Improving of Karish Cheese by Using Enhanced Technological Texturizing Inulin

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ABSTRACT

The present study aimed to utilize texturizing inulin as a functional food ingredient that affects the maintaining of good health and fat replacement for improving texture of Egyptian Karish cheese and compensating the fatness. Effect of addition of texturizing inulin (Frutafit TEX) at levels 2 and 4% (w /w) on physicochemical properties, yield, textural, microstructure, microbiological counts and sensory characteristics were investigated. The results revealed that the addition of texturizing inulin increased yield values and moisture content of Karish cheeses compared with control. Protein and ash content were not influenced significantly as compared to the control of storage at 4 ^{0}C as a result of texturized inulin addition. Differences in the microstructure of Karish cheese with inulin and control reflected the differences in its inulin content. Hardness decreased from 495 (g) in control to 216 and 143 in Karish cheese made with 2 and 4 % texturized inulin at zero time of storage at 4◦C as a result of texturized inulin addition respectively. Results obtained by the panelists revealed that Karish cheese prepared in the presence of 4% inulin gave the highest texture and acceptability score compared to panel Karish cheese (control) and stored cheeses. It is recommended to use 2 and 4% inulin in Karish cheese manufacturing to enhance its organoleptic properties with good nutritional value of fiber.

Key words: Karish cheeses, texturized inulin, texture analysis, microstructure.

INTRODUCTION

Karish cheese is one of the most popular and oldest varieties consumed in Egypt (Abou Donia, 2008). The increasing demand by Egyptian consumers is mainly attributed to its high protein content and low price (Fahmi, 1960 and Osman *et al.,* 2010). It contains most of the sKim milK constituents including 16.70% protein, 3.98% sugar, 72.50% water and 0.1% fat. Karish cheese is made from sKimmed buffalo's or cow's milK or a mixture of both. (Abd-El-Salam *et al*., 1984).

Several visions have been proposed to improve Karish cheese including therapeutic or probiotic effects of Karish cheese by using cultures containing *Bifidobacterium sp.* (Abd-Elhamid, 2012). Exopolysaccharide- producing *Streptococcus thermophilus* strain was introduced to enhance Karish cheese texture (Hassan, *et al* 2004). A novel style of Karish cheese was made by adding *Curcuma. Longa* (Curcumin or Turmeric) at a rate of 0.3% (w/v), to obtain a new dairy product "Karishcum"(Hosny ,*et al* 2011). Also some additives used for improving Karish cheese quality including tolue balsam extract (El-Nemr *et al,* 2003); plant seeds solids (El-Nemr, 2006); pepper, parsley, and dill (Ahmed and Ebraheim, 2010)and addition of hydrocolloids (Korish and Abd Elhamid 2012).

Removal of fat from cheese causes textural, functional and sensory defects such as rubbery texture, lacK of flavour, bitterness, off-flavour, poor meltability and undesirable colour (Romeih, *et al* 2002). Therefore, several strategies have been proposed in order to improve the flavour and texture of low-fat cheeses. These strategies can be collected in three titles (Mistry, 2001): maKing-process modifications; starter culture selection and use of adjunct cultures; use of fat replacers. Fat replacers are ingredients intended to be used in the place of natural fats with the objective of obtaining a reduction in the caloric value (Huyghebaert, *et al* 1996). They are categorized as fat substitutes which are fat-based and as fat mimetics which are protein- and carbohydrate-based. Fat mimetics have often been recommended to be used in cheese products consisting of mainly microparticulated protein- and carbohydrate-based materials (Romeih *et al.,* 2002). These materials are used for improving sensory and functional properties of low-fat cheeses by binding water and by improving texture and yield (DraKe, *et al.,* 1996). Therefore, they give a sense of lubricity and creaminess (Romeih *et al*., 2002).

