

Fatty Acid Profile of Dietetic Ice Cream Developed by Linseed Oil Rice Bran Wax Organogel

S. Banupriya*, A. Elango, N. Karthikeyan and C. Kathirvelan

Department of Livestock Product Technology (Dairy Science), Veterinary College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Namakkal 637 002, India; banupriyalpt@gmail.com, elangodsc@gmail.com, karthitamil_2007@gmail.com, kadhirc@gmail.com

Abstract

Objectives: Study has been carried out to develop low saturated fat dietetic ice cream by using linseed oil rice bran organogel in the place of milk fat. The linseed oil rice bran wax organogel was used at 0, 2.5, 5.0, 7.5 and 10.0% as a milk fat replacer. **Methods:** The raw ingredients linseed oil, rice bran wax and linseed oil rice bran wax organogel were analyzed for its fatty acid composition. Similarly, the control and treatment ice creams are also analyzed for fatty acid profile by using gas chromatography. **Findings:** The total saturated fatty acid in linseed oil, rice bran wax and linseed oil rice bran wax organogel was 9.40, 6.92 and 8.96% respectively. Similarly, the total unsaturated fatty acid in linseed oil, rice bran wax and linseed oil rice bran wax organogel was 89.53, 2.01 and 81.74% respectively. The levels of total saturated fatty acids in control, T1, T2, T3 and T4 ice creams were 49.56, 39.09, 28.89, 17.18 and 8.06% respectively. Similarly, the level of unsaturated fatty acids in control, T1, T2, T3 and T4 ice creams were 29.88, 41.57, 55.43, 67.10 and 79.97% respectively. **Application:** Present study results indicated that linseed oil was good source of linolenic acid (C18:3) fatty acid and milk fat in ice cream can be replaced up to 2.5% with linseed oil Rice Bran Wax (RBW) organogel without affecting the sensory attributes.

Keywords: Fatty Acids, Linseed Oil, Organogel, Rice Bran Wax (RBW)

1. Introduction

The Trans and saturated fatty acid intake through diet has been associated with an increase in serum levels of low density lipoprotein and decrease of blood levels of high-density lipoprotein. These dietary habits are responsible for the risk of coronary heart disease^{1,10}. Consumption of oil as a dietary source of omega-3 and omega-6 fatty acids has many health benefits to human^{2,10}. Organogelation is an alternative method that can be used to modify the

physical properties of oils without altering their chemical characteristics³. Hence this research has been carried out to study the impact of linseed oil rice bran wax organogel incorporation in fatty acid profile of the ice cream.

2. Materials and Methods

Linseed oil rice bran wax organogel was used at 0, 2.5, 5.0, 7.5 and 10.0% as a milk fat replacer to develop dietetic ice cream as detailed in Table 1.

*Author for correspondence

Table 1. Experimental groups

Treatments	Details	Milk fat replacement
Control	Ice cream with 10 % milk fat	0%
T1	7.5 % milk fat + 2.5 % linseed oil rice bran wax organogel	2.5%
T2	5 % milk fat + 5.0 % linseed oil rice bran wax organogel	5.0%
T3	2.5 % milk fat + 7.5 % linseed oil rice bran wax organogel	7.5%
T4	10 % linseed oil rice bran wax organogel	10.0%

3. Linseed Oil Rice Bran Wax Organogel Preparation

Linseed oil rice bran wax organogel was obtained by combining 10% (wt) of RBW and 90% (wt) of linseed oil and

the temperature of the blend was increased up to 80°C to melt the wax.

3.1 Ice Cream Formulation

Product formulation was comprised of 12% SNE, 10%

Table 2. Different proportion of ingredients used in ice cream

Ingredient	Control	T1	T2	T3	T4
Skim milk	715	719	723.5	727.5	731.5
Butter	92.5	69.5	46	23	0
LORBWOG	0	19	38	57	76
Skim milk powder	50	50	50	50	50
Sugar	140	140	140	140	140
Stabilizer & Emulsifier	1.5	1.5	1.5	1.5	1.5
Flavoring Agent	1	1	1	1	1
Total	1000	1000	1000	1000	1000

fat, 15% sugar, 0.5% stabilizer and Total solids 36.0% as per the (FSSR, 2011). The content level of ingredient was found out through mathematical calculation and for a batch size of 1000g (Table 2). The guidelines prescribed⁴ and the flow chart indicated⁵ were followed in the preparation of ice cream.

4. Fatty Acid Analysis

The composition of fatty acids in the samples was analyzed by Gas Chromatography (GC) with Flame Ionization Detector (FID). The lipids in ice cream test samples were extracted by following the method proposed⁶. Fatty Acid

Methyl Esters (FAMES) for ice cream samples were prepared by using sodium methoxide method⁷.

The data collected on various parameters were statistically analysed⁸ and the means of different experimental groups were tested for statistical significance by ANOVA.

