6.8m^2. The unit was operated with an inlet pressure of ~ 5 bars and outlet pressure of ~ 3 bars. Ultrafiltered skimmed milk retentate (UFR) contained ~ 25 % TS

B- The second part was concentrated by reverse osmosis technique to produce ROR using Reverse Osmosis lab, unit, type; 6 AFC 99, France with 7.2 m 2 film polyamide membrane area, the used pressure was 60 bars. The produced UR or RO-skimmed milk retentate contained ~ 25 % TS.

Preparation of Ice cream mix:

Plain ice cream vanilla base mix was calculated. All ingredients were mixed thoroughly and heat treated at ~ 72^{o}C for 15 min. The mixture was cooled to 50^{o}C then homogenized, by double stage homogenizer at 160 bar/in^2 then at 40 bar / in^2, using Rannie Homogenizator model Slow 700L / h Denmark, then cooled to ~ 5 oC, and aged at the same temperature for over night. The mix was pre-freezed (whipped) using ice cream freezing machine type IGLC, Italy. The produced ice cream was filled in plastic cups (cap. 150 ml), kept for hardening at -18^{o}C, and kept at the same temperature until analysis. The limited levels of standard ice cream ingredients as recommended by the Egyptian standard is shown in Table (1) and the gross chemical composation of the raw dairy ingredients used for ice cream making (g/100g) are shown in Table (2).Seven ice cream recipes were prepared using

Table (1) The limited levels of standard ice cream ingredients.

Fat %	**6**
MSNF %	**11**
Sugar %	**16**
Stabilizer %	**0.3**
Vanilla	**Traces**
Total solids %	**33.3**

Table (2) The gross composition of raw dairy ingredients used for ice cream making (g/100g).

Ingredients	T.S %	Fat %	Total Protein* %	Ash %	Lactose** %
Buffaloes' milk	16.50	6.60	4.20	0.90	4.80
Cream	47.00	40.00	2.60	0.60	3.80
Fresh skimmed milk	9.08	0.10	3.59	0.78	4.61
Skimmed milk powder	96.10	0.40	34.29	7.93	53.48
UFR	25.30	0.30	18.56	2.18	4.26
ROR	25.13	0.40	16.93	2.22	5.58

* Total protein: TN x 6.38 ** Lactose %: calculated by difference

Table (3) Formula of ice cream mix made by substitution of milk solids not fat (MSNF) with different levels of UFR or ROR.

Ingredients	Control	MSNF substitution levels					
		UFR			ROR		
	(T1)	50 % (T2)	75 % (T3)	100 % (T4)	50 % (T5)	75 % (T6)	100 % (T7)
Fresh cream (40 % fat)	0.375	0.375	0.375	0.375	0.375	0.375	0.375
Fresh skimmed milk (9.08 % MSNF)	1.5962	--	--	--	--	--	--
Skimmed milk powder (96.1 % solids)	0.121	0.134	0.067	--	0.134	0.067	--
UFR or ROR (~ 25 % solids)	--	0.510	0.764	1.019	0.510	0.764	1.019
Sucrose	0.40	0.40	0.40	0.40	0.40	0.40	0.40
CMC *	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Water	--	1.074	0.887	0.699	1.074	0.887	0.699
Vanilla	Traces	Traces	Traces	Traces	Traces	Traces	Traces
Weight of mix (kg)	2.567	2.568	2.568	2.566	2.568	2.568	2.568

* CMC: Carboxy Methyl Cellulose

the ingredients shown in Table (3) in which milk solids not fat (MSNF) was replaced by UFR or ROR (50, 75 and 100%). The resultant ice cream was tested and organoleptically evaluated.

All experiments were repeated in triplicates and average values were tabulated.