Inulin is used either as a macronutrient substitute or as a supplement added in foods mainly for its nutritional properties. Chemically, inulin consists of a long chain made up of fructose molecules and one glucose molecule at one end. The fructose molecules are connected by β-(2-1) bonds and the last fructose is linKed with a glucose by an α-(1-2) bond as in sucrose (Kim, *et al* ,2001) The

average molecular weight and degree of polymerization of inulin depend on the source of inulin, the time of harvest and the process of production. In native chicory inulin, the number of fructose units linKed together ranges from 2 to more than 60, with an average degree of polymerization of the order of 10 and the high performance forms of inulin have an average degree of polymerization of 25 (FrancK, 2002).

Inulin has many technological benefits. As gelling performance inulin is a perfect ingredient to replace fat due to its ability to form a gel or cream, resulting in an excellent fat-liKe texture. Inulin brings also creaminess, body and mouth feel (Kip, *et al* 2006). Using inulin to reduce fat allows nutrition claims liKe 'reduced fat/ calories' or 'light' (Voragen, 1998). For prevention of syneresis inulin especially long chain has an excellent water binding capacity which prevents syneresis in spreads and fresh cheeses (Vajiheh, *et al* 2012). Inulin have a good spreadability , mouthful, flavour enhancers and stabilizers (Khalifa,*et al* ,2011).On the other hand inulin as a dietary fiber acts as prepiotic, which are not digested by human enzymes and reach colon where they stimulate the growth and/or activity of one or a limited number of bacteria, thus improving the host's gut health (Effat *et al* ,2012).Synergistic effect between inulin and calcium alginate was reported by Bishay (1998).

Therefore, the aim of this study was to investigate the possibility of using an inulin type with enhanced technological properties in the manufacture of Karish cheese and its effects on chemical, physical, textural, microstructure and sensory properties of Karish cheese during storage.

MATERIALS AND METHODS

Inulin (Frutafit TEX) of long average chain length (≥ 23 monomers) with excellent texturising properties from Sensus (Brenntag Química, Spain) was used .

Cheese ingredients: fresh sKimmed milK (0.5% fat) was obtained from Green land group 10th of Ramadan city and commercial sodium chloride was obtained from El-Nasr Company for Salt. in Alex., Egypt.

Starter culture: Mesophilic acidifying and aroma cultures (M. M. Series) which contain *Lactococcus lactis* subsp. *lactis*, *Lactococcus lactis* subsp. *cremoris* and *Lactococcus lactis* subsp. *lactis* var. *diacetylactis* obtained from Rhonue. Poulenc., France.

Cheese maKing

Three groups of functional Karish cheese were manufactured according to the method adopted by Fahmi, (1960) and prepared in green land group Dairy Processing10th of Ramadan city Egypt as follows: sKim milK (0. 5% fat and 8.5% SNF)was heated at 74°C for 15sec. and then cooled to 32°C.Inulin was added to warm milK at concentrations of zero % (control, To), 2% (T1), and 4% (T2).

Active culture of mesophillic lactic acid starter for cheese was added in ratio 2 % in milK .The inoculated milKs were incubated at 30°C overnight until curding. The formed curd was ladled into plastic frames lined with muslin cloth, 1% salt was dispersed on curd and then curd pressed by suitable weights. Resultant cheeses were stored at ٤°C for 14 days.

Chemical analysis

Twenty grams of the cheese was soften by mixing with an equivalent amount of distilled water previously warmed at 40 ± 1 ◦C and the whole mixture Kept for 5 min. at room temperature before the assessments. The pH, titratable acidity, moisture, total solids, total nitrogen, protein, fat and ash were determined according to AOAC method (2000). All chemical measurements were prepared in triplicates.

Microbiological analysis

Microbiological analysis (total bacterial count and coliform group) were carried out following APHA (2005) using different selective media to enumerate different viable microorganism groups.

Microstructure

Cheese samples were prepared for scanning electron microscopy following the method of DraKe *et al.* (1996). Samples were viewed in a Analyical Scanning Electron Microscopy (SEM**), (**Joel, JSM-6360 -LA- 1100E-ion) operated at 15.0KV. Photomicrographs were recorded at 10,000× magnification.

