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Use of whey powder and skim milk powder for the production of fermented cream

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Abstract

This study is about the production of fermented cream samples having 18% fat by addition of starter cultures. In order to partialy increase non-fat solid content of fermented cream samples, skim milk powder and demineralized whey powder in two different rates (50% and 70%) were used. Samples were analyzed for changes in their biochemical and physicochemical properties (total solid, ash, fat, titratable acidity, pH value, total nitrogen, viscosity, tyrosine, acid number, peroxide and diacetyl values) during 29-day of storage period. Samples tested consisted of 7 different groups; control group (without adding any powder), skim milk powder, 50% demineralized whey powder and 70% demineralized whey powder samples were in two different addition rate (2% and 4%). Also samples were analyzed for sensory properties. According to the results obtained, the addition of milk powder products affected titratable acidity and tyrosine values of fermented cream samples. Although powder addition and/or storage period didn't cause significant variations in total solid, ash, fat, pH value, viscosity, acid number, peroxide, tyrosine and diacetyl values; sensory properties of fermented cream samples were influenced by both powder addition and storage period. Fermented cream containing 2% skim milk powder gets the top score of sensory evaluation among the samples.

Keywords: fermented cream; milk powder; whey powder.

Practical Application: Improvement the quality of fermented cream with skim milk powder and whey powder.

1 Introduction

Fermented cream is a sour tasty fermented product obtained by acidification of pasteurized cream containing 10-40% fat (Esen, 1994). It is commonly consumed with characteristic aroma and flavour in many countries. Fermented cream with fat content of 10-15% and nonfat solid content of 14-18%, has a lower viscosity and its shelf life is approximately four weeks (Özdemir, 2002).

Milk powder is a nutritious and stable product which is produced by vaporization of water from milk, condensation and powdering of dry matter (Üçüncü, 2005). Skim milk powder is used mostly in high protein-less fat content products because of its much stable structure. Whey is a green yellowish liquid remaining after coagulation process with acid or enzyme and it is a by-product of cheese and caseine production (Zadow, 1994).

In this study the effect of enrichment of nonfat solid content with addition of demineralized whey powder and skim milk powder on some properties (total solid, ash, fat, titratable acidity, pH, total nitrogen, tyrosine, diacetyl, peroxide and acid number) of fermented cream were investigated. The main purpose of this study was about the enhancement of some properties of fermented cream by increasing the nonfat solid content.

2 Materials and methods

Cow milk cream (with 35-40% fat) was obtained from the Dairy Factory of Atatürk Orman Çiftliği (Ankara, Turkey) and the milk (with 3.0-3.5% fat) which was used for the standardization of fat in cream (18% fat) was obtained from the Dairy Pilot Plant of Ankara University, Faculty of Agriculture (Ankara, Turkey). "Maymix MYS 108" (MAYSA®, İzmir, Turkey) was used as stabilizer. This stabilizer is composed of mono and diglycerides, guar gum and carragenan. "MyStarter RT1 A" (MAYSA®, İzmir, Turkey) which contains *Lactococcus lactis* ssp *lactis, Lactococcus lactis* ssp. *cremoris*, *Lactococcus lactis* ssp. *diacetylactis* and *Leuconostoc mesenteroides* was used as starter culture. Among these cultures, *Lactococcus lactis* ssp. *lactis* and *Lactococcus lactis* ssp. *cremoris* play a part in acid production; *Lactococcus lactis* ssp. *lactis* biovar. *diacetylactis* and *Leuconostoc mesenteroides* contribute in the production of flavour and aroma compounds like diacetyl and acetaldehyde (Chandan et al., 2006). Skim milk powder, 50% demineralized whey powder and 70% demineralized whey powder were obtained from Enka Milk and Food Products Inc., Konya, Turkey.

