AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

A Study of the Possibility of Low-Fat Feta Cheese Production using Dietary Fiber

[1]Farnaz Yahyavi and [2]Seyedeh Elham Mousavi Kalajahi

[1]Faculty member of Islamic Azad University, Mamaghan, Iran
[2]MS of Food Science and Technology, Tabriz Azad University, Iran

ARTICLE INFO

Article history:
Received 15 April 2014
Received in revised form 22 May 2014
Accepted 25 May 2014
Available online 15 June 2014

Keywords:
Inulin, Poly-Dextrose, Feta cheese, Low-fat Cheese and Fat Alternative

ABSTRACT

The use of dietary fiber poly-dextrose and Inulin examined as a fat replacer in feta cheese. The feta cheese without fat alternative, 1% poly-dextrose,1% Inulin and combined 0.5% poly-dextrose and 0.5% inulin was prepared to physicochemical and sensory tests. The feta cheese, low-fat (9-16% fat) was obtained from milk with 1.7-2.3% fat. The cheese passed the ripening period of about 45 days and then was under various chemical, textural and sensory evaluations. Fat content and fat alternatives were significantly affected the moisture, protein, efficiency and the stiffness. Corrected reduced fat cheese with poly-dextrose had the highest moisture content 67.7%, efficiency 14.5%, the lowest amount of protein 13.5% and the highest stiffness.Concerning the sensory evaluation, the composition of poly-dextrose and Inulin resulted in taste and tissue improvement and total acceptance of low-fat and fat-reduced feta cheese.

To Cite This Article: Farnaz Yahyavi and Seyedeh Elham Mousavi Kalajahi., A Study of the Possibility of Low-Fat Feta Cheese Production using Dietary Fiber. ***Adv. Environ. Biol., 8(11),*** *1245-1249, 2014*

INTRODUCTION

Fat as a great resource of energy, is essential for human growth, providing the essential fatty acids, absorbed of soluble vitamins in fat and others [7]. On the other hand, the increasing importance of diet in the prevention of certain diseases, consumers are looking for ways to reduce fat diet. In general, a diet is proper which provide the maximum 30% calories from fat [4]. The food industry is solved the need by reducing fat, calories and cholesterol in products. The result, according to the International Food Information Society, has been the annual production of more than a thousand new low-fat and fat-free products since 1990 [19].

Cheese, plays an important role in our country's population diet [12]. The feta is a white soft cheese of about 25 to 30% fat which remains in brine during the ripening period and its flavor characteristic is the acid and salt taste. The traditional feta cheese is produced of sheep's milk or a mixture of goat and sheep milk, which plays an important role in its taste [8]. Although cheese has high nutritional value but high-fat dairy consumption is associated with nutritional problems; because its high cholesterol and saturated fat resulted in reduction of cheese consumption by people who are caring about their health [6].

The cheese fat not only has the dietary role, but it has an important role in improving the texture and appearance. Low-fat cheese has some disadvantages, such as a firm and rubbery texture, bad color and taste and poor melting flexibility [15]. The effect of reducing in the amount of fat, protein network of cheese becomes more compact and dense and cheese texture becomes chewable [19].

Therefore, new methods for producing a high-fat cheese and low-fat cheese was developed with the same properties such as the change of conventional process, the selection of starter planting, adjunct planting and using fat replacers. The use of fat replacer is mentioned in different studies as a most important method to improve the functional and textural properties of low fat cheese [11]. Most fat replacers which are used, have no particular benefits effect on consumers, while fiber- based fat replacers could be useful which have proven beneficial effects on the colon cancer and heart disease [14]. The functional fibers such as poly- dextrose and Inulin could be used in dairy products as a fat replacer due to their useful properties. The inulin and poly-dextrose are functional fibers and have prebiotic properties which have led to increased growth of healthy bacteria in the gut and stimulation in the immune system [20].

Volikakis & *et al*. [22] are used the oat concentrate β glucan as a fat replacer in white low-fat cheese and could improve the all tissue markers, but β glucan showed a negative effect on the apparent Properties and taste

Corresponding Author: Farnaz Yahyavi, Faculty member of Islamic Azad University, Mamaghan, Iran.
E-mail: fz_yahyavi@yahoo.com

of cheese. Rahimi & *et al*. [18] used the gum of tragacanth as a fat replacer in low-fat Iranian white cheese and could reduce tissue stiffness parameters and to improve the texture size. Ma & *et al*. [13], in their study, concluded that in cheese making the use of micro-crystalline cellulose, gum of guar and carrageenan as fat replacer is more desirable than using a protein-based fat replacer.