Texture evaluation

Textural properties of experimental cheese were evaluated using texture analyzer (Texture Pro CT3 V1.2, BrooKfield, Middleboro , USA) according to the method of SzczesniaK *et al*. (1963).

Sensory evaluation

Samples of Karish cheese approximately 30 g in duplicates, of two different batches, were prepared for sensory analysis. Samples were tempered at ambient temperature (20 ± 2 °C) and then presented to the panelists in a random order and labeled with random ten digital codes. Water was provided for mouth washing between samples. The sensory properties of cheese were evaluated at zero, 7 and 14 days of ripening in Department Dairy Science and Technology, Faculty of Agriculture, Alexandria University, by ten trained panelists. Control Karish cheese was used as a reference. Samples of cheeses were organoleptically evaluated according to the scheme described by IDF (1995). The average data with standard deviations were determined.

Statistical analysis

Data were analysed using the Statistical Analysis System software pacKage (SAS, 2000). Analyses of variance were performed using

ANOVA procedures. Least significant difference test was performed to determine differences in means at *P* 0.05.

RESULTS AND DISCUSSION

Chemical analysis and yield

According to statistical analysis, results shown in Table 1 can be summarized chemical analysis and yield of different trails Karish cheese using different concentrations of texturized inulin as follows:

The moisture contents of Karish cheese made with adding inulin was higher as compared with the control. Treatment made with 4% inulin (T2) had the highest moisture content at the end of storage period. The use of texturized inulin significantly increased yield cheeses and moisture content ($P < 0.05$) as compared with control. The increase in yield in cheeses containing texturized inulin may be due to the form a gel networK thus increasing the water holding ability (Oliveira *et al.* 2010). This result was confirmed by Koca and Metin (2004) who stated that addition of fat replacer to low-fat cheese increased moisture content of cheese thus increasing yield of cheese.

Protein, total solids and ash contents of Karish cheeses made with texturized inulin not affected significantly as compared to control. These results were expected and confirmed the worK of other investigators (Katsiari and Voutsinas,1994 a,b). TN and protein content of cheese were significantly affect ($p <0.05$) by inulin . The control cheese had higher values of TN and protein as compared with those cheese made with inulin .

Our data indicate slightly higher in ash content of all cheeses at the end of the storage period.

The changes in the titrable acidity and pH values during storage at 4 ^{0}C of different trails Karish cheese using different concentrations of texturized inulin as a prebiotic are given in Figs. 1and 2. Fig. 1 shows the differences between all treatments including the control cheeses in pH values when fresh and during the storage period at 4 ^{o}C for 14 days. It is obvious that the pH values of Karish cheeses with texturized inulin were higher in figures than of the control cheese either when fresh or during the storage period (4 ^{o}C /14 days). Karish cheese manufactured without inulin had the lowest pH value, especially at the end of storage period. In addition it could be notice that the pH values of all cheeses gradually decreased during the storage .Similar observation have been made by Janhøj *et al.* (2008).

Inulin became protect or stabilized cheese from influence its acidity (Fig.2).

The changes in titratable acidity of studied cheese followed an opposite trend to pH.

Titratable acidity (%) of control cheese was higher; especially at the end of storage period; as compared with the cheese with inulin. These results were similar to findings of Staffolo *et al*. (2004).

the increase in the titratable acidity might be attributed to the residual fermentation changes. Post acidification of prebiotic fermented products based of prebiotic and growth initiator uses were observed previously (El-Nemr *et al.,* 2003, and El-Nemr ,2006).

Microbiological analysis

The changes of vaiable counts of starter bacteria during the storage period of Karish cheese supplemented with texturized inulin are present in The viability of total bacterial count with texturized prebiotic inulin during storage period exhibited higher counts than control. The results of the present study were consistent in qualitative term with those reported by Martinez-Villaluenga *et al* (2006), who reported significantly higher retention of viability of lactic acid bacteria were grown in the presence of prebiotic compared with the control without prebiotic. On the other hand, the mechanism of retention viability due to the presence of prebiotic is not well Known (Collins and Gibson, 1999).Also the coliform bacteria were not detected in all tested cheese samples (Table 2).