2.1 Preparation of fermented cream samples

Production steps are given in Figure 1. Fermented cream production were carried out in three independent replicates. Samples of fermented creams were coded as below:

A1: Fermented cream containing 2% skim milk powder

A2: Fermented cream containing 4% skim milk powder

B1: Fermented cream containing 2% 50% demineralized whey powder

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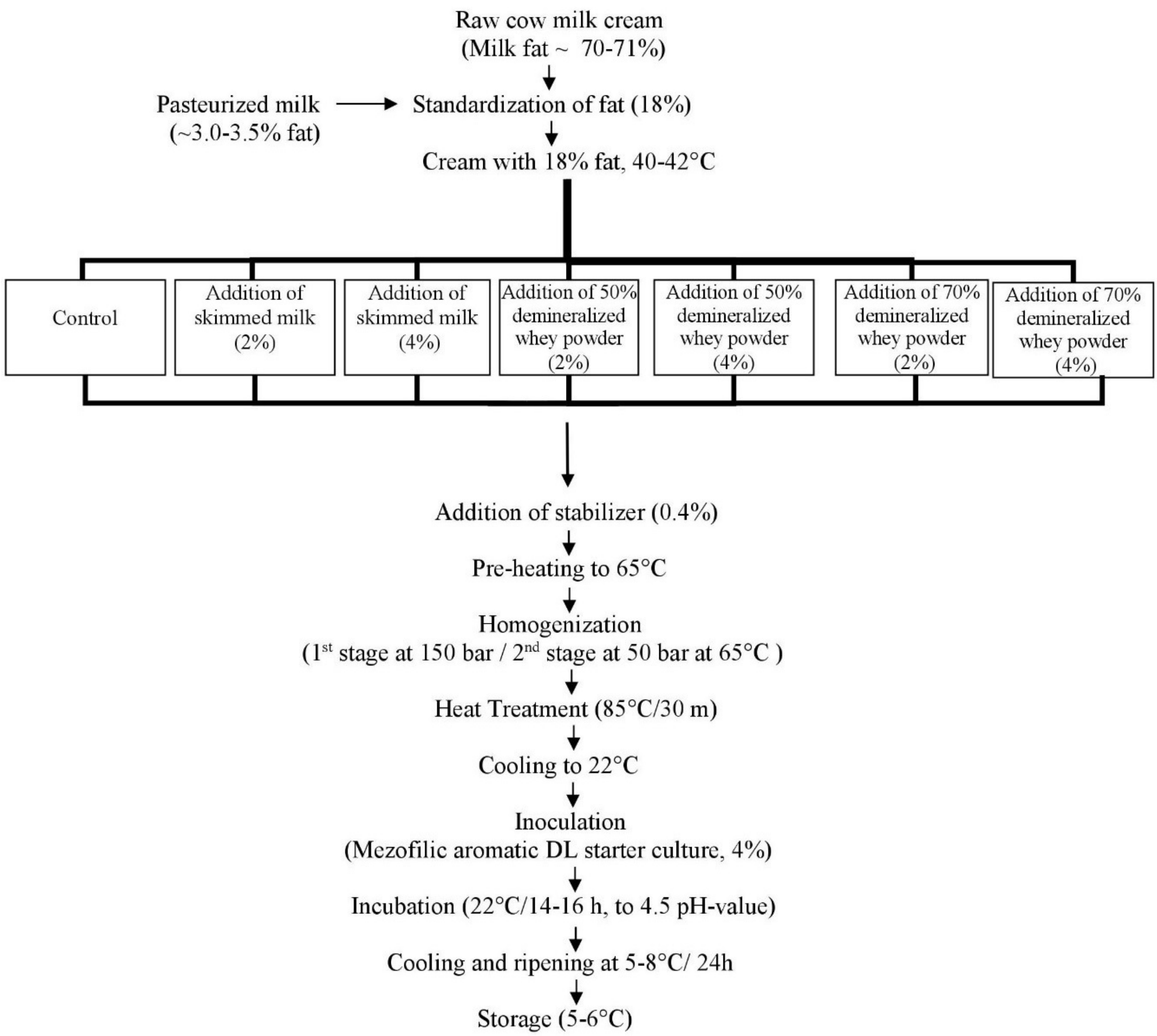

Figure 1. Production of fermented cream.

