

EFFECTS OF THE SUBSTITUTION OF INULIN FOR FAT ON TEXTURAL CHARACTERISTICS AND SENSORY EVALUATION OF REDUCED-FAT WHEYLESS CREAM CHEESE

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ABSTRACT

Demand for health oriented products such as low calorie and high fiber foods is increasing. One such recent trend is to decrease fat content in food products to overcome health problems such as obesity, coronary health diseases and diabetes, among others. However, such products must have been favorite texture features. Fat content modification results in flavor and textural variants, which are important factors for consumer perception and market success. The objective of this study was to examine the effects of addition of inulin to cheese-making milk, at 8% (treatment C_{1,8}), 10% (treatment C_{1,10}) and 12% (treatment C_{1,12}) (w/w), on the textural and sensory properties of a wheyless cream cheese in which about 60% the typical fat content was replaced by inulin. Results highlighted that hardness, gumminess and chewiness significantly increased ($p < 0.05$) as inulin levels increased. However, no significant differences were observed in the stringiness and cohesiveness values of cream cheeses. In sensory evaluation tests, the color was not affected by inulin content. Treatments (8 and 10%) achieved to required scores in taste parameter. Taste, aroma, texture and overall acceptability scores in the cream cheese sample containing 10% inulin were significantly higher ($p < 0.05$) than other treatments. The results showed that it is possible to make a wheyless cream cheese with lower fat content and desirable sensory and textural attributes using inulin (10%w/w) as fat replacer.

Keywords: Inulin, Cream cheese, Texture , Reduced- fat, Sensory analysis.

INTRODUCTION

Because of increasing consumer trend for low- fat products, the production of reduced- or low-fat cheeses has significantly increased since 1980. Food industry is facing a challenge to produce fat-reduced foods, which have similar properties as high-fat products. For example, removal of fat from cheese causes textural, functional and sensory defects such as rubbery texture, lack of flavor, bitterness, off-flavor, poor meltability and desirable color (Koca and Metin, 2004). Low- or reduced- fat cheese can be made by replacing fat with ingredients that bind water. Several fat replacers have been developed and used in the cheese-making industry with success, such as whey proteins in reduced fat Havarti-type cheese (Lo and Bastian,1998), Dairy-Lo in Cremoso Argentino low fat soft cheese (Zalazar *et al.*, 2002), Dairy- Lo and Simplese in low-fat white pickled cheese (Kavas *et al.*, 2004) and in low-fat fresh Kashar cheeses (Koca and Metin, 2004), resistant starch in imitation cheese (Noronha *et al.*, 2007), tragacanth in low-fat Iranian white cheese (Rahimi *et al.*, 2007), inulin in imitation cheese (Hennelly *et al.*, 2006) and in low-fat fresh Kashar cheeses (Koca and Metin, 2004). Also, it is possible to create a cream cheese with lower fat content by modification of production parameters (Wendin *et al.*, 2000).

The motivation for incorporating inulin into dairy products included replacement of milk fat in reduced-fat dairy products. However, until now, there is no report in relation to the use of inulin in low-fat wheyless cream cheese. The fat substituting property of inulin is based on its ability to stabilize the structure of the aqueous phase, which create an improved creaminess mouth feel (EL-Nagar *et al.*, 2002).

Fresh cream cheese is a cheese obtained from the homogenization of a fresh cheese base with further ingredients, including gums, hydrocolloids, salt and other spices. It is a soft unripened acid-coagulated cheese that contains at least 26% fat according to Iran standards of identity. In Iran, cream cheese is consumed as table cheese .

A serious problem in cream cheese, is that both partial and total fat reduction have profound effects on the final flavor and texture (Wendin *et al.*, 2000).

Nutritionally, inulin is regarded as a soluble dietary fiber; for this and also, its bifidogenic nature, inulin may represent a functional food ingredient in a health context. It is a generic term applied to heterogeneous blends of fructo-oligosaccharides which are reserve carbohydrate sources present in many plant foods such as bananas,

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onions, garlic, leeks, artichokes and chicory (Hennelly *et al.*, 2006; Schaller-Povolnyl and Smith, 1999). Meanwhile, synbiotic potential of fresh cream cheese supplemented with inulin and probiotic bacteria have been confirmed by Buriti *et al.* (2007).

The aim of the present research was: to use different concentrations of inulin [8% (treatment C_{1,8}), 10% (treatment C_{1,10}) and 12% (treatment C_{1,12}) (w/w)] in the production of reduced-fat wheyless cream cheese; to determine the influence of various concentration of inulin on textural and sensory characteristics of final products; and to compare the properties of experimental cheese samples to those of control.