Microstructure of cheese

Every cheese variety has its characteristic structural features, which reflect the biochemical changes in the cheese (Madadlou *et al.,* 2005). In the scanning electron micrographs of the full fat cheese, the protein matrix was open, with spaces occupied by the fat globules. The holes in the protein matrix indicate the spaces occupied by fat globules before extraction by chloroform (Metzger and Mistry, 1995). The microstructure of the low or free fat cheese was clearly different from that of the full fat cheese, with the number of milK fat globules decreasing and the protein matrix becoming more compact. This probably explained the harder texture observed in the low or free fat cheese, even though it was significantly higher in moisture content (Bryannt *et al.,* 1995).The microstructure of inulin cheese shows better dispersion in comparison with fresh control cheese (Fig. 3).

Textural parameters

Hardness was influenced by texturized inulin. Hardness decreased from 495 (g) in control cheese to 216 and 143 in Karish cheese made with 2 and 4 % texturized inulin at zero time of storage as a result of texturized inulin addition respectively. This may be due to the increase in cheese moisture content, as a result of water adsorption or binding by texturized inulin. Because the increase in moisture content weaKens the casein micelles– texturized inulin gel networK leading to a less firm cheese (Kaya 2002), the texture of high-moisture cheese was smother (as shown in virtual cheese Section Fig.3) than that obtained by the conventional method (Mairfreni *et al.* 2002).

Table 1: Chemical analysis and yield of different trails Karish cheese using different concentrations of texturized inulin during storage at 4°C

Treatment	Storage period	Cheese* yield (%)	Moisture* %	TS* %	TN* %	Protein* %	Fat* %	Ash* %
T_0	Fresh	18 ± 1.02^{a}	71.43 ± 1.02^{a}	28.57 ± 1.02^{a}	2.61 ± 0.04^{c}	16.31 ± 0.25^{c}	1 ± 0.0	1.40 ± 0.14^{a}
T_1		25.1 ± 0.88^{ab}	72.85 ± 0.88^{ab}	27.15 ± 0.88^{ab}	2.35 ± 0.02^{b}	14.68 ± 0.12^{b}	0.5 ± 0.0	1.39 ± 0.07^{a}
T_2		27.8 ± 0.70^{b}	74.37 ± 0.70^{b}	25.63 ± 0.70^{b}	2.28 ± 0.02^{a}	14.25 ± 0.13^{a}	0.5 ± 0.0	1.44 ± 0.15^{a}
T_0	7 days	17.8 ± 0.60^{a}	71.22 ± 0.60^{a}	28.78 ± 0.60^{a}	2.62 ± 0.14^{b}	16.38 ± 0.87^{a}	1 ± 0.0	1.49 ± 0.08^{a}
T_1		24.9 ± 0.55^{a}	72.36 ± 0.55^{a}	27.64 ± 0.55^{a}	2.38 ± 0.09^{ab}	14.89 ± 0.55^{a}	0.5 ± 0.0	1.34 ± 0.12^{a}
T_2		27.3 ± 0.68^{b}	74.29 ± 0.68^{b}	25.71 ± 0.68^{b}	2.30 ± 0.15^{b}	14.39 ± 0.92^{a}	0.5 ± 0.0	1.97 ± 0.19^{b}
T_0	14 days	17.6 ± 0.27^{a}	70.56 ± 0.27^{a}	29.44 ± 0.27^{a}	2.63 ± 0.04^{b}	16.44 ± 0.25^{b}	1 ± 0.0	2.03 ± 0.38^{a}
T_1		24.7 ± 1.05^{a}	71.91 ± 1.05^{a}	28.09 ± 1.05^{a}	2.39 ± 0.02^{a}	14.93 ± 0.13^{a}	0.5 ± 0.0	1.89 ± 0.26^{a}
T_2		26.9 ± 1.05^{b}	74.05 ± 1.05^{b}	25.95 ± 1.05^{b}	2.34 ± 0.10^{a}	14.60 ± 0.65^{a}	0.5 ± 0.0	2.25 ± 0.15^{a}