The purpose of present study is using two types of functional fiber of inulin and poly- dextrose as a fat replacer in feta cheese and examined the effects of these two compounds on tissue, some chemical properties and sensory of low-fat cheese.

MATERIALS AND METHODS

2.1. The Cheese production:

The fresh cow milk was prepared from traditional cattle-stable and was processed in adairy factory. In order to prepare the feta cheese, first, the milk was adjusted with 1.5, 2.5 and 3.5% of fat content. The standardized milk was heated about 60 ° C using a plate heat exchanger and then homogenized using a single-stage homogenizer. After homogenization, the milk pasteurized at 72 ° C for 30 seconds and then cooled to 30 ° C and was transferred to the Vat of Cheese. The cheese was prepared by full-fat (H) and reduced fat (M) and low fat (L) with milk containing 3.1, 2.1 and 5.1% fat. Reduced-fat feta cheese and low-fat were formulated and manufactured by Sensus Co. of Netherland with fat replacer, 1% poly dextrose (D) and 1% inulin (N). When combining of both types of replacer were used; the 0.5% poly-dextrose and 0.5% inulin was perfectly blended and added to the cheese. The nine treatments used in this study are: Full-fat cheese (H), reduced-fat cheese (M), reduced-fat cheese containing poly-dextrose (MP), reduced-fat cheese containing inulin (MN), reduced-fat cheese containing inulin and poly-dextrose mixtures (MDN), low-fat cheese (L). The low-fat cheese containing poly- dextrose (LD), low-fat cheese containing inulin (LN), and low-fat cheese containing inulin and poly-dextrose mixtures (LDN). All cheeses were prepared in two iterations. Batch of 15 liters of milk were heated to a temperature of 33° C. The batches of 15 liters of milk were heated to a temperature of 33°C, then, starter planting was added to the milk, and finally, 0/02 % rennet was added after 45 minutes. After complete coagulation, the samples were placed in 15% brine and for 24 hours incubated in 22° C and then in order to ripening, were maintained in a temperature of about 5°C for 45 days.

2.2. The Chemical Analysis:

The stiffness of the produced samples was measured using Texture Analyzer model CNS Farnell, England. The probe which is used was of diameter 2.5 cm, 5 cm in length and speed of the 100 mm per minute. The cheese samples were immediately out of the fridge before testing and after cutting to the dimensions of 4 × 4 × 4 cm, were compressed to 50% of initial height (depth 1 cm). Each test was performed at least in three iterations. To prevent from the friction and cheese sticking, the probe and fixed screen devices was lubricated with oil before the test. Numeric value of stiffness parameters based on the Newton-peak displayed on the device and recorded as an indicator of stiffness.

2.3. The Sensory Evaluations:

The sensory evaluation was performed using the sensory evaluation form and method of a 5-point utility assessment (Hedonic test). In this test, the cheese was evaluated by fifteen relatively experienced assessors (Panelists) due to its texture, flavor and overall acceptance. The cores was considered between 1 (very bad) and 5 (very good). In order to eliminate taste of samples, the assessors were asked to eat crackers without salt and water after testing each sample [17].

2.4. The Statistical Analysis of Results:

Tests were performed in three iterations and the analysis of the results was performed using SPSS 16. The results were studied using the Variance Analysis and Tukey test at 5% level was performed to determine the significant differences among treatments.

RESULTS AND DISCUSSION

In comparison with samples of total fat (H) protein containing, the M and L treatments had a significant increase as shown in Table 1. The results were expected and similar to results which also obtained by other researchers [2,10]. The efficiency in all samples decreased except in the sample treated with P. Since the casein and fat are the main components which determine cheese efficiency, an overall reduction was expected in the efficiency of cheese in the treatment of low-fat cheese [3]. The use of inulin in samples of LN and LN and poly-dextrose in MP and LP samples significantly increased the efficiency in compare with samples M and L. The use of poly-dextrose showed high efficiency about 14.5% in the MP treatment. Increasing the water content and efficiencies in the samples containing poly-dextrose can be attributed to the structure and chemical composition of different used fibers. The poly-dextrose structure is more split than inulin and therefore it is possible that

poly-dextrose forms a more homogeneous mass with casein complex due to its shorter-chain which leads to better interaction of carbohydrate and protein and finally shows reduction in adjusting the water amount of the sample containing poly- dextrose, and increasing in their efficiency and the water content. The inulin also due to having the hydrophobic groups (groups OH) has increased the water retention comparing the samples without fiber. The results of increasing moisture by adding inulin content was incompatible in the work of Guven and colleagues, who observed that adding the fiber results in increasing the water adjusting in low-fat casting cheese and dry material.