MATERIALS AND METHODS

Additives:

The following additives are involved in the production of wheyless cream cheese samples:

- Two stabilizers: locust bean gum (LBG, Robertet, The Netherlands) and carrageenan (CL220, Danisco, Denmark).
- Dairy proteins consisted of skim milk powder (SMP, Iran), whey protein concentrate (WPC, Progel, Netherlands) and sodium caseinate (EM7, Netherlands), to provide an aqueous dairy protein blend.
- Inulin (Frutafit TEX, SENSUS, Netherlands) .
- Coagulant (Standard rennet, Chy-Max, Chr, Hansen Inc., Denmark: 183 International MilkClotting Units (IMCU)/ml (International Dairy Federation, 1997)) .

Starter culture:

Mesophilic starter culture, contained *Lactococcus lactis subsp. Cremoris*, *Lactococcus lactis subsp. Lactis*, *Lactococcus lactis subsp. biovar diacetylactis* and *Leuconostoc mesenteroides subsp. Cremoris*, was obtained from Chr.Hansen, Denmark.

Cheese making:

Cream cheese was made according to the wheyless cream cheese process (Han, 2002) as that was illustrated by Fadaei *et al.* (2012). Wheyless cream cheese was produced from fresh bovine milk. The milk was first standardized to the fat content of about 10-12% for reduced- fat cream cheese and 24-28% for high fat cream cheese, which was kept as control. Then milk was heated at 60°C and mixed skim milk powder (2% w/w), whey protein concentrate (0.5% w/w), locust bean gum (0.01% w/w), carrageenan (0.7% w/w), sodium caseinate (5% w/w) and inulin [0% w/w (control or treatment C_{1,0}), 8% w/w (treatment C_{1,8}), 10% w/w (treatment C_{1,10}) and 12% w/w (treatment C_{1,12}). Then, the mix was heated at 70°C and homogenized at about 200 bar, pasteurized at 80°C for 20 min and cooled to 22°C. The pasteurized milk was inoculated with a mesophilic culture at 22°C and incubated at this temperature until the pH reached a value of ~ 4.7. Starter was used at the rate of 1% w/w. After 20 min, rennet was diluted 30 fold with cold water and then added, at concentration of 4.5 IMCU/kg of milk, to milk. The curd was heated, after coagulation, and added salt (0.8w/w). At this point, the mass was then agitated very gently. The mixture cooked at 40-60°C and homogenized at about 20-70 bar. The samples were then hot packed at 70°C into 100-g plastic cups and cooled to the storage temperature, 4°C.

Texture analysis:

Texture measurements were carried out using the Universal Texture Analyser (Testometric Instron, M350-10CT, UK) connected to a computer programmed with Texture ProTM texture analysis software according to Miri and Najafi (2010). A flat rod probe (12.5 mm in diameter) was attached to a 500 N compression load, while the target value was set at 10 mm with the speed of 10 mm/min. Samples were placed into glass Petri dishes (13 cm diameter • 1.5 cm deep). Probe was set to penetrate the samples to a depth of 5 mm.

Sensory evaluation:

Sensory evaluation was carried out using a ten – point hedonic scale (1=very poor, 10= very good) by 20 trained panelists who are the member of Tehran Pegah Dairy Co. for taste, aroma, color, texture, and overall acceptability of experimental cream cheeses.

Statistical analysis:

Each treatment was performed in three replications. All data are presented as the Mean. After verifying normality of variables, ANOVA analysis followed by Duncan post-hoc test for multiple comparisons were done at significant level of 0.05 ($p < 0.05$). The sensory properties of samples were analysed by Kruskal- Wallis method. All analysis was performed using the SPSS V.16 software package.

RESULTS AND DISCUSSION

Textural characteristics of reduced-fat wheyless cream cheese:

The mean values of textural properties of wheyless cream cheeses produced are shown in Table 1. The results illustrate that the addition of inulin (a mainly soluble dietary fiber) alters the texture of low-fat cream cheese samples. The hardness of the samples with added inulin shows significant increase ($p < 0.05$). In contrast to treatments C_{1,10} and C_{1,12}, there is no significant difference between the hardness of C_{1,8} and control. Increased hardness in the reduced-fat samples containing inulin can be explained, according to EL-Nagar *et al.* (2002), by the interactions the dietary fiber and liquid components of the cream cheese mix. Inulin, being highly hygroscopic, would bind water and form a gel-like network that, in addition to the other components, would modify the rheology of mix. Inulin may act as a stabilizer due to its capacity for binding water; so, it helps to the functionality of gums used in cream cheese. Thus, the water molecules become immobilized and unable to move freely among other molecules of the mix. Also, this effect may be due to the gelling properties of inulin improving the consistency of the mix together with the increased water binding, resulting in increased hardness. It was noted that we prepared wheyless cream cheese and; for this, we can not compare our results with the reports in which whey was separated from the cheese. The results are different from the findings of Hori (1982),, who indicated that the hardness decreases with the increasing bound water content because the bound water characterizes the cream cheese; the hardness decreases as both the amount and the structural strength of bound water increases .

