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Manufacture of Cholesterol - Reduced Double Cream Cheese from Buffalo's Milk

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ABSTRACT

Cholesterol- reduced cream cheese (CRCC) was made by treatment with β-cyclodextrin (β-CD), compared with regular cream cheese (RCC) made from milk containing the same fat content (11 %). The attained results revealed that 91.12 % of cholesterol-reduction was achieved by β-CD. The yield and gross chemical composition of RCC and CRCC were nearly similar, whereas some slight changes in moisture, acidity, acid value and pH were recorded during storage of the resultant cheese. Hardness, cohesiveness, springiness, gumminess and chewiness of fresh and stored cheese were relatively higher in CRCC than RCC, whereas storage decreased their values. Treatment with β-CD slightly improved appearance, body and texture and flavour of the resultant cheese, while storage had an opposite impact only on the appearance and flavour. The total scores given for all properties were 94.24, 96.19, 94.20 and 95.93 out of 100 for fresh RCC and CRCC and stored RCC and CRCC, respectively.

Keywords: Beta cyclodextrin, cholesterol reduction, cream cheese.

INTRODUCTION

Popularity of cream cheese in America is well-known, and its consumption is also greatly appreciated in Europe, especially, in the UK, Germany and France. (Tewari and Singh, 1991; Sanchez *et al.* 1996).

Cream cheese is highly nutritious being rich in fat and milk proteins since it is manufactured from cream or from a mixture of cream and milk or skim milk. In this respect, Jeon *et al.* (2012) mentioned that cream cheese is usually made from bovine milk, while its production from other milk sources or milk powders are still in developing stage.

Two kinds of cream cheese based on fat content in the initial and final composition were mentioned in the literature. One is single cream cheese (SCC), and the other is double cream cheese (DCC). It was reported that SCC is of 4-5 % fat content, while DCC is of at least 9-11 % fat in the initial mix (Guinee *et al.* 1993). However, one type of cream cheese is triple cream cheese that of 75% fat in dry matter (FDM) content (Sanchez *et al.* 1996).

On the other hand, the role of milk fat on the quality of dairy products is well-known, since a serious problem in low-fat products is that fat reduction of a sever effect on the final flavour and texture (Wendin *et al.* 2000; Brighenti *et al* 2008). Further healthier eating habits increase in the demand of the lower cholesterol dairy products (Jeon *et al*. 2012). This was the aim of some recent studies. In this respect, β-cyclodextrin (β-CD) was used to reduce cholesterol in milk (Lee *et al.* 1999; Kim *et al.* 2004; Han *et al.* 2005), in Cheddar cheese Kwak *et al*. 2002), in cream (Ahn *and* Kwak 1999; Shim *et al.* 2003; Han *et al.* 2007) and in cream cheese (Han *et al.* 2008). Littler information are available concerning the use of β-CD to reduce cholesterol from buffalo's cream.

Therefore, the objective of the present study was to make cholesterol-reduced cream cheese (CRCC) from a mixture of β-CD treated cream ad buffalo's milk. Composition and sensorial attributes of the resultant cheese were taken into consideration.

MATERIALS AND METHODS

Materials

Fresh buffalo's milk was purchased from milk processing unit (MPU), Dairy Dept. Fac. Agric., Cairo Univ., Giza, whereas commercial powdered beta-cyclodexxtrin (β-CD, purity 99.1%, supplied by Orkila) was purchased from Orkila Egypt Chemicals, Cairo. Mesophilic starter culture containing *lactobacillus lactis subsp lactis* and *lactococcus lactis subsp cremoris* (freeze- dried DVS, CHN 22) was obtained as a gift from MIFAD, Badr City, Cairo. The starter culture (CHr. Hansen Company (Denmark) was used. Liquid rennet, calcium chloride were obtained from MPU.

Cholesterol and the enzymatic kit (Bio-diagnostic Company, Lebanon) as well as the chemicals needed for cholesterol determination were purchased from Bio-diagnostic (Giza), and from the local market, respectively.