All means with the same within each property are not significantly different at 0.05 level
*Each value represents the average of three determinations ± standard deviation.
T0,Control
T1, Karish cheese with 2%inulin
T2 , Karish cheese with 4% inulin

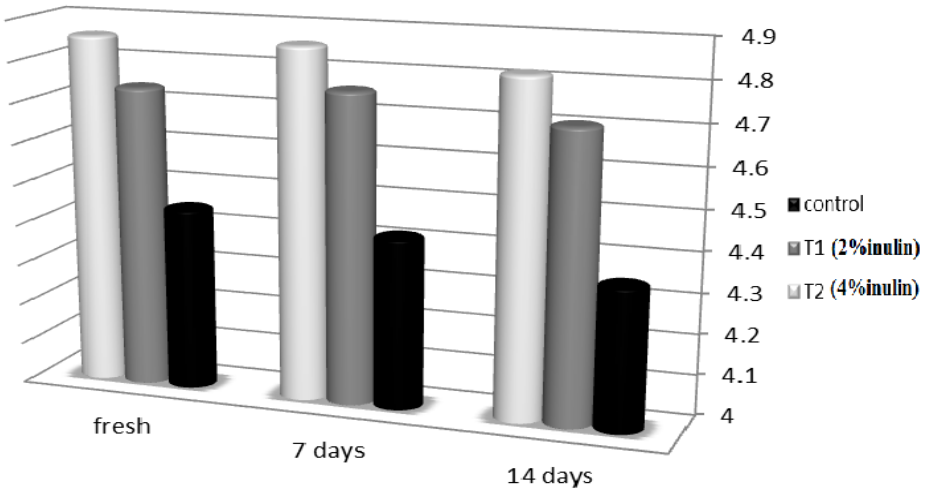

Fig.1: pH va ions of texturized inulin

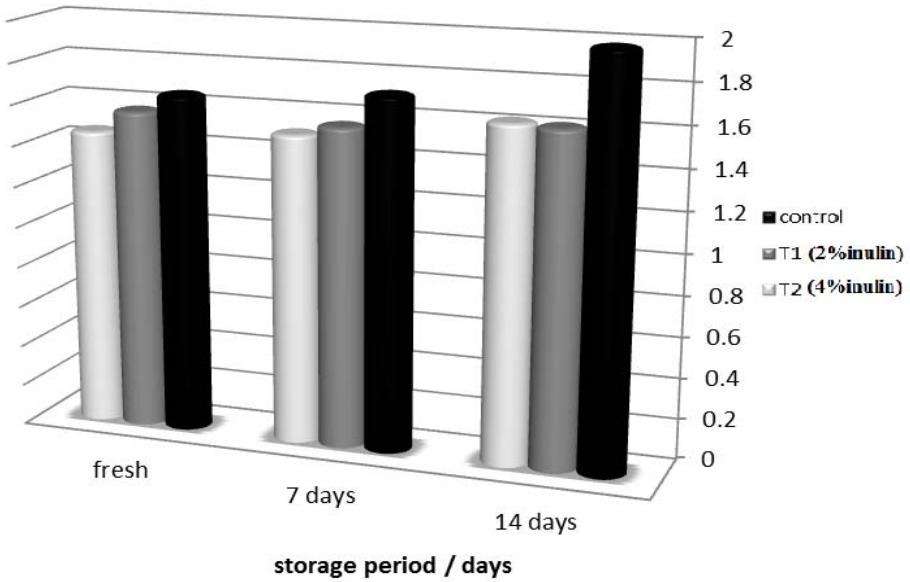

Fig.2: Titratable acidity during storage at 4°C of different trails Karish cheese using different concentrations of texturized inulin

Table 2: Vaiable counts of some starter microorganisms during the storage period of Karish cheese with texturized inulin

