J. Food and Dairy Sci., Mansoura Univ., Vol. 4 (11): 611 - 619, 2013

EFFECT OF CERTAIN DIETARY FIBERS ON THE PROPERTIES OF FUNCTIONAL YOGHURT.

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ABSTRACT

Two types of dietary fiber (maltodextrin and konjac) were used to evaluate the effect of dietary fibers on the properties of plain yoghurt fermented with the traditional yoghurt starter(*streptococcus thermophillus and lactobacillus delbruki susps. bulgaricus.* All treatments were evaluated for chemical, rheological, microbial as well as the sensory properties, and compared with the control plain yoghurt. Dietary fibers were added at (0.5 , 2.0 %) for maltodextrin and (0.2 , 0.4 %) for konjac fiber (w/w). Control and other treatments were monitored during refrigeration storage (4°C) for 15 days. Results showed that all treatments were characterized with increase in total solid, soluble nitrogen, non protein nitrogen, total nitrogen and total volatile fatty acid, when compared with the control. Titratable acidity of various yoghurt treatments gradually increased during storage period. The dietary fibers had pronounced effect on the curd tension, whereas they decreased the syneresis of yoghurt. Moreover, the addition of dietary fiber improved the viability of lactic acid bacteria which varied in their decreasing rate when all treatment compared with the control. The body& texture and flavor of the yoghurt were enhanced when fortified with dietary fiber.
Keywords: functional food, dietary fiber, maltodextrin, konjac fiber.

INTRODUCTION

The term ‘‘functional food’’ was first used in Japan, in the 1980s, for food products fortified with special constituents that possess advantageous physiological effects Stanton et al.,(2005). Functional foods may improve the general conditions of the body (e.g. probiotics and prebiotic), decrease the risk of some diseases (e.g. cholesterol-lowering products), and could even be used for curing some illnesses.

Dietary fiber is referred to polysaccharides, oligosaccharides and their hydrophilic derivatives, which cannot be digested by the human digestive enzymes, to absorbable components in the upper alimentary tract Soukoulis et al., (2009). Chemically defined dietary fibers include a group of heterogeneous substances such as celluloses, hemicelluloses, lignins, pectins, and seeweed or bacteria derived gums. A large number of studies dealing with the physiological and nutritional aspects of dietary fiber has led to their incorporation in a great number of food products, such as bakery, breakfast cereals, baby foods, meat products, pasta and yogurts Gelroth & Ranhotra, (2001).

Since fermented milk is a main dairy product consumed by most of the Egyptian people , no fibers are included in such product , it is of good use to try adding some milled grains to raise the yield and the nutritive value of yoghurt such as maltodextin and konjac fiber, they are a concentrated source of several essential nutrients. Maltodextrin is one of the more popular fat

replacers that have been introduced as food additives in the last 25 years, partly because of its capacity to reproduce a fat-like mouthfeel Loret and frith,(2000). Maltodextrin is produced as a result of starch fragmentation by enzyme and acid, and it is water soluble, non-sweet products that are supplied as spray-dried powders. It is defined by the Food and Drug Administration (FDA) as safe food ingredients Akhilesh *et al.,*(2012). Konjac has been listed as one of the top ten healthiest foods by World Health Organization (WHO). It is highly nutritious, with over 45% of glucomannan, 9.7% of crude protein, 16 different kinds of amino acids up to 7.8%, 7 essential amino acids up to 2.5% , low fat and high in fiber. Glucose fructose and sucrose are also present in konjac (Theivasanthi and Alagar, 2012). So, this work aims to study the effects of dietary fiber incorporation on the quality of plain yoghurt fermented with traditional yoghurt starter.

MATERIALS AND METHODS

The yoghurt starter culture used was obtained from Ch. Hansen's Laboratories , Denmark Lypholized .it consists of *Streptococcus thermophilus* and *lactobacillus delbrueki subsp. Bulgaricus*, The starter culture was in freeze-dried direct-to-vat set form. Konjac fiber and Maltodextrin were obtained from Ch. Hansen's Laboratories , Denmark.

