J Food Sci Technol (March–April 2010) 47(2):240–242
DOI: 10.1007/s13197-010-0034-0

SHORT COMMUNICATION

Quality of casein based Mozzarella cheese analogue as affected by stabilizer blends

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Revised: 27 July 2009 / Accepted: 3 August 2009

Abstract Suitability of xanthan gum (XG)-locust bean gum (LBG), carrageenan (CAR)-LBG, and XG-CAR in 1:1 proportion at 0.42% in the formulation was assessed in the manufacture of Mozzarella cheese analogue. The stabilizer blends did not significantly influence the composition, texture profile, organoleptic, baking qualities and pizza-related characteristics of cheese analogues. Considering the influence of stabilizer blend on the sensory quality of analogue and sensory rating of pizza pie, XG-LBG blend (1:1) was preferred over XG-CAR and CAR-LBG.

Keywords Mozzarella cheese analogue · Carrageenan · Xanthan gum · Locust bean gum

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Introduction

Cheese analogues are the products made of dairy, partial dairy or non-dairy ingredients, which tend to resemble a particular cheese variety. Mozzarella cheese is being commercially produced by several organized and private dairy plants in India, especially since younger generation has taken a liking towards fast food like pizza, on which Mozzarella cheese is used as topping. Cheese analogues have better storage stability with regard to their functional properties such as shred, stretch, fat leakage etc to give consistent product throughout its storage life (Guinee 2002). Casein products are already being exported by few reputed Indian food companies for use as ingredients in the manufacture of cheese analogues.

The dissolution of dried casein required sufficient amount of water which led to increased moisture content of cheese analogue (i.e. 53% vs. 47–50% in natural Mozzarella cheese). Thus, the analogues made without the use of stabilizers were less cohesive and did not possess desired shredability.

Properties of one hydrocolloid can often be modified by interaction with other gums. These interactions modify the functionality of the hydrocolloid by altering its solubility, rheology, gelling characteristics and reactivity (Igoe 1982). The stabilizer blends may exhibit synergistic effect and might help in cost reduction, when a costly stabilizer is blended with a cheaper one. In literature, use of starch (0.80%) plus guar gum (0.06%) or starch alone at the rate of 2 to 5% has been reported in the manufacture of casein based Mozzarella cheese analogue (Fox et al. 2000, O'Malley et al. 2000, Montesinos-Herrero et al. 2006). The impact of using carrageenan (CAR), xanthan gum (XG) and locust bean gum (LBG) singly in the formulation of MCA has already been studied (Jana et al. 2008). Hence, it was envisaged to study the influence of 3 stabilizer blends comprising of stabilizers already studied on the quality of resultant casein based Mozzarella cheese analogue (MCA).

Refined corn oil of 'Cornello' and 'Rasda' brand' hydrogenated vegetable oil were obtained from local market. 'Unigel-500'pre-gelatinized starch (A B Enterprises, Mumbai); tri-sodium citrate (TSC) (Qualigens Fine Chemicals, Mumbai); di-sodium orthophosphate (DSP) (Samir Tech Chem Pvt Ltd, Vadodara) and $CaCl_2$ (Krishna-Chem Industries, Vadodara) were obtained. Tween-80 and lactic acid were procured from S D Fine Chemicals Ltd, Boisar. Commercial grade CAR, XG and LBG were procured from Alok Chem Corp, Mumbai, whereas cheese flavouring was obtained from Dragoco India Ltd, Chennai.

Casein was prepared from 300 kg of fresh, pasteurized buffalo skim milk procured from Amul Dairy, Anand using the method of Gupta (1989). Lactic acid was used to obtain pH of 4.3. The casein was dried to about 6% moisture in a tray-drier (Divaker Industries, Ahmedabad) and powdered (< 355 µm size) in a 'Flora domestic flour mill' (Model Supreme; capacity 5 kg/h).

The analogue (500 g for each treatment) was prepared as per the method described by Jana and Upadhyay (2001). The formulation for MCA adopted was the one reported by Jana et al. (2008).

The MCA was analyzed for pH, total solids, fat, protein, ash and salt (Jana et al. 2008). Meltability was determined using 'Schreiber test' (Park et al. 1984), fat leakage by the method of Breene et al. (1964) and fork stretch as per USDA (1980). Shredability of cheese was assessed subjectively (Jana et al. 2008).

Shredded cheese analogue (60 g) was topped on pizza base (~20 cm diameter) and baked in forced-draft oven maintained at 230°C. Scoring (maximum 10) was used for attributes such as appearance (including fat leakage, browning), flavour, melting, stringiness, chewiness and the final score was given out of 50. A panel consisting of 6 members performed the sensory analysis.

Compression (70% compression) testing of tempered (23 ± 1°C) cubical (1 cm^3) cheese samples was carried out using Instron Universal Testing Instrument (Model 1000, Instron Ltd, England) using 0.5 kg load at cross-head speed of 20 mm/min and a chart speed of 100 mm/min. The texture profile analysis of the cheese samples was interpreted from their force-distance compression curve as per Larmond (1976).

MCA tempered at 23 ± 1°C were evaluated for sensory characteristics by a panel of 6 trained judges. The score-card suggested by Duthie et al. (1980) was used.

Four replicates values of each attribute were subjected to statistical analysis using completely randomized design with equal number of observations (Steel and Torrie 1980).

