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# Physicochemical Properties of Functional Low-Fat Whipped Cream with Oats

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## ABSTRACT

Various foods have been supplemented with oats to increase their physicochemical and hygienic properties, however little work has been carried out concerning its suitability in whipping cream. The purpose of the present study is to highlight the effect of its incorporation with low-fat whipped cream on the physicochemical and sensory properties of the resultant mix. Treatments were prepared by partial replacement of skim milk powder with 0, 25, 50, 75 and100% of oats. The results showed decrease of pH values in the low-fat whipping cream, while the pH values were gradually increased in the cream with oats additives. Total solids, protein and ash in low-fat whipping cream containing oats decreased, while an increase in carbohydrate were observed. It could also be seen that the low-fat whipped cream with the oats characterized with higher content of fiber and iron. Addition of oats improved the foaming stability of low - fat whipped cream, and increased viscosity. incorporation of oats improved whipping time, it reached maximum overrun after 5 min. Sensory evaluation showed that the low-fat whipped cream samples with oats were acceptable and the highest scores were for the treatments with ratios 25% and 50% oats. It could be concluded that it is possible to use oats as a component in producing functional low – fat whipped cream.

**Keywords:** Oats, low-fat whipping cream, chemical composition, overrun, foam stability, viscosity, sensory evaluation.

## INTRODUCTION

Whipped creams are popular for many people. Those are widely used for cooking in households, especially, for desserts and cake decorations. Whipped cream usually characterized with its content of not less than 36% of fat. Various studies were carried out to make low fat whipped cream of 10 - 25% fat, as reported by Padiernos *et al. (*2009), Shalaby *et al. (*2013) and US FDA, (2016). High fat intake, especially saturated fats are of harmful effects mainly due to the obesity, heart diseases, and certain types of cancer. The need of developing of functional foods of low fat contents became vital so as to improve the health and well-being of the consumers. (Glicksman, (1995), Charalampopoulos *et al.,* (2002) and Ellin Doyle, (2004). Functional foods supplemented with oats were also reported as an important effect on lowering cholesterol. Using cereals in preparing functional foods were reported to be an important component to lower the cholesterol level and reduce the risk of heart diseases Charalampopoulos *et al. (*2002).

Food and Drug Administration (FDA). Oats were found rich in their contents of fibers, proteins,various vitamins and minerals being essential for human health (Food and Drug Administration (FDA) and Esposito *et al.,* 2005). Oat-rich material in fiber soluble and insoluble, the soluble fiber found in oats component is β-glucan, which proved to be effective in lowering cholesterol in the blood (Kerckhoffs *et al*., 2003). Studies showed that the health benefits of oats improved the immune system response (Hong *et al*., 2004 & Yang *et al.,* 2008). These attributed to a good antioxidant capacity of oats such as tocopherols, and phenolic acids and their derivatives (Mattila *et al.,* 2005 & Ahmad *et al*., 2014). In addition to their importance in the diet, oats antioxidants may also contribute to the stability and the taste of food products.

As oats can be incorporated into different varieties of foods, researches to investigate its suitability in whipping cream are scarce. For these reasons the present study is devoted to utilize oats in producing functional low-fat whipped cream and study its impact on the physicochemical properties of the end product.

## MATERIALS AND METHODS

Buffalo cream and skim milk were obtained from the Unit of Milk Industry**,** Animal Production Research Institute, Agricultural Research Center, Giza, Egypt. Skim milk powder, sugar and vanilla were purchased from a local super market. Carboxy methyl cellulose (CMC) as stabilizer was obtained from the Pharmaceutical Chemicals Nasr Co., Abo-Zaabel, Kalubia.

Rolled oats (*Avena sativa* L) (origin Germany) was purchased from the local market; it was used as an ingredient in preparing low fat whipped cream. The chemical composition of oats was represented in Table (1).

**Table 1. Chemical composition of oats**

| Chemical composition | Percentage % |
|---|---|
| Total solids | 92.0 |
| Protein | 11.2 |
| Fat | 8.7 |
| Ash | 5.1 |
| Fiber | 9.5 |
| Carbohydrate | 57.5 |

Whipping cream control consisted of 35% fat, 5% sugar and 0.3% carboxy methyl cellulose, (skim milk ,9% T.S was used to standardize the fat content ). To obtain the low fat whipping cream, fat content was lowered to 20% and by replacing the removed fat by skimmed milk powder (T1). Low fat whipping cream with oats treatments (20% fat) were prepared by partial replacement of skim milk powder with different levels of oats of 25%, 50% ,75% and 100%, in 6 treatments(1-5), in the same order.