Methods of Analysis:

Total solids, Fat Content,Titratable Acidity and Ash Content of Ice cream mix were determined according to British Standard Institute (BSI): 1954. pH value ice cream mix was measured using JENWAY Digital pH meter model 3310. Protein content was determined according to AOAC (1990). Lactose content was calculated by deference as follows:

Lactose % = Mix total solids - (Fat+ protein+ash+ sugar)

Properties of Ice Cream:

The specific gravity was measured according to Winton, (1958). Weight per gallon in Kilogram (Kg) was calculated according to Burke (1947) by multiplying the specific gravity by the factor 3.786. Freezing point of ice cream mix was measured according to the method recommended for milk by the Food Agriculture Organization (FAO) (1977) Regional Dairy Department and Training Center for the Near East Viscosity of ice cream mix was carried out using a rotary viscometer (RHEOTEST, type RV and Pruefgeraetewerk Medingn, Dresden) as described by Toledo (1980). The melting resistance of the resultant ice cream was determined according to Arbuckle (1986).

Sensory Evaluation:

The organoleptic properties of Ice cream was evaluated according to the scoring sheet of Ice cream according to IDF (1991): Falvour: 50, Body & texture: 40 and Melting quality: 10

Statistical Analysis:

The general liner models procedure of SAS was used to analyze the data. Analysis of variance for all constituents, were carried out according to the methods described by Clarke and Kempson (1997).

RESULTS AND DISCUSSION

Properties of Ingredients:

Chemical composition of the mixes:

The chemical composition of ice cream mixes as affected by different replacement levels of the milk solids not fat (MSNF) with UFR or ROR are demonstrated in Table (4).

Fat and Total solids content (TS):

It is obvious from the data that there is no differences between all treatments in **fat content** as it was adjusted to be $\simeq$ 6 % either in the control or in the mixes containing UFR or ROR. The fat content of the mixes was 6.0-6.2 % which, is within the limited levels of the Standards given by the (Egyptian Legal Standard , 1993).

Data in the same table also indicate that there was slightly differences in the total solids content of the mixes. It ranged from 33.15 to 34.35 %. The TS content of the mixes are within the **Egyptian Legal Standard, (1993)**

Table (4) Chemical composition and pH value of ice cream mixes made using UFR or ROR retentates in replacement of MSNF.

Constituents	Control	UFR			ROR		
	(T1)	50 % (T2)	75 % (T3)	100 % (T4)	50 % (T5)	75 % (T6)	100 % (T7)
T.S %	33.15	33.66	34.00	34.25	34.17	34.20	34.35
Fat %	6.20	6.20	6.20	6.10	6.20	6.10	6.00
Protein %	4.27	7.39	7.99	8.29	4.92	5.10	5.45
Ash %	0.98	0.99	1.06	1.19	1.09	1.13	1.25
Lactose % *	5.70	3.08	2.75	2.67	5.98	5.87	5.65
Lactose/ protein ratio	1.33	0.42	0.34	0.32	1.22	1.15	1.04
Lactose/Water phase %	8.53	4.64	4.17	4.06	9.08	8.92	8.65

* Protein = TN x 6.38
** Lactose (milk CHO) =TS – (Fat + Protein + Ash + Sugar).

Statistical analysis of total solids cleared that there is no significant differences between T3, T4, T5, T6 and T7 treatments. However, there was a significant differences between T1 and T2 and both of them with other treatments ***(P < 0.0001*)** with LSD = 0.479 of treatment.

The proportional replacement of fresh skimmed milk (FSM) and skimmed milk powder (SMP) with UFR or ROR resulted in highly significant differences ***(P < 0.0001)*** in the protein contents of ice cream mixes, (LSD = 0.715).

The protein content in UFR mixes raised proportionally from 4.27 % to 7.39, 7.99 and 8.29 % by increasing the MSNF replacement level to 50, 75 and 100 %, respectively. The same trend was observed when the MSNF was replaced with 50, 75 and 100 % of ROR but, with lower protein contents as it was 4.92, 5.10 and 5.45 % in the same order. Similar trends were obtained by **Masters & Kosikowski (1986), Grow *et al*. (1989), Lee & White (1991)** and **Sallam (1998)**.

On the other hand, **Guy (1980)** discussed a proposed change in the standards of identity for frozen desserts, permitting ice cream to be formulated from any milk derived ingredient with a minimum of 2.7 % protein. Thus, we note that all the produced ice cream in this experiment satisfied well this minimum protein requirement. From statistical analysis of protein content there was highly significant differences ***(P < 0.0001)*** between all treatment due to using different retentates contains high protein contents.