B2: Fermented cream containing 4% 50% demineralized whey powder

C1: Fermented cream containing 2% 70% demineralized whey powder

C2: Fermented cream containing 4% 70% demineralized whey powder

Control: Fermented cream without any powder addition

2.2 Determination of chemical and sensory properties

The total solid content of samples was determined by oven drying method. The fat content was determined by Gerber method and total nitrogen content was determined by Kjeldahl method (Gripon et al., 1975), the pH-value was measured using a pHmeter model Mettler Toledo (Analytical, CH-8603, Schwerzenback, Switzerland) and the non-fat-solid content was measured by refractometry (Atago hand held refractometer). Tyrosine and peroxide values were determined by spectrophotometric method (Hull, 1947; Downey, 1975); acid number was determined by titrimetric method (Hortwitz, 1965). Samples of fermented cream were analyzed by 7 panelists in the scope of sensory analyses according to the scoring card described by Bodyfelt et al. (1988).

2.3 Determination of viscosity

Viscosity values were measured by viscosimetry (Haake VT 181/VTR 24) with MV II heading.

2.4 Determination of diacetyl value

The quantity of diacetyl was measured by headspace method (Ulbert, 1991) using gas chromatography (Agilent 6890 Series, Agilent Tech., Inc, USA) equipped with a FID detector and 30 m x 320 μm i.d. polyethylene glycol capillary column with

0.25 μm film thickness. 5 g of each fermented cream sample was weighted into headspace vials and capped with crimper. Samples were stored at -18 °C until they were used. Samples were held at 70 °C/30 min before injection to the GC. Injector block temperature was 80 °C and FID temperature was 250 °C. Flow rates of air, hydrogen and nitrogen (make up) were 400, 40 and 30 mL/min, respectively.

2.5 Statistical analysis

For the statistical analyses of results, randomized block design variance analysis method was used and Duncan multiple comparison test was applied to assess the differences between the averages (Düzgüneş et al., 1987).

3 Results and discussion

Mean value of fat (%), total solid (%), non-fat solid (%), total nitrogen (%), total protein (%), pH-value and the titratable acidity (lactic acid %) of the cream that was used in the production of fermented cream were 70.33 ± 0.33, 73.20 ± 0.4, 2.86 ± 0.1, 0.06 ± 0.0, 0.38 ± 0.0, 6.35 ± 0.0 and 0.003 ± 0.0, respectively. Nonfat solid (%), fat (%), pH-value and titratable acidity (lactic acid %) values of pasteurized full-fat milk used in the standardization of fat content of cream were 10.01 ± 0.01, 3.25 ± 0.10, 6.64 ± 0.07 and 0.15 ± 0.01, respectively. The percentage of moisture content (%) and total protein (%) of skim milk powder were 5.12 ± 0.00 and 31.10 ± 2.52. The moisture content (%) and total protein amount (%) of 50% demineralized whey powder were 1.78 ± 0.03, 8.51 ± 0.35 and 2.19 ± 0.04, 2.26 ± 0.01 for 70% demineralized whey powder, respectively.

3.1 Total solid, ash, pH and titratable acidity

Total solid content is one of the most substantial parameter in food industry. It effects food quality directly and it gives information about product composition (Reh & Gerber, 2003). It is also considered as indicator of nutrition value (Lindmark-Mansson et al., 2003). There was no difference between solid contents of samples during storage ($p > 0.05$). The total solid content of A1 was 26.00%; sample A2 was 27.05%; sample B1 was 26.25%; sample B2 was 27.38%; Sample C1 was 26.50%; sample C2 was 26.94% and control sample was 25.6%.

The results show that the addition of milk powder directly affected the solid content of fermented cream samples. The mean value of total solid content of control sample was 25% after the 29th day of storage. The total solid content of control and skim milk powder added samples increased on the 8th day of storage and it did not change afterwards. That was because, fermentation process continued until the 8th day and then it slowed down.

During the storage period, there was a small change in the fat ratio standardized at 18 ± 0.5% for the production of fermented cream samples but it wasn't statistically important and so was the dry matter change.

There was no significant difference between ash values in samples during storage and this was the same to solid contents. The total ash content of sample A1 was 0.67%; sample A2 was 0.72%; sample B1 was 0.64%; sample B2 was 0.74%; sample C1 was 0.67%; sample C2 was 0.74% and control sample was 0.55%. The ash values of the fermented cream samples were lower than the other dairy products because of ash reduction due to the increase in fat ratio (Milanović et al., 2008) in dairy products.