The liquid ingredients, including skim milk and cream were mixed and heated at 45°C. Solid ingredients, including stabilizer CMC powder, white sugar, powder and skim milk powder were mixed well, then added to the liquid ingredients, and mixed properly. Pasteurization of mixes was carried at 72°C for 15sec,,followed by cooling in cold water. When cream mixes were cooled to 40 ± 2°C. and vanilla flavor was added. The formulations used for preparing the low-fat whipped cream mixes and control were presented in Table (2). Cream mixes were refrigerated at 6 ± 2°C for at least 12 h. (Smith *et al.,* 1999).

**Table 2. Formula of Whipping Cream mixes.**

| Substances (g) | Treatments (20 % fat) | | | | | |
|---|---|---|---|---|---|---|
| | Control (35% fat) | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| Cream 50 % | 315 | 180 | 180 | 180 | 180 | 180 |
| Skim milk | 111.15 | 178.65 | 178.65 | 178.65 | 178.65 | 178.65 |
| Skim milk powder | -- | 67.50 | 50.63 | 33.75 | 16.87 | -- |
| Oat | -- | -- | 16.87 | 33.75 | 50.63 | 67.50 |
| Sugar | 22.50 | 22.50 | 22.50 | 22.50 | 22.50 | 22.50 |
| Stabilizer | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 |
| Vanilla | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Total | 450.20 | 450.20 | 450.20 | 450.20 | 450.20 | 450.20 |

**Control**: **Whipped cream (35 % fat) without oats.**
**$T_1$: Whipped cream (20 % fat) without oats.**
**$T_2$: Whipped cream (20% fat) with 25 % oats replaced the skim milk powder.**
**$T_3$: Whipped cream (20% fat) with 50% oats replaced the skim milk powder.**
**$T_4$: Whipped cream (20% fat) with 75 % oats replaced the skim milk powder.**
**$T_5$: Whipped cream (20% fat) with 100 % oats replaced the skim milk powder**

pH values of whipping cream samples were measured by laboratory pH-meter(Jenway 3505 pH meter). The viscosity of the cream mixes was measured by using a Brookfild DV-E Viscometer, (Brookfild Engineering Laboratories, Inc, Middle boro, U.S.A.) The viscometer was equipped with a R3 spider and the speed was set on 200 rpm.

The total solids, protein, ash and crude fiber were determined according to AOAC (2007). Fat was analyzed by using Soxhlet method. Carbohydrate content was calculated by deference for all samples analyses. Minerals content of whipping cream samples, namely phosphorus, magnesium, calcium, iron and zink were determined by colorimetric methods according to El-Merzabani *et al*., (1977), Teitz (1983), Ginder and King (1972), Dreux (1977) and Hayakawa and Jap (1961), in the same order.

The overrun of the whipped creams was determined and calculated using the equation reported by Phillips *et al*., (1990).

$$\text{Overrun \%} = \frac{\text{weight of un whipped cream} - \text{weight of whipped cream}}{\text{Weight of whipped cream}} \times 100$$

Foam stability of whipped cream was determined according to Lim et al. (2008).

Sensory evaluation of the Low-fat whipped cream treatments were evaluated by the staff of the Dairy Department, Animal Production Research Institute using the following scale: 50 for flavor, 35 for body and texture, and 15 for appearance. The total scores were 100.

## RESULTS AND DISCUSSION

Table (3) shows that all pH values of low – fat whipped cream treatments were lower than the control (35 % fat), due to increase in milk solid not fat (MSNF). While the pH values of different treatments of whipped cream with oats gradually increased by increasing the amount of oats. However, there were no highly differences between pH values in low – fat whipped cream with and without oats. Results in Table (3) also show that there were markedly differences in the viscosity values between low-fat whipping cream mixes and control. The low – fat whipping creams containing oats were characterized with higher viscosity values, as compared with control and low fat whipping cream without oats, which might be due to β – glucan in oats (Gazal *et.al*, 2014).