Table 1: Results of chemical analysis of high-fat feta cheese, reduced fat, low fat, made with poly-dextrose (1%) and inulin (1%) and their combination (0.5% polypropylene Dextrose 0.5% inulin).

	Stiffness (N)	pH	Protein%	Efficiency%	Muisture(%)	Fat(%)
H	$47.5^{b}\pm2.34$	$4.88^{a}\pm0.03$	$14.9^{c}\pm0.26$	$13.9^{a,b}\pm0.33$	$56.9^{e}\pm0.54$	$19.5^{a}\pm0.49$
M	$63.5^{a}\pm4.25$	$4.82^{a}\pm0.01$	$18.3^{a}\pm0.87$	$11.2^{e}\pm0.1$	$59.1^{e}\pm0.87$	$16.3^{b}\pm0.52$
MP	$26.5^{c}\pm2.98$	$4.85^{a}\pm0.02$	$13.5^{d}\pm0.77$	$14.5^{a}\pm0.4$	$67.7^{a}\pm0.6$	$12.1^{e}\pm0.47$
MN	$32.3^{c}\pm3.5$	$4.83^{a}\pm0.01$	$14.2^{c}\pm0.63$	$13.2^{b}\pm0.23$	$62^{c}\pm0.59$	$13.8^{c}\pm0.58$
MPN	$38.9^{b,c}\pm3.86$	$4.81^{a}\pm0.00$	$15.5^{b}\pm0.53$	$13.1^{b}\pm0.43$	$60.7^{d}\pm0.69$	$14.3^{c}\pm0.72$
L	$74.2^{a}\pm3.8$	$4.80^{a}\pm0.01$	$18.8^{a}\pm0.22$	$10.9f\pm0.13$	$61.6^{d}\pm0.75$	$12.4^{d}\pm0.65$
LP	$31.1^{b,c}\pm3.56$	$4.78^{a}\pm0.05$	$13.6^{d}\pm0.62$	$13.9^{a,b}\pm0.25$	$67.1^{a}\pm0.8$	$9.5^{e}\pm0.42$
LN	$40.5^{b,c}\pm4.34$	$4.87^{a}\pm0.04$	$15.3^{b}\pm0.85$	$12.7^{c}\pm0.17$	$64.4^{b}\pm0.66$	$10.8^{e}\pm0.54$

(Common letters in each column, indicate no significant difference at the level of 5%)

As is clear from Table 1, the addition of poly-dextrose to M and L resulted in reduction of and protein content comparing to the H samples. Adding the inulin protein to MN showed no significant difference in comparison with the H samples but the rate of MPN, LN and LN increased. The reduction in amount of protein in low-fat cheeses is probably due to the dilution effect caused by the moisture retention characteristic of fat replacer [5]. In general, the highest amount of moisture was seen in the sample MP, LP and LN in this sample which had the lowest protein. The HP of all samples was approximately equal and no significant difference was observed between the samples which indicate the lack of effect of adding dietary fiber on the activity of the starter planting.

3.1. The Stiffness:

The stiffness of samples is mentioned in Table 1. As it obvious, stiffness of cheese samples were influenced by fat reduction. The effect of fat reduction from 19.5% for increasing of stiffness and flexibility of low-fat cheeses is assigned to the constant and uniform network of protein (Olson & Johnson, 1990). The MP and LP Poly-dextrose

cheese samples were contained the least amount of firmness of 26.6 and 31.1. Poly- dextrose and other fat substitutes play an important role in soft cheese trap water. Olson & Johnson [16] in their study have mentioned the relative amounts of water, protein and fat as the main factors in stiff cheese. The use of inulin in MN and LN decreased the stiffness of cheese but the amount reduction was not as of P.