Mean values of titratable acidity and pH value of fermented cream samples are shown in Table 1. Titratable acidity changes showed similar differences in all samples. It was determined that titratable acidity of control sample was lower than the other samples. Titratable acidity of the samples added with skim milk powder was the highest of all samples. There was no significant effect of storage on titratable acidity ($p > 0.05$). But titratable acidity values of all samples were increased during storage. However there was significant difference between titratable acidity values of samples with skim milk powder added than the other samples ($p < 0.05$). According to this result, fermented cream samples with milk powder had increased lactic acid production because of high lactose content.

It is shown that addition of milk powders effected the pH-values of samples (Table 1). Control samples showed the highest pH value and samples that had skim milk powder showed the lowest pH value. Thus the addition of powdered milk can increase the growth of microorganisms (Ünlütürk & Turantaş, 2003). pH decreased with increase in acidity in later days of storage in fermented dairy products (Hassan & Amjad, 2010; Hiller & Lorenzen, 2010; Kailasapathy, 2006). The average pH value was reported as 4.41 in fermented cream samples with 18% fat. It was concluded consequently that pH value variation was based on starter culture activity. In statistic evaluations, there was a significant difference between pH values of samples

Table 1. Titratable acidity (Lactic acid, %) and pH value of fermented cream samples (n = 3)[1].

Sample	1st day		8th day		15th day		22nd day		29th day	
	pH value	Lactic acid	pH value	Lactic acid	pH value	Lactic acid	pH value	Lactic acid	pH value	Lactic acid
A1	4.44 ± 0.0^{a2}	0.78 ± 0.8^{a}	4.43 ± 0.1^{a}	0.78 ± 0.3^{a}	4.38 ± 0.0^{a}	0.81 ± 0.2^{a}	4.40 ± 0.0^{a}	0.82 ± 0.2^{a}	4.39 ± 0.0^{a}	0.82 ± 0.6^{a}
A2	4.48 ± 0.0^{a}	0.86 ± 0.3^{b}	4.47 ± 0.0^{a}	0.87 ± 0.6^{b}	4.46 ± 0.0^{a}	0.88 ± 0.2^{a}	4.47 ± 0.0^{a}	0.90 ± 0.4^{b}	4.48 ± 0.1^{a}	0.90 ± 0.4^{a}
B1	4.56 ± 0.1^{ab}	0.64 ± 0.9^{c}	4.46 ± 0.1^{a}	0.68 ± 1.2^{c}	4.40 ± 0.0^{a}	0.69 ± 0.9^{b}	4.37 ± 0.0^{a}	0.74 ± 0.8^{c}	4.33 ± 0.0^{a}	0.77 ± 0.9^{b}
B2	4.62 ± 0.1^{b}	0.67 ± 0.1^{c}	4.50 ± 0.1^{a}	0.71 ± 0.5^{c}	4.46 ± 0.0^{a}	0.72 ± 0.4^{b}	4.43 ± 0.0^{a}	0.74 ± 0.5^{c}	4.37 ± 0.0^{a}	0.76 ± 0.5^{b}
C1	4.57 ± 0.1^{b}	0.66 ± 0.1^{c}	4.49 ± 0.1^{a}	0.70 ± 0.5^{c}	4.44 ± 0.1^{a}	0.72 ± 0.9^{b}	4.45 ± 0.0^{a}	0.77 ± 0.7^{ac}	4.33 ± 0.0^{a}	0.77 ± 0.8^{b}
C2	4.60 ± 0.1^{b}	0.70 ± 0.5^{c}	4.53 ± 0.1^{a}	0.75 ± 0.2^{ac}	4.49 ± 0.0^{a}	0.77 ± 0.8^{ab}	4.44 ± 0.0^{a}	0.77 ± 1.7^{ac}	4.37 ± 0.0^{a}	0.81 ± 0.6^{ab}
Control	4.70 ± 0.1^{c}	0.64 ± 0.1^{c}	4.66 ± 0.1^{b}	0.65 ± 0.4^{d}	4.63 ± 0.1^{b}	0.70 ± 0.9^{b}	4.59 ± 0.0^{b}	0.70 ± 0.5^{c}	4.57 ± 0.0^{b}	0.70 ± 0.5^{b}

[1]: Repeat number; [2]: Different exponential letters indicate that the values differ significantly ($p < 0.05$).