All treatments showed increasing in gumminess and chewiness as inulin increased. Increasing the inulin content from 8% to 12% significantly ($p < 0.05$) increased these parameters (Table 1).

Increasing the levels inulin from 8% to 12% did not affect the cohesiveness and stringiness of cream cheeses (Table 1). So, cheese cohesiveness and stringiness were not affected by a reduction of fat and with added inulin; however, a non-significant and slight decrease in cohesiveness and stringiness was observed between treatment C_{1,8} and control.

Table 1. Textural characteristics of experimental treatments *

Treatment	C _{1,0}	C _{1,8}	C _{1,10}	C _{1,12}
Hardness	1.24 ^c	1.8 ^c	2.59 ^b	3.54 ^a
Gumminess	0.22 ^c	0.68 ^c	1.06 ^b	1.41 ^a
Chewiness	0.33 ^c	0.39 ^c	0.64 ^b	0.93 ^a
Stringiness	0.6 ^a	0.58 ^a	0.6 ^a	0.67 ^a
Cohesiveness	0.45 ^a	0.38 ^a	0.41 ^a	0.4 ^a

*Means within the same row with different superscript letters differ significantly ($P < 0.05$).

Table 2. Sensory properties of experimental treatments *

Treatment	C _{1,0}	C _{1,8}	C _{1,10}	C _{1,12}
Color	7.53 ^a	8.07 ^a	8 ^a	7.8 ^a
Aroma	5.87 ^b	6.73 ^{a,b}	7.2 ^a	6.2 ^{a,b}
Taste	4.8 ^b	6.67 ^a	6.4 ^a	5.93 ^{a,b}
Texture	4.8 ^c	6.33 ^b	7.93 ^a	6.67 ^b
Overall acceptability	5 ^c	6.33 ^b	7.87 ^a	6.27 ^b

*Means within the same row with different superscript letters differ significantly ($P < 0.05$).

Sensory properties of reduced-fat wheyless cream cheese:

Table 2 shows the organoleptic evaluation of the different treatments of cream cheese. Cream cheese containing 8% inulin was ranked higher taste and color scores than the other treatments and followed by treatments 10, 12% and control, respectively. Overall acceptability of control was 5 while in the other treatments increased from 6.27 in treatment 12% to 6.33 in treatment 8% and 7.87 in treatment 10%. This variation has been attributed to inulin addition. The same trend was observed for texture and aroma.

Replacement of fat in the cream cheese resulted in the production of a desirable cheese as assessed by a sensory panel. Reduced-fat wheyless cream cheese with 10% (w/w) inulin was ranked the most preferred by panelists; the preference for the treatment 10% was most likely due to its harder texture.

Conclusion

Wheyless cream cheese samples were analyzed with respect to sensory characteristics and textural parameters. Reducing the fat content (60%) with added inulin [8%(treatment C_{1,8}), 10%(treatment C_{1,10}) and 12% (treatment C_{1,12}) (w/w)] had a positive effect on hardness, gumminess and chewiness parameters; However, no significant differences were observed in the stringiness and cohesiveness values of cream cheeses. In sensory evaluation tests, the color was not affected by inulin content. Treatments C_{1,8} and C_{1,10} achieved to required scores in taste parameter. Taste, aroma, texture and overall acceptability scores in the cream cheese sample containing 10% inulin were significantly higher (p<0.05) than other treatments. Keeping in mind the important of sensory features for the choice of preference treatment, the reduced-fat wheyless cream cheese with 10% (w/w) inulin was well received by the sensory panel. The current study indicate that inulin may act as a stabilizer, due to its capacity for binding water; so, it may be applied in the manufacture of many low-fat food products such as low-fat bakery, meat and dairy products. Moreover, it is important to emphasize that due to inulin ability to act as a dietary fiber and its bifidogenic nature, inulin may represent a functional food ingredient in a health context, especially in making of symbiotic foods.

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