Ash content recorded slightly significant increases with the proportional increase of UFR or ROR in the mixes. This may be attributed to the high protein content in these treatments as the minerals are bound with casein leading to higher ash content than that of SMP itself. This was explained by **Master & Kosikowski (1986)** who revealed that increasing the protein content by membrane techniques caused an increase in the contents of the retentates, and hence the contents of the total ash of the ice cream mix. There are significant variations ***(P < 0.0001)*** in the ash content of ice cream mixes, with LSD = 0.061.

Concerning to **milk charbohydrate content**, it was clear that the percentage of substitution with ROR increased the lactose content and lactose/water phase in the mix. Lactose / water phase was higher in the different ROR mixes than the control. While, an opposite trend was observed with UF-mixes as the lactose content and lactose/water phase were very low than either the control or the RO-mixes.

Statistically, there was highly significant difference in lactose content between the control and ROR compared with UFR mixes with LSD = 0.042, 0.007 and 0.036 for lactose, lactose/water phase and lactose/protein ratio, respectively.

Arbuckle (1986) mentioned that, if the water phase of the ice cream mix contains 9 % lactose, a sandiness defect may occur. Thus, reducing lactose by UFR could be make it possible for utilization in the ice cream industry. These results are in agreement with those reported by **Hofi (1989), Lee and White (1991), Geilman and Schmidt (1992),** and **Sallam (1998).**

Lactose/protein ratio in the control was 1.33 and in ROR mixes they were 1.22; 1.15 and 1.04 ***vis-à-vis*** 0.42, 0.34 and 0.32 in UFR-mixes containing 50, 75 and 100 % replacement of the MSNF, in sequence. **Hofi (1989)** found that lactose/protein ratio was 1.4 - 1.45 against 0.42 - 0.44 in recipes used UFR which are in the vicinity of our results. Therefore, UF-concentrate can be used with the high level (100 %) for substitution to increase the MSNF without occurrence of sandiness. Also, the ROR can be used in ice cream mixes with some precautions.

The high protein and low lactose content and lactose/protein ratio in UFR mixes than those manufactured using ROR-concentrates could be attributed to the nature of the two process as RO-membranes retain all milk components, while UF-membranes remove most of lactose and salts leaving high protein ratio in the retentates **(Medonough *et al*.,**

1971). From statistical point of view for lactose, lactose/protein ratio and lactose/water phase there were highly significant differences between all treatments ***(P < 0.0001).***

Acidity and pH value of ice cream mix:

Data in **Table (5)** reveal that the use of UFR or ROR increased significantly the acidity of the mix than that in the ROR-mixes containing 50, 75 and 100 % of the retentate. Conversely, the pH value decreased in the UFR and ROR than the control. These changes in acidity and pH values may be ascribed to the increase of protein and ash contents related to the use of UFR- or ROR- instead of SMP as MSNF source as these components contribute in the natural acidity of milk and its products. The same observations were reported by **Hofi (1989), Renner & Abdel Salam (1991)** and **Mohamed (1997)** in UFR-ice cream and by **Sallam (1998)** in ROR-ice cream.

Statistical analysis showed that there was high significant differences of acidity and pH values ***(P < 0.0001)*** with LSD 0.034 and 0.010 for acidity and pH values, in sequence.

Physical properties of the mixes:

Table (6) illustrates the data of viscosity, freezing point, sp.gr. and weight/gallon in different treatments of ice cream mixes. The viscosity of the control mix was 95.0 C.P. All UFR- and ROR- mixes tended to increase the viscosity of the mix as the MSNF substitution level with UFR or ROR increased. This may be due to the high protein and ash contents of the retentates and the hydration properties of these proteins.

Table (5) Titratable acidity and pH values of Ice Cream mixes made using UFR or ROR retentates in replacement of MSNF.

Property	Control (T1)	UFR			ROR		
		50 % (T2)	75 % (T3)	100 % (T4)	50 % (T5)	75 % (T6)	100 % (T7)
Acidity %	0.18	0.21	0.22	0.23	0.22	0.23	0.24
pH value	6.58	6.55	6.52	6.45	6.53	6.49	6.44

T1 Control Ice Cream
T2 Ice Cream with 50 % MSNF from UFR. **T3** Ice Cream with 75 % MSNF from UFR.
T4 Ice Cream with 100 % MSNF from UFR. **T5** Ice Cream with 50 % MSNF from ROR.
T6 Ice Cream with 75 % MSNF from ROR. **T7** Ice Cream with 100 % MSNF from ROR.