($p < 0.05$) but there was no significant effect of storage time on pH value in fermented cream samples ($p > 0.05$).

3.2 Total protein and tyrosine

Mean values of total nitrogen of fermented cream samples are presented in Figure 2. There was no significant difference between the samples ($p > 0.05$) except for the samples which contained skim milk powder (Sample A1 and A2) ($p < 0.05$). It is known that the ratio of total nitrogen of skim milk powder is more than that of whey powders. So nitrogen value increase by addition of skim milk powder. Samples A1 and A2 had the highest total nitrogen values. Total nitrogen values of samples decreased during the first 7 days of storage. It is known that demineralization process has no effect on protein content. Consequently there was no differences between samples of 50% (B1 and B2) and 70% (C1 and C2) of demineralized whey powder addition. Total nitrogen value increases with the increase of powder and the same applies with skim milk powder.

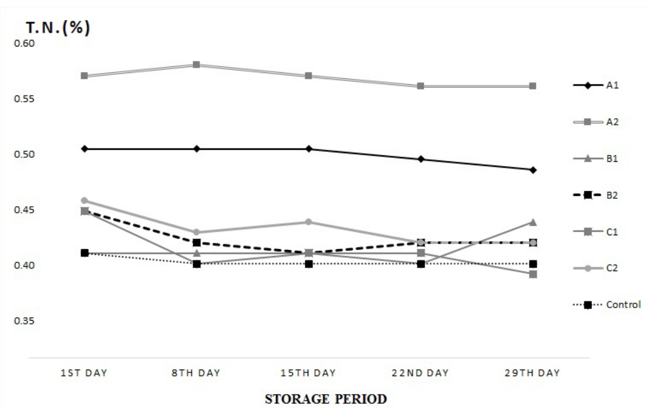

Figure 2. Total nitrogen (%) values of fermented cream samples.

Tyrosine is an amino acid which has aromatic and bitter taste and it is known as 4-hydroxiphenilalanin or 2-amino-3-propanoic acid. The amount of tyrosine is considered as an indicator of proteolitic activity (Ersoy & Uysal, 2002). The tyrosine values of fermented cream samples were changed at a range of 0.116-0.121 mg/g and the mean value of tyrosine of fermented cream samples added with milk powder and whey powder was 0.118 mg/g. There was no difference between tyrosine values of samples during storage ($p > 0.05$).

3.3 Peroxide and acid number

Mean values of peroxide and acid number of fermented cream samples are presented in Table 2. The acid number indicates the amount of free fatty acids in lipids and is calculated by measurement of KOH which is used to neutralize 1 gram of fat. Acid number is important because it is an indicator of degree of lipolysis. According to Table 2, acid numbers of all samples increased until the 15th day of storage. Rancid taste was detectable when acid number was higher than 3.065 mg KOH in fermented cream with 18% fat ratio (Manav, 2011).

Oxidative deterioration in dairy products generally occurs as a result of unsaturated fatty acids otooxidation. Peroxide is a primary product of oxidation. Lipid reacts with oxygen which is contained in the product resulting into a rancid flavour (Bandyopadhyay et al., 2008). The results showed that peroxide values of all samples increased on the 8th day of storage (Table 3) and it is seen that the peroxide values decreased after that date. This is because peroxide is unstable and it turns easily into a secondary oxidation product. In the following days of storage,

Table 2. Acid number (mg KOH/g fat) and peroxide (mEqO_2/kg fat) values of fermented cream samples, (n = 3)[1].