5. Results and Discussion

5.1 Fatty Acids Composition of Raw Ingredients

The mean fatty acids composition of linseed oil, rice bran wax and linseed oil RBW organogel are presented in the Table 3.

Table 3. Mean fatty acid composition (%) of linseed oil, rice bran wax and linseed oil RBW organogel

Fatty acid	Linseed oil	Rice bran wax	Linseed oil RBW organogel
C14:0	--	0.63±0.09	0.04 ± 0.01
C16:0	5.57 ± 0.23	3.73±0.22	5.04±0.04
C18:0	3.20 ± 0.21	2.47 ± 0.09	3.08 ± 0.05
C18:1	22.20 ± 0.30	2.01 ± 0.03	20.52±0.39
C18:2	20.17 ± 0.63	--	18.09±0.15
C18:3	47.17 ± 0.73	--	43.12±0.07
C20:0	0.63 ± 0.07	2.56 ± 0.14	0.80± 0.03
Total Saturated	9.40 ± 0.46	6.92± 0.44	8.96 ±0.07
MUFA	22.20 ± 0.30	2.01 ± 0.03	20.52±0.39
PUFA	67.33 ± 1.02	--	61.22 ±0.13
Total Unsaturated	89.53 ± 1.25	2.01 ± 0.03	81.74 ±0.41

Values are Mean ±SE of triplicate results (n=3)

The level of C16:0, C18:0 and C20:0 in linseed oil used in the study were 5.57 ± 0.23 , 3.20 ± 0.21 , and $0.63 \pm 0.07\%$ respectively. The total saturated and unsaturated fatty acid content was 9.40 and 89.53% respectively. The level of C 18:1, C18:2 and C18:3 in linseed oil used in the present study were 22.20 ± 0.30 , 20.17 ± 0.63 and $47.17 \pm 0.73\%$ respectively. Similar results also observed by⁹ who reported that the level of C18:1, C18:2 and C18:3 in linseed oil were 21.42, 15.18 and 54.20% respectively.

The total saturated and unsaturated fatty acid content in rice bran wax was 6.92 ± 0.44 and $2.01 \pm 0.03\%$ respectively, and similar values are reported¹⁰. The level of total saturated and unsaturated fatty acids in linseed oil RBW organogel was 8.96 ± 0.07 and $81.74 \pm 0.41\%$ respectively which was similar to the observations¹¹.

5.1.1 Fatty Acids Composition of Ice Creams

The fatty acids composition of control and treatment ice cream is presented in the Table 4.

Table 4. Fatty acid composition of ice creams

Fatty acid	Control	T1	T2	T3	T4
C14:0	9.22 ^e ± 0.09	6.76 ^d ± 0.10	4.90 ^c ± 0.17	2.32 ^b ± 0.06	0.05 ^a ± 0.02
C16:0	25.57 ^f ± 0.66	20.50 ^e ± 0.40	14.96 ^d ± 0.21	9.77 ^c ± 0.37	4.71 ^b ± 0.29
C18:0	14.58 ^e ± 0.41	11.47 ^d ± 0.48	8.63 ^c ± 0.09	4.47 ^b ± 0.15	2.58 ^a ± 0.11
C18:1	26.39 ^{cd} ± 0.51	25.17 ^c ± 0.62	23.00 ^b ± 0.58	21.20 ^a ± 0.42	20.27 ^a ± 0.55
C18:2	1.93 ^a ± 0.06	5.80 ^b ± 0.26	9.73 ^c ± 0.47	14.07 ^d ± 0.47	17.87 ^e ± 0.20
C18:3	1.56 ^b ± 0.05	10.60 ^c ± 0.32	22.70 ^d ± 0.65	31.83 ^f ± 0.84	41.83 ^g ± 0.60
C20:0	0.20 ^a ± 0.04	0.36 ^{ab} ± 0.02	0.47 ^{bc} ± 0.09	0.62 ^{cd} ± 0.10	0.72 ^d ± 0.10
Total Saturated	49.56^f ± 0.41	39.09^e ± 0.54	28.89^c ± 0.19	17.18^b ± 0.16	8.06^a ± 0.30

MUFA	26.39 ^{cd} ±0.51	25.17 ^c ±0.62	23.00 ^b ±0.58	21.20 ^a ±0.42	20.27 ^a ±0.55
PUFA	3.49 ^a ± 0.11	16.40 ^b ±0.06	32.43 ^d ±1.09	45.90 ^f ±0.42	59.70 ^h ±0.60
Total unsaturated	29.88^a ±0.62	41.57^b ±0.56	55.43^c ±0.60	67.10^d ±0.42	79.97^f ±0.90

Values are Mean ±SE of three observations (n=3)

Values bearing different superscript in a row differ significantly at (P<0.05)

The level of C18:1, C18:2 and C18:3 fatty acids in control ice cream are 26.39, 1.93 and 1.56% respectively. The total saturated and unsaturated fatty acid in control (milk fat) ice cream was 49.56±0.41 and 29.88±0.62% respectively. This was in close agreement¹¹, who reported that the total saturated fatty acid content in milk fat based ice cream was about 50 %.