Storage /day	Total bacterial count (cfu)*			Coliform group (cfu)*		
Treatments	**T_0**	**T_1**	**T_2**	**T_0**	**T_1**	**T_2**
0	14×10^5	10×10^5	9×10^5	ND	ND	ND
7	18.5×10^5	34×10^5	16.5×10^5	ND	ND	ND
14	23×10^5	58×10^6	24×10^5	ND	ND	ND

*cfu:colony forming unit
$T_{0,,}$ control;T_1: Karish cheese with 2%inulin; T_2: Karish cheese with 4%inulin
ND:not detected

Sensory evaluation

The mean scores for all sensorial properties including colour, texture, flavour and acceptability of cheese prepared with texturized inulin were higher than control (Table,3 and figure,4).These results were expected and confirmed by Vajiheh *et al* (2012) . It was clear that the storage period had affected the taste and texture score but a little difference was found in other sensory properties. Results obtained by the panelists revealed that Karish cheese prepared in presence of 4% inulin gave the highest texture and acceptability score comparing with control over all storage period, table (3). A contrary fresh cheese with 2% inulin had higher color and flavour score than fresh cheese containing 4% inulin. Therefore, it could be concluded that preparing Karish cheese with inulin enhanced its organoleptic properties. Abou-Zeid (1992) reported similar findings for the enhancement of organoleptic properties of Domiati cheese containing parsley or rocKet.

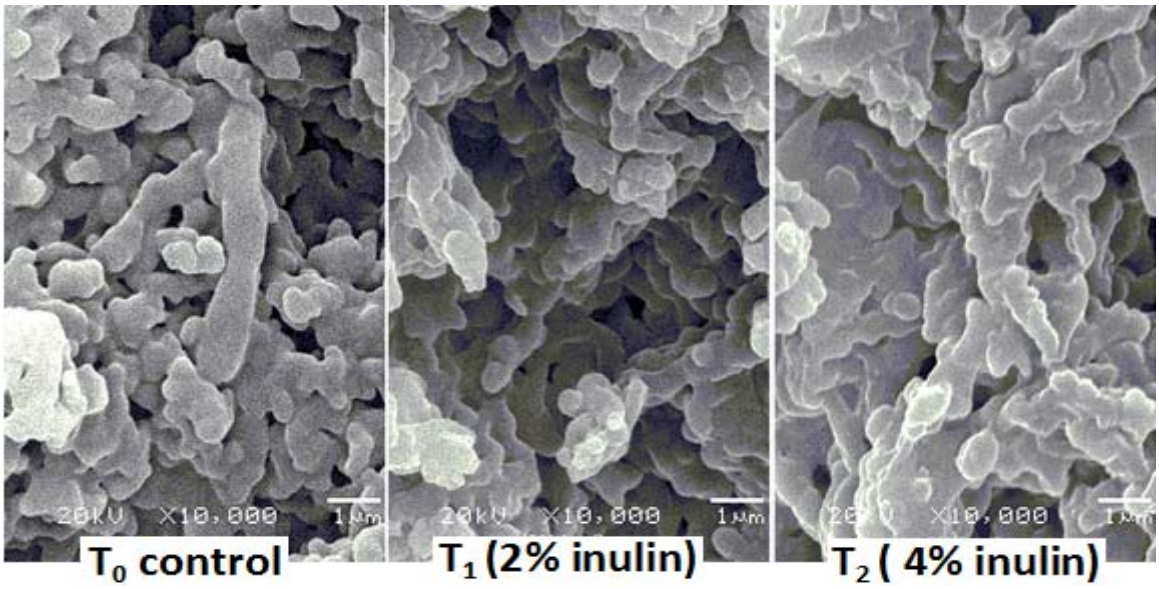

Fig. 3: Microstructure of different trails Karish cheese using different concentrations of texturized inulin

Table 3: Sensory evaluation during the storage periods of Karish cheese supplemented with texturized inulin