The results agree with those given by **Arbuckle (1977), Lee and White (1991)** and **Sallam (1998).** However, **Hofi (1989)** showed that the use of UF fresh skimmed milk in ice cream making had no effect on the viscosity of the resultant ice cream mix.

Analysis of variance of viscosity showed that, there was high significant differences between all ice cream treatments ***(P < 0.0001)*** with LSD = 1.661.

Specific gravity (Sp.Gr.) and Weight per gallon (Wt./gal):

The proportional replacement of MSNF with UFR- or ROR in making ice cream mix was associated positively whereas, it caused an increase in the sp.gr. and wt./gal. of the mix comparing with control.

Table (6) Some physical properties of ice cream mixes made from UFR and ROR.

Property	Control	UFR*			ROR**		
		50 % (T2)	75 % (T3)	100 % (T4)	50 % (T5)	75 % (T6)	100 % (T7)
Viscosity (C.P)	95.0	99.0	108.7	112.7	107.0	113.0	116.0
Freezing point (°C)	- 2.78	- 2.60	- 2.51	- 2.38	-2.40	- 2.44	- 2.58
Specific gravity ($gm/cm^{3)}$	1.110	1.111	1.115	1.119	1.117	1.119	1.122
Weight per gallon (Kg)	4.203	4.206	4.221	4.237	4.229	4.237	4.248

T1 Control Ice Cream
T2 Ice Cream with 50 % MSNF from UFR.
T3 Ice Cream with 75 % MSNF from UFR.
T4 Ice Cream with 100 % MSNF from UFR.
T5 Ice Cream with 50 % MSNF from ROR.
T6 Ice Cream with 75 % MSNF from ROR.
T7 Ice Cream with 100 % MSNF from ROR.

Mohamed (1997) reported a slightly increase in the sp.gr. of ice-cream mix when the MSNF substitution level with UFR increased which is coincided with our results. However, **Hofi (1989)** and **Renner & Abd El-Salam (1991)** reported that the use of UFR in ice cream making had a negligible effect on the sp.gr. of the mix.

From statistical analysis of (sp.gr. and wt./gal) data it was clear that, there were highly significant differences between all ice cream treatments ***(P < 0.0001)*** with LSD of 0.008 and 0.001 for sp.gr and weight per gallon, respectively.

The freezing point of ice cream mixes increased gradually upon increasing the UFR- or ROR- in the mix formula instead of SMP. In the UFR or ROR-mix. The differences may be due to the relatively low lactose content of UFR compared with other MSNF components. However, the reduction in the freezing point of the mixes containing UFR due to the increase in ash content may disappeared by the pronounced low content of lactose. These results are in accordance with those given by **Omar (1983), Hofi (1989)** and **Mohamed (1997).**

Analysis of variance revealed that there were high significant differences between all ice cream treatments ***(P < 0.0001)*** with LSD = 0.097.

Physical Properties of the Resultant Ice Cream:

Specific gravity and Weight/gallon:

Table (7) show that the sp.gr. and wt/gall. of the resultant ice cream. They tended to decrease with the proportional increase of UFR or ROR level in the mix. The sp.gr. and wt/gal. Similar results were reported in 75 % UFR- ice cream by **Mohamed (1997).** However, **Hofi (1989)** found that the use of UFSM in ice cream making had negligible effect on sp.gr. and wt/gall., of the resultant ice cream. Also, similar finding was observed in using hyperfiltration concentrate in manufacture of ice cream by **Iversen, (1979).**

Statistical analysis of sp.gr and wt/gallon showed that, there was high significant differences between all ice cream treatments ***($P < 0.0001$)*** with LSD 0.014 and 0.052 for sp.gr and wt. /gallon, respectively.