Preparation of cholesterol- reduced cream (CRC):

The fresh milk was skimmed at 40 °C using cream separator to obtain skim milk and cream. The attained cream was divided into two equal portions. The first one was kept as a regular cream and served as control, whereas the second portion was treated by β-CD to prepare CRC. This was done by blending β-CD with cream at the level of 10% (w/w) with steaming for 30 min in a temperature- controlled water bath at 40 °C (Ahn and Kwak,1999). The mixture was centrifuged (4000 rpm/min) at 40 °C for 10 min to remove β-CD - cholesterol complex (Lee *et al.* 1999). The regular cream and CRC were added separately to different portions of skim milk to adjust fat content to 11%. The standardized milk portions were pasteurized (72 °C / momentary) to be ready for making regular cream cheese (RCC) and cholesterol- reduced cream cheese (CRCC) respectively.

Making of cream cheese:

Cream cheese was made according to the method given by Kosikowski and Mistry (1997) as described in details by Han *et al*. (2008).

The prepared standardized mixtures were inoculated with 0.05% lactic culture (CHN 22), and incubated at 28 °C after adding small amount of liquid rennet and calcium chloride to get a complete coagulation in 4 h. The curd was cut and ripened for about 1 h to reach the required pH (~ 4.7- 4.8). The whey was drained and the curd was salted by adding 1% sodium chloride. A complete drainage of whey was done in cloth bags under moderate pressure. The cold salted curd was packed in plastic containers, and kept in the refrigerator for analysis. Three replicates were done from each treatment.

Extraction and determination of cholesterol:

This was done using the modified enzymatic method as described by Mohamed (2010) depending on saponification of fat with methanolic KOH under certain conditions of heating and extraction of the unsaponifiable fraction by hexane. This fraction was treated after evaporating the hexane at 37^{o}C with the enzymatic kits (cholesterolesterase (CE), cholesterol peroxidase (CP), cholesterol oxidase (COD)). The concentration was determined by using spectrophotometer (670 uv/ vis spectrophotometer-Jenway (England)) at 550 nm and calculated from the standard solutions.

Chemical analysis of cheese:

Cheese samples were chemically analyzed when fresh and after 2 weeks of cold storage for moisture, fat (Gerber's method), protein (TN x 6.38, Kjeldhal's method) , acidity and pH as described by Ling (1963). Acid value was measured according to AOAC (2000) after extraction of fat. The results were expressed as ml KOH (0.1N) required to neutralize the acidity of one gram of extracted fat.

Sensory evaluation:

This was done using scoring card suggested on the basis of cream cheese attributes mentioned by Nelson and Trout (1981) and Wendin *et al*. (2000).

RESULTS AND DISCUSSION

Table (1) reveals that the cholesterol content of regular cream cheese (RCC) as mg/100g was 94.6, whereas treatment with β-CD decreased it to only 8.4. Such reduction in cholesterol-reduced cream cheese (CRCC) was 91.12%. This agrees with the results given in the Literature. Ahn and Kwak (1999) could obtain reduction of 94.2-97.99% depending on the conditions applied for treatment with β-CD. Kim *et al.* (2005) made cream cheese with reduction of its cholesterol by 92.0% using 10% β-CD. Han *et al.* (2008) achieved approximately 91% of cholesterol reduction in cream cheese using powdered or cross linked β-CD. Jeon *et al.* (2012) showed that RCC contained 96.28 mg cholesterol/100 g, while CRCC contained only 7.47 mg/100g. Such different reduction rates could be attributed to the concentration of β-CD used, and to the conditions of applying β-CD, such as mixing temperature and temperature and time of the centrifugal force (Ahn and Kwak, 1999; Lee *et al.* 1999 Shim *et al.* 2003)

Yield and gross chemical composition of fresh cheese seem to be not affected by the treatment with β-CD. (Table 1) shows that the average yield of fresh RCC and CRCC were 35.5 and 36.3%, respectively. This agrees with Kim *et al.* (2005), who detect the corresponding concentration of 33.0 and 34.8 %, whereas those given by Han *et al.* (2008) were 33.5 and 34.2 and by jeon *et al.* (2012) was 36.2 % for both cheeses.

Slight differences (Table 1) with respect to fat (34.2 and 33.9%) and protein (8.7 and 8.65%) of RCC and CRCC were detected, which came in agreement with those obtained by Kim *et al.* (2005), Han *et al.* (2008) and Jeon *et al.* (2012). The lower fat content of CRCC than the control might be due to less incorporation with casein via a fat-protein network as a result of probable modification of casein matrix by β-CD (Han *et al*. 2008).