**Table 3. Physicochemical properties of low- fat whipping cream mixes with oats.**

| Chemical properties | Treatments (20 % fat ) | | | | | |
|---|---|---|---|---|---|---|
| | Control (35 % fat) | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| pH | 6.44 | 5.88 | 5.90 | 5.95 | 6.00 | 6.10 |
| Viscosity (c.P) | 1144 | 1128 | 3736 | 5128 | 5552 | 5945 |
| Total solids % | 44.12 | 43.52 | 43.37 | 43.22 | 43.07 | 42.92 |
| Protein % | 2.09 | 7.34 | 6.44 | 5.52 | 4.64 | 3.74 |
| Oats fat % | - | - | 0.33 | 0.66 | 0.98 | 1.31 |
| Fiber % | - | - | 0.36 | 0.71 | 1.07 | 1.43 |
| Ash % | 0.50 | 1.56 | 1.49 | 1.42 | 1.33 | 1.26 |
| Carbohydrate % | 6.53 | 14.62 | 14.75 | 14.91 | 15.05 | 15.18 |

Total solids of low –fat whipped cream reached 43.52 (Table 3). The results revealed gradual decrease in the total solids of low –fat whipped cream with oats. However, there were no great differences in the total solids of the low – fat whipped cream without oats and all treatments with oats. Protein content of low –fat whipped cream was higher than the control, this could be attributed to the elevated level of solids not fat in low fat treatments. The protein content of low – fat whipped cream was affected by adding oats, which replaced skim milk powder. The replacement of oats resulted in reduction in protein content (Table 3). This result was expected due to the protein content of oats of 11.2% (Table 1), compared with that in skim milk powder (35%). Oat protein is nearly equivalent in quality to meat, milk, and egg protein (Ahmad *et al*., 2014). Moreover, oats proteins have functional technology as speed melt and foam, also emulsifying association with water and fat (Kaukonen *et al*., 2011; Ercili-Cura, 2013).

The results in Table (3) also show the content of oats fat in low – fat whipped cream with oats due to the fat content in oats (8.7%) as shown in Table (1). Oats contain relatively high amounts of lipids compared with other cereal grains with a substantial level of essential linoleic acid (Mattila *et al.*, 2005).

With regard to carbohydrate which elevated in low –fat whipped cream, compared to control, and gradually increased with increasing of oats substitution

level. Moreover, the data indicated that oats had pronounced effect on the fiber content in low- fat whipped cream. These results attributed to high content of carbohydrate and fiber in oats as shown in Table (1), which were in agreement with the report of Ahmad *et al*. ( 2014), who mentioned that β-Glucan is a soluble fiber in oat grains that has been gaining interest due to its multiple functional and bioactive properties. Its beneficial role in insulin resistance, hypertension, lower cholesterol and obesity is being continuously documented.

Generally, minerals content in all low – fat whipping cream treatments were higher than control as shown in Table (4). It was noticed that calcium, phosphorus, potassium and zinc contents in low- fat whipped cream with oats were less than that in low fat whipped cream without oats. The same trend observed in magnesium (Mg) content in low- fat whipping cream mixes ( Table 4). The obtained data also indicated that oats had a pronounced effect on the iron content in low - fat whipped cream. These results attributed to high content of iron in oats as reported by Ahmad *et al*. (2014).

**Table 4 .The minerals contents (mg/100 g) of oats whipping cream mixes**

| Minerals | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | Control | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| Ca | 67 | 235 | 195 | 155 | 115 | 75 |
| P | 56 | 183 | 162 | 142 | 120 | 99 |
| K | 92 | 334 | 286 | 238 | 190 | 142 |
| Mg | 7.76 | 27.27 | 27.26 | 27.26 | 27.26 | 27.26 |
| Zn | 0.24 | 0.84 | 0.77 | 0.69 | 0.62 | 0.54 |
| Fe | 0.02 | 0.06 | 0.20 | 0.34 | 0.48 | 0.62 |

Concerning the whipping time and Overrun, the results in Table (5) revealed that low-fat whipping cream without oats achieved the maximum overrun 193% after 10 min. The data indicated that the oats effect on whipping time decreased to 5 min. and the maximum overrun were 96, 108,120 and 171%, for treatments $T_5$, $T_4$, $T_3$ and $T_2$ respectively. As whipping continued until 10 min, the overrun decreased steadily as the air-water interface structure holding the foam was disrupted by mechanical agitation of the mixer. The differences of overrun among low-fat whipped creams were attributed to the amount of skim milk, and the exclusion or inclusion of oats. This indicated that the incorporation of oats into low-fat whipping cream relatively decreased the overrun due to high viscosity.

As with the foam stability, good-quality whipping cream must exhibit a short whipping time, a large overrun, and stable foams (Jakubczyk and Niranjan, 2006). The results illustrated more serum drained from the foam of control and low-fat whipping cream without oats after 12 h than from low-fat whipped cream containing oats (Table 5). These indicated the high foam stability of the low-fat whipped cream containing oats compared to control and low-fat whipped cream without oats. The high foam stability of the low-fat whipped cream containing oats may be attributed to protein of oats produced a cohesive film around the air bubbles. Stable foams require a protein film surrounding air bubbles and the packaging of large amounts of air bubbles into an overall structure (Foegeding *et al*., 2006).