Yoghurt samples was prepared from fresh standardized buffaloe's milk (3% milk fat), It was heated at 90°C for 5 min then cooled to 40°C. Milk was divided into 5 equal portions. The five yoghurts treatments were made using traditional yoghurt starter. The first yogurt sample was used without any additives and considered as control, whereas the treatments from two to three were fortified with maltodextrin by ratios (0.5 and 2.0%). The treatments from four to five were fortified with konjac fiber by ratios (0.2 and 0.4%), respectively. All treatments were distributed into 100 mL aliquots plastic cups, the cups incubated at 45°C until a firm curd was formed. The resultant yoghurt was stored in the refrigerated condition (4-5°C) for 15 days.

Total solids contents of samples was determined according to AOAC, (2005), pH was measured using a pH meter (Corning pH/ion analyzer 350, Corning, NY) after calibration with standard buffers (pH 4.0 and 7.0). Titratable acidity , total nitrogen, soluble nitrogen , non protein nitrogen were estimated according to the methods described by ling, (1963). Total volatile fatty acids (TVFA) were determined according to Kosikowiski,(1978). The curd tension was determined using the method of Chandrasekhara et al., (1957) whereas the curd syneresis was measured as given by Mehanna and Mehanna, (1989). analysis for lactic acid bacteria (LAB)were carried out according to the methods described by the American Public Health Association (1992). Sensory evaluation was done by using 15 points for appearance, 35 points for body and texture and 50 points for flavour, according to the method of Scott, (1981).

RESULTS AND DISCUSSION

The effect of adding different concentrations of dietary fiber on the curd tension and curd syneresis of bioyoghurt and control treatments was stated in (Table 1). Addition of dietary fiber (Maltodextrin and Konjac) at the different levels showed makeable effect on both curd tension and whey synersis. These results were in agreement with Brennan and Tudorica (2008), who reported that, using fiber in the processing of yoghurt reduced syneresis and improved the texture, and rheological properties.

Treatment of Konjac (TK2 0.4%) gained the highest curd tension and the lowest whey syneresis , these results might be due to the formation of strong gel web by dietary fiber and binding a lot of water, which delayed the frok movement and the synersis of whey. These results came in harmony with those reported by Akesowan, (2010), who reported that Konjac increased the apparent viscosity of yoghurt.

Table 1. Rheological properties of Yoghurt .

Treatment	Curd Tension(gm.)	Curd Syneresis (ml)		
		10	30	60
Control	39.90	1.75	2.80	3.00
M1(0.5%)	46.75	2.90	2.99	3.86
M2(2.0%)	52.50	2.00	2.50	3.00
K1(0.2%)	62.50	1.62	2.22	2.71
K2(0.4%)	70.00	1.59	2.00	2.20

***Whey excluded (grams) from 15 gm of curd kept at room temperature after 10, 30 and 60 min.**

Control: yoghurt with traditional starter +without dietary fiber)
M1 :yoghurt with Maltodextrin (0.5 %)
M2 : yoghurt with Maltodextrin (2 %)
K1 : yoghurt with Konjac fiber (0.2 %)
K2 :yoghurt with Konjac fiber(0.4 %)

The changes in the titratable acidity, pH and total solids (TS) during the refrigerated storage of yoghurt are presented in table (2). The titratable acidity % and pH values gradually increased and decreased, respectively, during refrigerated storage of all samples of yoghurt. This might be due to fermentation of lactose, which produces lactic and acetic acids during fermentation and storage period. These findings are in agreement with the findings of Osman and Ismail, (2004).

Control treatment had the lowest acidity content than other treatment with dietary fiber throughout all storage periods. These results agree with Qureshi *et al .,(*2012), who reported that the dietary fiber yoghurt sample had a higher acidity as compare with control .