3.2. The Sensory Evaluation:

The taste of samples with reduced and low fat was affected by fat reduction. High-fat cheeses, gained the highest score of taste about 6.8 and 6.9 in two separate evaluations while M and L treatments, respectively, won the 5.8 and 5.9 grades (Tables 2 and 3). The fat replacer did not affect the taste, however, MPN and LPN treatments which was the combine both fibers, respectively, obtained the scores 2.6 and 5.9, which was similar to H. The milk fat is considered as a critical factor in the cheese flavor [16]. The low-fat cheese taste usually has fewer flavors and taste comparing the high- fat cheese which probably due to dilution of flavor in low-fat cheeses and fat drop because of preserving of more moisture by fat replacer and this effect was also seen in the present study. However, the highest dilution effect was seen in MP and LN treatments. The results were consistent with the result of Brummel and Lee [2] which had shown that the use of hydrocolloids in processed cheese results in flavor dilution. In another study, it was reported that, the rate of lipolysis in fat reduces when the rate of fat is low. The reactions of proteolysis and lipolysis are associated with changes in cheese flavor, but they were not measured in the present study.

The sensory evaluation scores of samples were consistent with the highest stiffness seen in samples, i.e. 63.5 and 74.2 respectively. Use the P and N were recovered the tissue scores of low-fat and reduced fat samples which showed no significant difference in the measuring of the fat samples. According to Table 2 and 3, in terms of tissues the M and L samples were without replacing fat, obtained the grades 4.9 and 5.4 which were the lowest scores.

No significant difference was seen in overall acceptance of fat decreased samples. In the case of low-fat cheeses, only samples containing a mixture of P and N were not significantly different from full-fat cheese (Table 3). In general, it could be said that it is better to use a mixture of both fat replacer and the reason could be

that in the combination of the two (each 0.5%) have not reached the threshold of poor taste while use of 1%, may be cause the defects in taste and structure of the products.

Table 2: The results of sensory evaluation of reduced fat cheese by Hedonic test.

Treatment	Total acceptance	color	tissue	flavor
H	$6.8^{a}\pm1.6$	$6.2^{a}\pm1.3$	$6.9^{a}\pm1.7$	$6.9^{a}\pm1.5$
M	$5.9^{a}\pm1.3$	$6.9^{a}\pm1.4$	$5.4^{b}\pm1.2$	$5.9^{b,c}\pm1.9$
MP	$6.3^{a}\pm2.2$	$6.3^{a}\pm2.1$	$6.7^{a}\pm1.9$	$5.5^{c}\pm1.3$
MN	$6^{a}\pm2$	$6.1^{a}\pm1.5$	$6.8^{a}\pm1.7$	$5.4^{c}\pm2.1$
MPN	$6.6^{a}\pm1.7$	$6^{a}\pm1.5$	$7^{a}\pm0.8$	$6.2^{a,b}\pm1.1$

(Common letters in each column, indicate no significant difference at the level of 5%)

Table 3: The results of sensory evaluation of low fat cheese by Hedonic test.

Treatment	Total acceptance	color	tissue	flavor
H	$6.9^{a}\pm1.4$	$6.1^{a}\pm1.6$	$7.5^{a}\pm0.7$	$6.8^{a}\pm1.2$
L	$5.8^{b}\pm1.6$	$6.6^{a}\pm1.1$	$4.9^{c}\pm1.3$	$5.8^{b}\pm1.5$
LP	$5.5^{b}\pm1.5$	$6.9^{a}\pm0.9$	$6.2^{b,c}\pm1.7$	$5.4^{b}\pm1.2$
LN	$5.9^{b}\pm1.3$	$6.4^{a}\pm1$	$6.7^{a,b}\pm1.6$	$5.6^{b}\pm1.8$
LPN	$6.4^{a,b}\pm1.4$	$6.5^{a}\pm1.3$	$6.6^{a,b}\pm1.4$	$5.9^{a,b}\pm1.6$

(Common letters in each column, indicate no significant difference at the level of 5%)

Conclusions:

Reduction of fat in feta and use of poly-dextrose and inulin as a fat replacer affected the low-fat and reduced-fat cheese differently. The fat reduction results in the increase of firmness, moisture and reduction in proficiency. The evaluation of total acceptance showed the possibility of producing a desired fat reduced feta cheese even without fat replacer. The decline in output and increase in stiffness in feta cheese which cause by fat reduction, can be compensated by water absorption capacity of poly-dextrose and inulin. In all treatments, firmness declines when replace fat is used.

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