Table 1. Cholesterol content (mg/100g), yield (%) and gross Chemical composition of fresh regular cream cheese (RCC) and cholesterol – reduced cream cheese (CRCC) (Average of 3 replicates).

Property	RCC	CRCC
Cholesterol	94.60	8.40
Reduction, %	-	91.12
Yield	35.50	36.30
Total solids, %	45.16	44.33
Fat, %	34.20	33.90
Fat/ Dry Matter, %	75.73	76.47
Protein, %	8.70	8.65

Slight variations were observed during the storage of both RCC and CRCC (Table 2). These included slight decrease in the moisture content and pH, and an increase in the acidity and acid value. Similar results were noticed by Elkot and Khalil (2018).

Table 2. Some chemical changes during cold storage of regular cream cheese (RCC) and cholesteroL-reduced cream cheese (CRCC) (Average of 3 replicates)

Property	Fresh cheese		Stored cheese	
	RCC	CRCC	RCC	CRCC
Moisture %	54.84	55.67	52.41	53.27
Acidity %	0.90	0.82	1.10	0.89
Acid value*	0.35	0.31	0.54	0.45
pH	4.47	4.52	4.37	4.46

***Expressed as ml KOH (0.1N)/gram fat**

Concerning the rheological attributes, hardness, gumminess and chewiness are shown in Table(3). They were the most properties affected by treatment with β-CD. This was true in fresh or stored cream cheese. The values given for hardness were 2.4 and 3.1g in the fresh RCC and CRCC, respectively, whereas the corresponding values in stored cheese were 1.43 and 2.47 g., in order. The corresponding values of gumminess (N) were 0.90, 1.50, 0.40 and 0.70, whereas those of chewiness were 2.52, 06.55, 2.22 and 3.95 mj, respectively. Less differences were recorded between RCC and CRCC with respect to the adhesiveness, cohesiveness and springiness.

Table 3. Rheological properties of fresh and stored regular cream cheese (RCC) and cholesterol–reduced cream cheese (CRCC) (Average of 3 replicates)

Property	Fresh cheese		Stored cheese	
	RCC	CRCC	RCC	CRCC
Hardness, g	2.4	3.1	1.43	2.47
Adhesiveness, mj	0.910	0.852	0.723	0.757
Cohesiveness	0.37	0.48	0.26	0.27
Springiness, mm	4.05	4.52	5.95	5.98
Gumminess, N	0.90	1.50	0.40	0.70
Chewiness, mj	2.52	6.55	2.22	3.95

During Storage, all the pre-mentioned rheological properties, except springiness decreased. This was noticed in RCC and CRCC, The rate of decrease was more pronounced in hardness, cohesiveness, gumminess and chewiness as well as in CRCC than in RCC with respect to some properties like cohesiveness and chewiness.

Different impacts of β-CD on the rheological properties of CC were given in the literature. β-CD treatment significantly increased hardness of CC (Kim *et al*. 2005), while lower values due to β-CD were observed by Han *et al.* (2008) and Jeon *et al*.(2012). Kim *et al.* (2005) and Han *et al*. (2008) recorded gradual decrease in hardness during storage of both control and β-CD treated CC, while the opposite was shown by Jeon *et al.* (2012). Cohesiveness was higher in β-CD than the control (Kim *et al*. 2005, jeon *et al.* (2012). Jeon *et al*. (2012) found that cohesiveness of CC gradually decreased up to 2 weeks of cold storage and increased during the rest of storage of 4 weeks. The same authors revealed that β-CD treatment or storage had insignificant effect on springiness of CC. Treatment with β-CD significantly increased gumminess of CC when fresh or stored (Kim *et al.* 2005; Han *et al.* 2008), while this was true for fresh CC and the opposite was recorded during storage (Jeon *et al.* 2012). A decrease in gumminess of β-CD treated CC was given with advancing storage period (Kim *et al.* 2005, Han *et al.* 2008), whereas Jeon *et al.* (2012) recorded a corresponding increase. Chewiness of fresh CC was significantly increased by β-CD treatment, but a gradual increase was almost noticed during the storage of both the control and β-CD treated CC made by Jeon *et al.* (2012).