Melting resistance:

The effect of treatments on meltdown property is shown in **Table (7).** After 15 min there was almost the same quantity collected from the control and UFR or ROR-ice cream of 50 % substitution level and this was continued during the 3rd hour as the collected amount reached 93.43, 91.36 and 92.27 ml, consecutively. At the same time there was no melting in the 100 % UFR-ice cream at first 15 min. Generally, increasing the substitution level of UFR and ROR in ice cream lowered gradually the melt down and improved this property. These results agree with those reported by **Arbuckle (1977), Hofi (1989) Geilman and Schmidit (1992)** and **Sallam (1998)** 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 UFR or ROR may be due to their higher freezing point as it was reported by **Arbuckle (1986)** and **Sallam (1998)**. Also, the high protein content in UFR ice cream has a role in giving excellent melting quality.

Overrun:

Data in **Table (7)** clear that using 50 % UFR in making ice cream gave the highest overrun as it was 91.7 %. Overrun for the different treatments ranged from 71 to 91.7 % and it was generally higher in the UFR and ROR-ice cream than the control except that of 100 % UFR as it had the lowest overrun.

Table (7) Specific gravity, weight / gallon, melting resistance and overrun of the resultant ice cream made from UFR and ROR.

Property	Control	UFR			ROR		
	(T1)	50 % (T2)	75 % (T3)	100 % (T4)	50 % (T5)	75 % (T6)	100 % (T7)
Specific gravity gm/cm^3	0.685	0.615	0.623	0.636	0.602	0.617	0.631
Weight / gallon (Kg)	2.593	2.328	2.359	2.408	2.279	2.336	2.389
Melting resistance as after: 15 min.	4.73^h	4.76^h	1.04^h	$--^h$	4.65^h	1.96^h	0.94^h
30 min.	10.26^g	9.80^g	3.38^g	1.81^g	9.35^g	3.45^g	2.62^g
45 min.	14.61^f	14.47^f	7.25^f	3.25^f	13.79^f	7.49^f	5.82^f
60 min.	20.85^e	19.91^e	14.28^e	6.84^e	19.66^e	16.59^e	13.80^e
75 min.	45.49^d	45.35^d	21.21^d	18.55^d	44.45^d	21.24^d	19.43^d
90 min.	79.99^c	79.36^c	48.73^c	39.40^c	79.15^c	50.37^c	46.20^c
105min.	88.62^b	84.52^b	59.69^b	50.41^b	82.85^b	70.51^b	61.40^b
120min.	93.43^a	91.36^a	71.78^a	61.45^a	92.27^a	80.06^a	76.86^a
Overrun %	73.00	91.70	87.00	71.00	83.00	81.70	77.30

The same letters are not significant at the level ***0.05***

T1 Control Ice Cream
T2 Ice Cream with 50 % MSNF from UFR. **T3** Ice Cream with 75 % MSNF from UFR.
T4 Ice Cream with 100 % MSNF from UFR. **T5** Ice Cream with 50 % MSNF from ROR.
T6 Ice Cream with 75 % MSNF from ROR. **T7** Ice Cream with 100 % MSNF from ROR.

The results are in agreement with **Mohamed (1997)** who demonstrated that the overrun of 75 % UFR-ice cream was lower than that of 50 % UFR replacement, and this was attributed to the associated increase in titratable acidity. **Arbuckle (1986)** stated that, increasing the acidity of the mix. caused an decrease in its whipping ability.

Statistical analysis of overrun showed that, there is higher significant differences between treatments ***(P < 0.0001)*** with LSD 6.532.

On the other hand, **Hofi (1989)** and **Geilman and Schmidit (1992)** observed a negligible effect of UFR replacement on the overrun of the ice cream.

Organoleptic Quality of the Resultant Ice Cream:

The organoleptic scores of ice cream as affected by MSNF replacement with different levels of UFR or ROR are illustrated in **Table (8).**

It was obvious that ice cream made with UF- or RO-retentates gained higher flavour scores than the control which made with skimmed milk powder. This could be attributed to the absence of the salty flavour which associated the use of SMP as the source of MSNF in ice cream mix. Also, the high level of lactose in ROR-ice cream increased the sweetness which masks the high salt content in RO-retentate. No significant difference was found in flavour scores among the UF- or RO-products. **(Lee and White, 1991)** except high sweetness in 100 % RO-ice cream.

Concerning body & texture, UFR- products gained the highest recipes as they characterized by smooth, velvety and more creamy body & texture compared with control and ROR recipes. This may be due to the lower lactose and higher protein contents especially whey proteins.