**Table 5. Overrun and foam stability of whipped cream with oats.**

| Treatments | Time min. | Overrun % | Amount of drainage* % |
|---|---|---|---|
| Control | 5 | 151 | 26 |
| $T_1$ | 10 | 193 | 15 |
| $T_2$ | 5 | 171 | 12 |
| $T_3$ | 5 | 120 | 8 |
| $T_4$ | 5 | 108 | 6 |
| $T_5$ | 5 | 96 | 4 |

***Weight of drainage obtained after 12 h divided by the weight of whipping cream at the beginning.**

Sensory evaluation is the key to achieve knowledge about whether consumers and panelists perceive differences in a final product. Generally, the data (Table 6) showed that the low-fat whipped cream samples with oats were acceptable. No differences were detected between low-fat whipped cream without oats and low-fat whipped cream with oats for treatment $T_2$ and $T_3$ (Table 6). However, the differences were observed in treatments $T_4$ and $T_5$.

**Table 6. Sensory evaluation of low – fat whipped cream with oats.**

| Treatments | Flavour (50) | Body & Texture (35) | Appearance (15) | Total (100) |
|---|---|---|---|---|
| Control | 48 | 34 | 14 | 96 |
| $T_1$ | 47 | 33 | 13 | 93 |
| $T_2$ | 46 | 33 | 13 | 92 |
| $T_3$ | 45 | 32 | 13 | 90 |
| $T_4$ | 43 | 29 | 11 | 83 |
| $T_5$ | 38 | 26 | 10 | 74 |

## CONCLUSION

It could be concluded that using oats in low-fat whipped cream improved whipping time, viscosity, foam stability with acceptable sensory properties. Moreover, low-fat whipped cream containing oats characterized by high content of fiber and iron. Consequently, using oats as an ingredient in producing functional low-fat whipped cream is desired.

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## الخواص الطبيعية – الكيميائية للقشدة المخفوقة منخفضة الدهن والمحتوية على الشوفان

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يهدف البحث إلى تحسين الخواص الوظيفية والصحية للقشدة المخفوقة وذلك بإنخفاض نسبة الدهن إلى ٢٠% بدلا من ٣٥% وإستخدام الشوفان المطحون الجاف كأحد مكونتها ودراسة تأثيره على خواصها الطبيعية والكيميائية والحسية. كانت المعاملات كالآتى: ١- كنترول القشدة المخفوقة ٣٥% دهن. ٢- قشدة منخفضة الدهن ٢٠% دهن بدون شوفان. ٣- تدعيم القشدة منخفضة الدهن (٢٠% دهن) بالشوفان وذلك باستبدال جزئى للبن الفرز الجاف بالشوفان بنسب ٢٥، ٥٠، ٧٥، ١٠٠%.وقد أظهرت النتائج الأتى : كان تأثيرالشوفان على التركيب الكيميائى للقشدة المخفوقة منخفضة الدهن أكثر وضوحا مقارنة بالكنترول . أظهرت النتائج إنخفاض قيم الـ pH فى القشدة المخفوقة منخفضة الدهن عن عينة الكنترول ثم إرتفع هذا الإنخفاض تدريجيا فى القشدة المضاف لها مسحوق الشوفان. كذلك لوحظ إنخفاض طفيف فى النسب المئوية للجوامد الكلية والبروتين والرماد للقشدة المنخفضة الدهن المحتوية على الشوفان بينما إرتفاع فى نسب الكربوهيدرات. تميزت القشدة المخفوقة منخفضة الدهن المحتوية على الشوفان بإرتفاع واضح فى نسبة الألياف والحديد مقارنة بالكنترول والقشدة منخفضة الدهن بدون شوفان. أدى التدعيم بالشوفان إلى ثبات الرغوة وزيادة ثبتها بزيادة نسبة الشوفان المضاف وكذلك زادت قيم اللزوجة فى تلك المعاملات مقارنة بالكنترول والقشدة منخفضة الدهن بدون شوفان. أيضا حسن وقت الخفق ووصل أقصى نسبة ريع عند ٥ دقائق. عند تقييم العينات حسيا , حققت القشدة المضاف له الشوفان قبولا لدى المحكمين وكانت الأعلى فى المعاملات المضاف لها الشوفان بنسبة ٢٥, ٥٠%. نستخلص من نتائج هدة الدراسة أنه يمكن التوسع فى إستخدام الشوفان كمكون من مكونات القشدة المخفوقة منخفضة الدهن وأنها كانت ذات خواص طبيعية وحسية مقبولة.