	1st day		8th day		15th day		22nd day		29th day	
	Acid Number	Peroxide	Acid Number	Peroxide	Acid Number	Peroxide	Acid Number	Peroxide	Acid Number	Peroxide
A1	1.93 ± 0.12	3.55 ± 0.16	1.94 ± 0.16	3.65 ± 1.29	2.09 ± 0.25	2.54 ± 0.22	1.95 ± 0.19	2.05 ± 0.71	2.02 ± 0.02	1.29 ± 0.04
A2	1.81 ± 0.03	4.52 ± 0.02	1.86 ± 0.02	4.63 ± 0.50	2.48 ± 0.09	3.01 ± 0.65	2.41 ± 0.11	2.11 ± 0.39	1.73 ± 0.13	1.99 ± 0.48
B1	1.75 ± 0.49	2.37 ± 0.12	2.20 ± 0.09	4.10 ± 0.31	2.23 ± 0.09	4.02 ± 0.05	2.44 ± 0.09	1.73 ± 0.06	2.32 ± 0.26	1.69 ± 0.23
B2	1.67 ± 0.08	3.12 ± 0.09	1.84 ± 0.07	4.34 ± 0.13	1.86 ± 0.09	3.86 ± 0.31	2.31 ± 0.44	1.57 ± 0.06	1.93 ± 0.08	1.62 ± 0.09
C1	1.83 ± 0.20	3.61 ± 1.27	1.92 ± 0.23	3.62 ± 0.87	2.09 ± 0.10	3.29 ± 0.25	2.12 ± 0.16	1.59 ± 0.15	2.49 ± 0.25	1.54 ± 0.02
C2	1.74 ± 0.55	4.25 ± 0.07	2.05 ± 0.26	4.95 ± 0.52	2.23 ± 0.22	3.42 ± 0.14	2.56 ± 0.13	1.72 ± 0.47	2.54 ± 0.01	1.28 ± 0.14
Control	1.60 ± 0.48	3.10 ± 1.08	1.86 ± 0.20	3.61 ± 0.13	1.99 ± 0.28	2.90 ± 0.75	2.01 ± 0.23	2.54 ± 0.79	2.12 ± 0.22	2.62 ± 0.91

[1]: Repeat number.

Table 3. Diacetyl content of fermented cream samples, (mg/kg) (n = 3)[1].

Sample	1st day	8th day	15th day	22nd day	29th day
A1	0.42 ± 0.1	0.60 ± 0.1	1.74 ± 0.2	1.01 ± 0.4	0.81 ± 0.5
A2	0.47 ± 0.1	0.90 ± 0.0	1.23 ± 0.1	1.22 ± 0.7	0.12 ± 0.6
B1	0.43 ± 0.4	0.61 ± 0.1	1.16 ± 0.4	1.11 ± 0.9	0.31 ± 0.1
B2	0.74 ± 0.0	1.23 ± 0.5	1.75 ± 0.5	0.63 ± 0.1	0.22 ± 0.1
C1	0.46 ± 0.2	1.25 ± 0.2	1.23 ± 0.0	1.03 ± 0.1	0.80 ± 0.2
C2	0.61 ± 0.0	0.71 ± 0.1	1.27 ± 0.2	0.97 ± 0.5	0.56 ± 0.1
Control	0.46 ± 0.1	0.60 ± 0.0	0.60 ± 0.0	0.47 ± 0.1	0.47 ± 0.1

[1] : Repeat number.

peroxide value decreased in all samples. This is because of the unstable nature of peroxide whereby the primary oxidation occurs rapidly into secondary oxidized products (Semeniuc et al., 2009). There was no significant difference between the samples during storage ($p > 0.05$). Peroxide value was between 2.54-3.61 meqO_2/kg fat in control samples without addition of powder.

3.4 Viscosity

Viscosity is one of the most important factors for consumers. It has to be at an acceptable level in all kinds of cream products. The mean values for viscosity of fermented cream samples are presented in Figure 3. Viscosity values increased with the amount of milk powder supplement and kept on increasing during the storage.