These results confirmed the finding of **Hofi (1989)** and **Lee & White (1991). Arbuckle (1977)** mentioned that the body & texture and storage quality of the finished ice cream was improved when low lactose products are used. However, it was observed that replacement of 100 % of the SNF with ROR in ice cream resulted in some sandiness and coarse texture. This may be due to the high content of lactose which form some crystals **(Arbuckle, 1977** and **Sallam, 1998).** From statistical point of view there was no significant differences between all produced ice cream concerning this property.

As mentioned before the high protein enhancing the melting property of the resultant ice cream. Thus, the melting quality was going on with the melting quality which was discussed before.

Table (8) Organoleptic scores of ice cream made either from UFR or ROR.

Property	Control (T1)	UFR*			ROR**		
		50 % (T2)	75 % (T3)	100 % (T4)	50 % (T5)	75 % (T6)	100 % (T7)
Flavour (50)	46.00	46.70	47.00	47.20	47.60	46.70	46.50
Body & Texture (40)	38.00	38.50	38.70	39.00	38.50	38.40	37.00
Melting Quality (10)	9.30	9.60	9.70	9.80	9.50	9.60	9.50
Total (100)	93.30	94.80	95.40	96.00	95.60	94.70	93.00

* UFR: Ultrafiltration Retentate. ** ROR: Reverse Osmosis Retentate.

T1 Control Ice Cream

T2 Ice Cream with 50 % MSNF from UFR.
T3 Ice Cream with 75 % MSNF from UFR.
T4 Ice Cream with 100 % MSNF from UFR.
T5 Ice Cream with 50 % MSNF from ROR.
T6 Ice Cream with 75 % MSNF from ROR.
T7 Ice Cream with 100 % MSNF from ROR.

With regard to the overall scores, products made with UF-retentate had higher flavour, higher body and texture scores and excellent melting quality especially that of 100 % of the MSNF replacement. No significant differences were detected among the other UFR products, control and ROR products except that mix containing 100 % ROR which characterized with some coarse and sandy texture.

Statistical analysis revealed that, there was no significant difference in ice cream made from UF- or RO-retentate replacement of MSNF and the control sample ***(P < 0.0001),*** with LSD 2.194.

Moreover, **Glover (1985)** indicated that ice cream made with RO-concentrates was as good as that made with traditional ingredients.

CONCLUSIONS

From such a study it could be recommend that ice cream could be successfully made using UF or RO-retentates rich-in-protein as a source of MSNF with any percent up to 100 % UFR and 75 % of ROR of MSNF replacement with exception only MSNF supplementation 100 % of ROR.

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استخدام اللبن المركز بالترشيح الدقيق والاسموزية العكسية في صناعة الآيس كريم.

يهدف هذا الجزء إلى استخدام مصادر مختلفة لجوامد اللبن اللادهنية في تصنيع مخلوط آيس كريم يحتوى على (٦ % دهن ، ١١ % جوامد لبن لادهنية ، ٠.٣ مادة رابطة CMC ، ١٦ % سكر). وفى هذا الإطار تم استخدام مركز اللبن الفرز(٢٥ % جوامد كلية) المتحصل عليه بالترشيح الدقيق **Ultrafiltration** أو بالاسموزية العكسية **Reverse Osmosis** فى مخاليط الآيس كريم. ومقارنتها بمخلوط الآيس كريم المستخدم فيه اللبن الفرز المجفف كمصدر رئيسى لجوامد اللبن اللادهنية وقد تضمن هذا الجزء على إجراء ٧ معاملات على النحو التالى:-

١- مخلوط الآيس كريم المصنع والمضاف إليه اللبن الفرز المجفف كمصدر رئيسى لزيادة جوامد اللبن اللادهنية (كنترول).

٢- مخلوط الآيس كريم المصنع باستبدال ٥٠ % من جوامد اللبن اللادهنية التى مصدرها اللبن الفرز المجفف بمركز اللبن الفرز والمتحصل عليه بالترشيح الدقيق.

٣- مخلوط الآيس كريم المصنع باستبدال ٧٥ % من جوامد اللبن اللادهنية التى مصدرها اللبن الفرز المجفف بمركز اللبن الفرز والمتحصل عليه بالترشيح الدقيق.