The level of total saturated fatty acids in T1, T2, T3 and T4 ice cream are 39.09 ± 0.54, 28.98 ± 0.19, 17.18 ± 0.16 and 8.06 ± 0.30% respectively. Similarly, the level of total unsaturated fatty acids in T1, T2, T3 and T4 ice cream was 41.57±0.56, 55.43±0.60, 67.10±0.42 and 79.97±0.90 respectively

As the level of incorporation of linseed oil RBW organogel increased, the level of total saturated fatty acids decreased significantly (P<0.05) among the treatments. The treatment ice creams significantly (P<0.05) had lower level of saturated fatty acid compared to the control. As the percentage of organogel incorporation increased the level of total unsaturated fatty acids increased significantly (P<0.05) from T1 to T4. The total saturated and unsaturated fatty acid in control (milk fat) ice cream was 49.56 and 29.88 per cent respectively. This was in close agreement with¹¹ who reported that the total saturated fatty acid content in milk fat based ice cream was about 50%. Similar results were also observed by¹² who reported that as percentage incorporation of palm olein oil increased

from 1 to 3% inclusion to milk fat, resulted in a significant (P<0.01) increase in unsaturated fatty acid content.

6. Conclusion

Results of present study indicated that linseed oil has rich source of alpha linolenic acid (C18:3, Omega 3) fatty acid and moderate source C18:2. In rice bran wax, fatty acid analysis revealed that traces of unsaturated fatty acids and 6.92% of saturated fatty acids were noticed.

The cost of production of Linseed oil RBW organogel incorporated treatment ice creams was higher than the milk fat based control ice cream. In linseed oil RBW organogel group, beyond 2.5% inclusion, acceptability score decreased in spite of the unsaturated fatty acids content was increased. Hence it can be concluded that, substitution of milk fat with 2.5% linseed oil RBW organogel produce ice-cream with good physico-chemical properties and gives overall acceptability as compared to control ice cream. The level unsaturated fatty acids are increased at the expense of decreased level of saturated fatty acids.

Though the cost of production for linseed oil RBW organogel incorporated dietetic low saturated fat dietetic ice cream was higher than that of control, the resultant product was enriched with health giving unsaturated and omega-3 fatty acid in linseed oil organogel ice cream

which will be immensely helpful in reducing coronary artery disease, tumor and lowering serum triglycerides.

7. References

1. Mozaffarian D, Katan MB, Ascherio A, Stampfer MJ, Willett WC. Trans fatty acids and cardiovascular disease. *The New England J. of Med.*, 2006; 354(15):1601-1613.
2. National Institute of Health. Omega-3 fatty acids, fish oil, alpha-linolenic acid. 2005. <http://www.nlm.nih.gov/medlineplus/druginfo/natural/patient-fishoil>. (accessed on 15-4-2015)
3. Weiss RG, Terech P. Introduction-Molecular gels materials with self assembled fibrillar networks. Dordrecht (NL), Springer; 2006. p. 978-990
4. Bureau Indian Standards. Handbook of food analysis. Dairy products, New Delhi; 1980. p. 167-171.
5. Sukumar De. Outlines of Dairy Technology. Published by Oxford University Press. New Delhi; 1980. p 183.
6. Bligh EG, Dyer WJ. A rapid method of total lipid extraction and purification. *Canadian J. Biochem and Physio.* 1959; 37: 911-917.
7. Qian M. Gas chromatography, Food analysis laboratory manual, New York: Kluwer academic publishers; 2003. p. 230-278.
8. Snedecor GW, Cochran WG. Statistical methods. Eighth edition, IOWA State University Press, USA; 1994.
9. Lyubov Vladimirovna Golubeva, Yekaterina Anatolievna Pozhidaeva, Yevgeny Sergeevich Popov, Lyubov Nikolaevna Golubeva. Optimization of Blend Composition of Polycomponent Dry Mix for Enriched Soft Ice Cream. *Indian Journal of Science and Technology.* 2015; 8(29):1-7.
10. Daniele CB. Application of rice bran wax organogel to substitute solid fat and enhance unsaturated fat content in ice cream. Master thesis submitted to the University of Guelph, Canada; 2012.
11. Lim CW, Norziah MH, Lu HFS. Effect of flaxseed oil towards physicochemical and sensory characteristic of reduced fat ice creams and its stability in ice creams upon storage. *International Food Res. Journal.* 2010; 17: 393-403.
12. Nadeem M, Abdullah M, Ayesha, Ellahi MY. Effect of milk fat replacement with palm olein on physico chemical and sensory characteristics of ice cream. *Pakistan J. Sci.* 2009; 61(4):210-214.