3.5 Diacetyl

2,3 di-butanone, also known as diacetyl, is a major required aroma compound in fermented creams. Flavour in fermented cream products is derived from diacetyl. Many consumers evaluate fermented creams without diacetyl as flavorless (Clark et al., 2009). The mean values of diacetyl of fermented cream samples are presented in Table 3. The diacetyl values of all samples increased until 15th day at storage and the highest value was determined on that day. Diacetyl value decreased after 15th day of storage period. The reason of this, is that bacteria rapidly degrade diacetyl to asetoine (acetyl methyl carbinol); a kind of odourless compound formed when citrate is broken down during fermentation process (Mistry, 2001). Diacetyl value was detected ranging from 0.5-2.0 mg/kg in butter sample which manufactured from cultured cream (Spreer, 1998). It was considered that outcomes of fermented cream with powder addition are higher in diacetyl value than the average because of its high lactose content.

3.6 Sensory properties

Homogenous appereance, smooty structure and shiny surface are favorite characteristics in fermented cream products. Panelists were requested to evaluate appearance, body/texture, odor and flavor. Mean scores were used for comparison of the samples. Results of sensory analysis showed that sample A1 had the

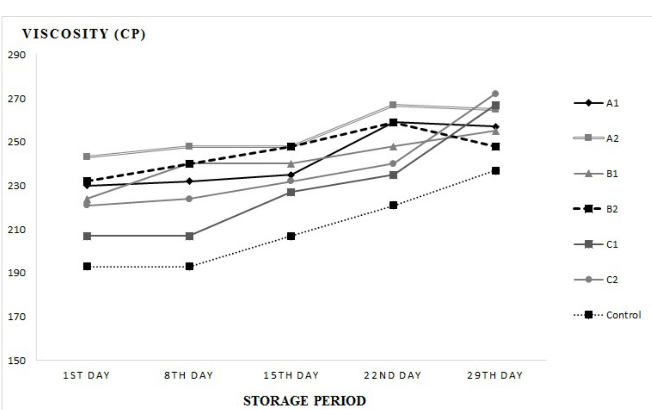

Figure 3. Viscosity (cP) values of fermented cream samples.

highest total sensory value (15.4/20.0) during the whole storage period followed by control sample (15.2/20.0), A2 (15.0/20.0), B1 (14.1/20.0), C2 (13.7/20.0), B2 (13.2/20.0) and C1 (12.8/20.0) samples, respectively. The lowest value was determined in the last day of storage (29th day) and panelists pointed out that the products were not acceptable for consuming. Therefore, the shelf life of fermented cream with 18% fat ratio could be notified as 22 days or less. At the same time highest points of sensory analysis of all samples were detected on 15th day of storage. These results were similar to the outputs of diacetyl values.

4 Conclusions

Addition of milk based powders during production of fermented cream improves the properties of the product. The higher solid and ash contents of fermented cream increase the nutritional value. Due to the high lactose content, skim milk powder, 50% and 70% demineralized whey powder enhanced activity of starter culture. Development of acidity was stimulated and the diacetyl amount which is the most important aroma compound of the fermented cream, also increased.

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References

Bandyopadhyay, M., Chakraborty, R., & Raychaudhuri, U. (2008). Antioxidant activity of natural plant sources in dairy dessert (Sandesh) under thermal treatment. *LWT - Food Science and Technology*, 41(5), 816-825. http://dx.doi.org/10.1016/j.lwt.2007.06.001.

Bodyfelt, F. W., Tobias, J., & Trout, G. M. (1988). *The sensory evaluation of dairy products*. New York: AVI Van Nostrand Reinhold Comp. Inc.

Chandan, R. C., White, C. H., Kilara, A., & Hui, Y. H. (2006). *Manufacturing yogurt and fermented milks*. Iowa: Wiley-Blackwell Publishing.

Clark, S., Costello, M., Drake, M. A., & Bodyfelt, F. (2009). *The sensory evaluation of dairy products*. New York: AVI Van Nostrand Reinhold Comp. Inc.

Downey, W. K. (1975). *Butter quality oxidation and hydrolytic rancidity in salted sweet cream and slightly salted ripened cream butter* (Dairy Research and Review Series, no. 7). Dublin: An Foros Toluntais.

Düzgüneş, O., Kesici, T., Kavuncu, O., & Gürbüz, F. (1987). *Research and experiment methods*. Ankara: Ankara Üniversitesi Ziraat Fakültesi Yayınları.