٤- مخلوط الآيس كريم المصنع باستبدال ١٠٠ % من جوامد اللبن اللادهنية التى مصدرها اللبن الفرز المجفف بمركز اللبن الفرز والمتحصل عليه بالترشيح الدقيق.

٥- مخلوط الآيس كريم المصنع باستبدال ٥٠ % من جوامد اللبن اللادهنية التى مصدرها اللبن الفرز المجفف بمركز اللبن الفرز والمتحصل عليه بالاسموزية العكسية.

٦- مخلوط الآيس كريم المصنع باستبدال ٧٥ % من جوامد اللبن اللادهنية التى مصدرها اللبن الفرز المجفف بمركز اللبن الفرز والمتحصل عليه بالاسموزية العكسية.

٧- مخلوط الآيس كريم المصنع باستبدال ١٠٠ % من جوامد اللبن اللادهنية التى مصدرها اللبن الفرز المجفف بمركز اللبن الفرز والمتحصل عليه بالاسموزية العكسية.

والنتائج المتحصل عليها يمكن تلخيصها فى النقاط الآتية:-

١- استخدام مركزات اللبن سواء المتحصل عليها من الترشيح الدقيق أو الاسموزية العكسية لم يسبب أى تغير معنوى فى نسبة الجوامد الكلية أو المحتوى الدهنى للمخاليط. بينما زادت نسبة البروتين في المخاليط بزيادة نسبة الاستبدال باللبن المركز. ولقد كان محتوى البروتين للمخاليط المتحصل عليها باستبدال جوامد اللبن اللادهنية بمركز اللبن المتحصل عليه بالترشيح الدقيق يزيد عما هو الحال فى الاستبدال بمركز اللبن بالاسموزية العكسية فى جميع نسب الاستبدال المستخدمة.

٢- انخفاض نسبة اللاكتوز فى المخاليط بزيادة نسب الاستبدال فى كلا النوعين من مركز اللبن سواء بالترشيح الدقيق أو الاسموزية العكسية.

٣- زادت نسبة الرماد فى المخاليط بزيادة نسب الاستبدال فى كلا النوعين من مركز اللبن سواء بالترشيح الدقيق أو الاسموزية العكسية.

٤- زيادة الحموضة تدريجيا وانخفاض قيم الـ pH فى المخاليط بزيادة نسب الاستبدال فى كلا النوعين من مركز اللبن سواء بالترشيح الدقيق أو الاسموزية العكسية.

٥- أدى الاستبدال بمركزات اللبن إلى زيادة تدريجية فى الوزن النوعى للمخاليط وزيادة الريع وذلك عن عينة المقارنة (المصنعة بدون مركزات اللبن). كما ظهر أن الاستبدال بمركزات اللبن سواء بالترشيح الدقيق أو الاسموزية العكسية يزيد من مقاومة الناتج للانصهار.

٦- من الناحية الحسية كانت جميع العينات مقبولة بدون استثناء ولكن كانت العينة الناتجة من المعاملة باستبدال ١٠٠ % بمركز اللبن الفرز والمتحصل عليه بالترشيح الدقيق أفضلهم ، يليها ٧٥ % بمركز اللبن الفرز والمتحصل عليه باستخدام الترشيح الدقيق أو الاسموزية العكسية. ولقد ظهر عيب الترميل (Sandy) بدرجة طفيفة عند الاستبدال بنسبة ١٠٠ % بمركز اللبن بالاسموزية العكسية (المعاملة رقم ٧) . وقد يرجع ذلك إلى زيادة نسبة (اللاكتوز) فيها عن باقي المعاملات كما زادت نسبة الحلاوة فى هذه المعاملة.

مما سبق يتضح أنه يمكن استخدام مركز اللبن بالترشيح الدقيق في صناعة المثلجات اللبنية بنسبة ١٠٠ % من الجوامد اللبنية اللادهنية. أما في حالة استخدام مركز اللبن المتحصل عليه بالاسموزية العكسية فلا ينصح بزيادة نسبة الاستبدال فيه عن ٧٥ % من جملة جوامد اللبن اللادهنية الداخلة فى مخاليط الآيس كريم.