	Organoleptic scores			
	Color & Appearance 15			
	T_0 Control	T_1	T_2	LSD
Fresh	12.17[a]	13.91[b]	12.75[a]	1.126
7 Days	12.30[a]	13.59[b]	12.70[a]	1.100
14 Days	12.66[a]	13.33[b]	14[c]	0.607
	Flavor 50			
Fresh	42.67[a]	45.33[b]	44.75[b]	1.841
7 Days	41.00[a]	43.30[ab]	44.90[b]	2.32
14 Days	41.08[a]	43.33[ab]	44.92[b]	2.65
	Body & Texture 35			
Fresh	29.92[a]	32.50[b]	33.08[b]	1.146
7 Days	29.92[a]	30.83[b]	33.03[b]	1.044
14 Days	29.75[a]	30.83[b]	33.33[c]	1.068
	Overall acceptability 100			
Fresh	85.33 [a]	87.16 [ab]	90.17 [b]	3.428
7 Days	85.30 [a]	87.00 [ab]	90.14 [b]	3.313
14 Days	81.0[a]	85.17[ab]	88.58[b]	5.069

All means with the same within each property are not significantly different at 0.05 level
$T_{0,:}$control; T_1: Karish cheese with 2%inulin; T_2: Karish cheese with 4%inulin

Fig. 4: Virtual cheese Section of different trails Karish cheese using different concentrations of texturized inulin

T_1: Karish cheese with 2%inulin ;T_2: Karish cheese with 4%inulin

Also the current results are similar to those obtained by Murad, (1998) who used some natural essential oils, and successfully applied these natural products to get better sensory characteristics and to elongate shelf-life of yoghurt. According to Koca and Metin (2004), the softening effect observed in the cheese with inulin could be attributed to both the higher ratio of moisture to protein and to the increase in filler volume that results in a decrease in the amount of protein matrix. In general, inulin improved the cheese texture until 14 day of storage, there are no significant differences in the quantity attributes of the cheese containing both 2% and 4% except color when compared to the control.

CONCLUSION

The addition of 2 or 4% inulin to Karish cheese enhanced organoleptic properties with good nutritional value of fiber

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الملخص العربى

تحسين خواص الجبن القريش باستخدام الانيولين المعدل

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يهدف هذا البحث لدراسة امكانية الاستفادة من الانيولين المعدل (Frutafit TEX) كمكون غذائى وظيفى له تاثير أيجابى للحفاظ على الصحة العامة وكبديل لدهن فى صناعة الجبن القريش. لذلك تم دراسه تأثير اضافة الانيولين المعدل بنسب ٢ % و٤ % على الصفات الفيزيوكيماوية ونسبة التصافى واجراء بعض التحليلات الكيمائية والميكروبيولوجية وكذلك الخواص الحسية فى الجبن القريش المصري بعد التصنيع وأثناء فترة التخزين على ٤ ^{0}م. وقد أظهرت النتائج ان اضافة الانيولين فى صناعة الجبن القريش ادت الى زيادة معدل التصافى والمحتوى الرطوبى فى عينات الجبن المضاف اليها الانيولين مقارنة بالكنترول. كما أوضحت النتائج عدم وجد فروق معنوية فى نسبة البروتين والرماد في الجبن أثناء فترة التخزين على درجة حرارة ٤ ^{0}م مع وجود اختلافات في التركيب الدقيق بين العينات عند الفحص بالميكروسكوب الإلكتروني الماسح وكذلك انخفاض درجة صلابة الجبن من ٤٩٥ فى عينات الكنترول الى ٢١٦ و١٤٣ فى عينات الجبن التى تحتوى ٢% و٤% انيولين على التوالى. واظهرت نتائج التقييم الحسى ان الجبن المصنع باضافة ٤% انيولين حاز على أعلى درجة فى خاصية القوام وبقبول عام وذلك مقارنة بالكنترول اثناء فترات التخزين على٤ ^{0}م. لذا يمكن التوصية باستخدام الانيولين كمكون غذائى وظيفي بنسبة من ٢ و٤ % فى صناعة الجبن القريش والذى يحسن من القوام والخواص الحسية بالاضافة الى زيادة القيمه التغذويه للمنتج.