The scoring points given for the organoleptic properties are shown in (Table 4). The fresh CRCC gained higher scores for the appearance than RCC. This might be attributed to the whiter colour and to more compact and homogeneous body of the CRCC . The scores achieved for the appearance of fresh RCC and CRCC were 8.64 and 9.20 out of 10 points. The differences in scores of body and texture were slight. Both fresh cheeses had silky and smooth body and texture, whereas their spreadability was nearly similar. Concerning the flavor as shown in Table (4), the scores given for the fresh RCC and CRCC were 48.50 and 48.73 out of 50 points, respectively.

Table 4. The average scores of the organoleptic properties of fresh and 2 weeks old cream cheese made as regular cream cheese (RCC) and as cholesterol –reduced cream cheese (CRCC) (Average of 10 panelists)

Property	Fresh cheese		Stored cheese	
	RCC	CRCC	RCC	CRCC
General appearance (10)	8.64	9.20	8.48	8.81
Body and Texture (40)	37.10	38.26	37.34	38.46
Flavour (50)	48.50	48.73	48.38	48.66
Total score (100)	94.24	96.19	94.20	95.93

Such high scores might be attributed to the absence of free sourness and yeasty taste, as well as rancidity and oxidized flavor in the resultant control or treated cheeses. The resultant cheese was characterized by creamy taste and pleasant odour. However, the stored cheese (2 weeks old) gained slightly less scores for the appearance and flavour, whereas slight improvement was noticed in the body and texture of RCC and CRCC.

Slight different were detected in the literature. Kim *et al.* (2005) revealed insignificant differences between fresh control and CRCC with respect to texture and flavour, whereas bitterness was noticed in control cheese. Jeon *et al.* (2012) observed significant higher scores of both appearance, texture (creamy and softness properties) of control fresh CC, whereas insignificant differences were recorded in the flavour of RCC and CRCC. Impact of storage was also different, since less scores were obtained by Kim *et al*. (2005) during storage of all cheese samples, while Jeon *et al.* (2012) reported insignificant differences in this respect.

In conclusion, a good quality cream cheese with reduced cholesterol content could be made from buffalo's milk using β-Cyclodextrin.

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تصنيع جبن القشدة منخفض الكوليسترول من اللبن الجاموسي

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أهتمت الدراسة بتصنيع جبن القشدة من اللبن الجاموسي وذلك بعد محاولة خفض الكوليسترول في القشدة المحضرة من ذلك اللبن عن طريق المعاملة بالبيتا سيكلودكسترين ثم اضافتها مرة أخرى الى اللبن الفرز الجاموسي لرفع نسبة الدهن الى 11٪ وقد تم خفض الكوليسترول بنجاح بنسبة 91,12٪ حيث كانت نسبة الكوليسترول في الجبن غير المعامل (جبن المقارنة) 94.6مجم /100 جم بينما كان المحتوى في الجبن المعامل 8.4 مجم/100 جم . أوضحت نتائج الدراسة أيضا أن تصافي الجبن كانت 35.5 ٪ و 36.3٪ في جبن المقارنة والجبن منخفض الكوليسترول على التوالي في حين لم تكن هناك فروقا كبيره في المحتوى من الجوامد الكلية، الدهن، الدهن على المادة الصلبة و البروتين. انخفض محتوى الجبن من الرطوبة انخفاضا بسيطا عند التخزين في الثلاجة لمدة أسبوعين و لوحظ ذلك الانخفاض ايضا مع الرقم الهيدروجيني في حين زادت الحموضة المعايرة و حموضة الدهن مقدرة كرقم الحامض. أوضح تحليل الجبن للخواص الريولوجيه المختلفة سواء الجبن الطازج أو المخزن أن المعامله ببيتا سيكلوديكسترين أدت الى زيادة نسبية في معظم الصفات الريولوجية المقدرة في حين كان للتخزين تأثيراً مخفضا. أوضحت الدراسة أيضا أن الجبن منخفض الكوليسترول تميز بصفات حسية افضل مثل المظهر العام و القوام و التركيب و النكهه.