Ersoy, M., & Uysal, H. (2002). A research on the properties of the kefirs produced from blends of skimmilk powder, whey powder and buttermilk I. Some chemical properties. *Ege Üniversitesi Ziraat Fakültesi Dergisi*, 39, 64-71.

Esen, N. (1994). *A study on the use of various cultures in manufacture of cultured cream with different fat content* (Master's thesis). Department of Dairy Technology, Ankara University, Ankara.

Gripon, J. C., Desmazeud, M. J., Le Bars, D., & Bergere, J. H. (1975). Role des microorganismes et des enzymes du cours de la maturation. *Le Lait*, 548, 502-516. http://dx.doi.org/10.1051/lait:197554828.

Hassan, A., & Amjad, İ. (2010). Nutritional evaluation of yoghurt prepared by different starter cultures and their physiochemical analysis during storage. *African Journal of Microbiological Research*, 4(1), 22-26.

Hiller, B., & Lorenzen, P. C. (2010). Properites of set-style skim milk yoghurt as affected by an enzymatic or Maillard reaction induced milk protein oligomerisation. *Food Science and Technology*, 44, 811-819.

Hortwitz, W. (1965). *Official Methods of Analysis of the Association of Official Agricultural Chemist*. Washington: AOAC.

Hull, M. E. (1947). Studies on milk proteins. II. colorimetric determination of the partial hydrolysis of the proteins in milk. *Journal of Dairy Science*, 30(11), 881-884. http://dx.doi.org/10.3168/jds.S0022-0302(47)92412-0.

Kailasapathy, K. (2006). Survival of free and encapsulated probiotic bacteria and their effect on the sensory properties of yoghurt. *LWT - Food Science and Technology*, 39(10), 1221-1227. http://dx.doi.org/10.1016/j.lwt.2005.07.013.

Lindmark-Mansson, H., Fonden, R., & Pettersson, H. E. (2003). Composition of Swedish dairy milk. *International Dairy Journal*, 13(6), 409-425. http://dx.doi.org/10.1016/S0958-6946(03)00032-3.

Manav, M. (2011). *Researching some properties of cultured cream during storage* (Master's thesis). Department of Dairy Technology, Ankara University, Ankara.

Milanović, S. D., Lončar, E. S., Đurić, M. S., Malbaša, R. V., Tekić, M. N., Iličić, M. D., & Duraković, K. G. (2008). Low energy kombucha fermented milk-based beverages. *Acta Periodica Technologica*, 39(39), 37-46. http://dx.doi.org/10.2298/APT0839037M.

Mistry, V. V. (2001). Fermented milks and cream. In E. H. Marth & J. L. Steele (Eds.), *Applied dairy microbiology* (pp. 301-305). New York: Marcel Dekker Inc.

Özdemir, Ö. (2002). *A research on production of fermented cream with fruit and cacao* (Master's thesis). Department of Dairy Technology, Ege University, Ankara.

Reh, C. T., & Gerber, A. (2003). Total solids determination in dairy products by microwave oven technique. *Food Chemistry*, 82(1), 125-131. http://dx.doi.org/10.1016/S0308-8146(02)00585-X.

Semeniuc, C. A., Guş, C., Rotar, A. M., Socaci, S. A., Suharoschi, R., & Laslo, C. (2009). Effect of storage time on the oxidative status of infant formula. *Bulletin UASVM Agriculture*, 66, 448-452.

Spreer, E. (1998). *Milk and dairy products technology*. New York: Marcel Decker Inc.

Üçüncü, M. (2005). *Technology of milk and milk products*. İzmir: Ege Üniversitesi Mühendislik Fakültesi Yayınları.

Ulbert, F. (1991). Headspace gas chromatographic estimation of some yoghurt volatiles. *Journal Association of Official Analytical Chemists*, 74, 630-634.

Ünlütürk, A., & Turantaş, F. (2003). *Food microbiology* (3th ed). İzmir: Ege Üniversitesi Meta Basım Matbaacılık Hizmetleri.

Zadow, J. G. (1994). Utilisation of milk components: whey. In R. K. Robinson (Ed.), *Modern dairy technology* (pp. 313-373). London: Springer Science and Business Media Dordrech.