The results are presented in Table 1. There was no discernible difference in the composition of the experimental cheese analogues containing 3 stabilizer blends. This is obvious since the formulation used was same in all the cases. However, looking at the fat and fat-on-dry matter (FDM) content of analogues, it is evident that incorporation of vegetable oil was best in XG-CAR and least in XG-LBG blend. Maximum moisture in fat free substances, FDM and protein at constant moisture were observed for analogues

Table 1 Influence of stabilizer blend (1:1) on quality of Mozzarella cheese analogue

	Cheese analogue made using		
	XG-LBG	CAR-LBG	XG-CAR
Composition			
Moisture,%	56.8	56.4	55.5
MFFS,%	62.5	62.8	62.5
Fat,%	9.2	10.2	11.2
FDM,%	21.2	23.3	25.2
Protein,%	22.6	22.0	21.9
Protein,%*	24.5	23.7	23.1
Salt,%	0.9	0.9	0.9
Ash,%	4.2	4.1	4.1
pH	5.7	5.7	5.7
Instrumental Texture			
Hardness, kg	3.6	3.3	3.6
Cohesiveness	0.303	0.314	0.309
Springiness, mm	2.4	2.4	2.3
Chewiness, kg-mm	2.7	2.5	2.8
Gumminess, kg	110.3	105.4	113.2
Adhesiveness, kg-cm	0.15	0.16	0.13
Sensory quality of cheese			
Appearance (3)	2.6	2.6	2.6
Body and texture (5)	4.2	4.1	3.9
Flavour (10)	7.6	7.6	7.3
Total score (18)	14.5	14.3	13.8
Baking quality			
Oven melting time, min	8.3	7.7	9.0
Schreiber meltability#	3.9	4.1	3.8
Fat leakage, cm^2	1.3	1.2	1.9
Fork stretch, cm	22.2	19.7	20.7
Sensory rating of pizza			
Appearance (10)	7.1	7.1	6.9
Flavour (10)	6.9	7.1	7.1
Melting (10)	7.3	7.2	7.2
Stringiness (10)	7.5	7.4	7.5
Chewiness (10)	7.1	7.2	7.2
Total score (50)	36.0	36.0	35.9

XG:Xanthan gum, CAR:Carrageenan, LBG:Locust bean gum, MFFS:Moisture in fat-free substances, FDM:Fat-on-dry matter, *:Protein at constant (53%) moisture, #:Arbitrary number

Number of panelists for sensory evaluation was 6. Figures in parentheses indicate maximum score

Critical difference was not significant (p≤0.05)(n=4) in all cases containing CAR-LBG, XG-CAR and XG-LBG stabilizer blend, respectively.

None of the cheese analogues differed significantly from each other with respect to their textural characteristics. The maximum hardness, cohesiveness, springiness, chewiness, gumminess and adhesiveness were observed in analogue made using XG-LBG, CAR-LBG, XG-LBG, XG-CAR, XG-CAR and CAR-LBG, respectively. Carrageenan when used alone at 0.42% in the formulation of MCA led to harder product than when using XG or LBG (Jana et al. 2008). The analogues made incorporating other stabilizers (XG or LBG) in blend with CAR helped in attaining desirable softness in the analogue. The springiness of analogues made using stabilizer combination tended to decline, whereas adhesiveness increased when compared to stabilizers used singly (Jana et al. 2008). The type of stabilizer used in the admixture has been reported to influence the textural properties of the resultant food product (Igoe 1982).

The MCA made utilizing 3 stabilizer blends did not differ significantly from each other with regard to their sensory characteristics. XG-LBG analogue had uniform body and was brighter than the other 2 analogues. CAR-XG analogue was occasionally gluey and fragile, whereas CAR-LBG had a dry mouth feel. Hence, XG-LBG analogue scored highest for body-texture attribute. XG-LBG analogue had a pleasant cheese-like flavour, whereas slight oily aftertaste was perceived in other 2 analogues; the former one was the most preferred one. XG-LBG analogue had the highest total score since it had the maximum appearance, body and texture and flavour scores.

The shredability of cheese analogue made using XG-LBG was 'excellent' (i.e. thin and long shreds), whereas that made using CAR-LBG and CAR-XG had 'adequate' shredability which was accompanied by slight lumpiness; such lumpiness was greater in shreds from CAR-XG analogue.

Maximum and minimum time required for melting in baking oven was observed for XG-CAR and CAR-LBG analogues, respectively. The extent of melting (judged by Schreiber test) was slightly superior in CAR-LBG analogue. XG-CAR analogue exhibited highest fat leakage on pizza pie; it had the highest FDM content. The maximum stretch was associated with XG-LBG analogue, whereas the least stretch was found in CAR-LBG analogue.

The main application of analogue is as a topping on pizza pie. All 3 types of MCA made did not differ from each other significantly with regard to their sensory characteristics as topping on pizza pie. However, closer examination revealed that the visible extent of fat leakage in XG-CAR and XG-LBG analogues was more than that exhibited by CAR-LBG analogue; greater fat leakage in former 2 cheeses was rather found appealing by the judges. XG-CAR and CAR-LBG analogues had same flavour score which was slightly superior compared to that of XG-LBG analogue. All 3 analogues melted properly on pizza. XG-LBG analogue stretched on pizza to a greater extent than the other analogues; such finding is well corroborated with the results of 'fork stretch test'. XG-LBG analogue was chewier than the other 2; XG-CAR analogue was sometimes associated with glueyness. XG when used singly as stabilizer often led to gluey product; such problem could be overcome when it was used in admixture with LBG (Jana et al. 2008). Yang et al. (1983) overcame the problem of stickiness in soy protein based MCA by replacing stabilizer gum arabic with an admixture of XG-LBG.

Based on the findings, it is concluded that XG-LBG (1:1) used at 0.42% in the MCA formulation is recommended since it was superior with regard to stretch and sensory quality as pizza topping compared to other 2 stabilizer blends. CAR-LBG would be the next choice as stabilizer blend. Nevertheless, use of XG-CAR was beneficial with regard to oil incorporation in cheese analogue.

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