The same data showed that the treatment of TK2(Konjac 0.4%) gained the lowest pH values either at zero time or throughout storage period , This might be due to the enhancing effect of dietary fiber on the strain starter

bacteria metabolism , and these results agree with wichienchot *et al*.,(2010), who reported that dietary fiber were found capable of stimulating the growth of lactobacilli. Moreover, maltodextrin treatments were lower in acidity content than other treatments which treated with Konjac fiber.

Data illustrated in the same (table 2) showed that the addition of dietary fiber resulted in remarkable increase in (TS) of the resultant yoghurt, and this increase was associated with the level of addition . These results agreed with Fernandez-Garcia,(1998), who reported that addition of dietary fiber increased the total solids . Maltodextin treatment had the highest TS as compare with konjac treatment. This might be due to the increase of its addition ratio. In addition, there are gradual increase in TS content in control and other treatment during storage; this resulted from the partial losing of moisture content during the refrigerant storage.

Table (2).The Effect of dietary fiber on the chemical composition of functional yoghurt.

Treatment	Storage Period (days)	Acidity	pH Values	TS
control	0	0.76	4.33	14.8
	7	1.37	4.31	15.1
	15	1.45	4.26	15.7
M1(0.5%)	0	0.87	4.29	15.4
	7	1.42	4.25	15.9
	15	1.50	4.22	16.4
M2(2.0%)	0	0.85	4.31	16.0
	7	1.40	4.26	16.5
	15	1.48	4.23	17.6
K1(0.2%)	0	0.77	4.32	15.1
	7	1.50	4.24	15.7
	15	1.48	4.29	16.1
K2(0.4%)	0	0.80	4.26	15.6
	7	1.60	4.20	15.9
	15	1.58	4.20	16.5

Data of total protein, WSN/TN, NPN/TN and TVFA of fresh yoghurt and during storage period were tabulated in (Table 3). All of these terms increased during storage period. There was a slight increase in the WSN/TN, NPN/TN during storage periods**.** This trend was similar to that reported by Eid (2009). This might be resulted from the gradual increase in the total solids content during storage periods. At the same time, the slight increase in the WSN/TN, NPN/TN was refered to an increase on the protiolytic effect of bacterial starter in all treatment during storage . Moreover, the Increasing in dietary fiber ratio increased the WSN/TN and NPN/TN, compared with control. Similar results were reported by Tamime and Robinson, (1985) and Mervat *et al.,* (2007) .

The total protein content had a slight increase in all treatments and control during storage periods, and this was due to the slight increase in the

total solid content of all treatment, which resulted in from the partial loss of free water content of all treatments and control over storage by the evaporation process in cold storage. Addition of dietary fiber such as konjac fiber and maltodextrin increased the TP of the resultant yoghurt, these results agreed with Hussain et al ., (2009), who reported that, protein content increased with the addition of dietary fibers in yoghurt within 15 days of storage.

Moerover, There were changes in total protein content of all treatment. These changes differed from one treatment to another according to the type of used dietary fiber and it's addition ratio. Treatments made by adding konjac fiber gained the highest protein content either at zero time or during the storage period, when compared with the with the maltodextrin , These results agree with Theivasanthi and Alagar, (2012), who reported that Konjac fiber is highly nutritious , with over 45%of glucommans ,9.7% of crude protein , 16 different kinds of amino acid .

Total volatile fatty acids (TVFA) are usually taken as a measure of fat hydrolysis in dairy products during storage period.TVFA values of yoghurt at zero time and during storage period were tabulated in table (3) . The result showed that there were an increase in the TVFA among treatments and during the progress of storage period. Similar results were found by Eid (2009). Also these data revealed that the lipolytic ability of starter bacteria was improved during storage periods and by the differentiation in the dietary fiber used type.

Moreover, the yoghurt treatment TK2(Konjac 0.4%) gained the highest TVFA, either in fresh or stored product.

Table (3): The Effect of dietary fibers on total protein, soluble protein ,non protein nitrogen and total volatile fatty acid of Yoghurt during the storage period.

Treatment	Storage Period (days)	TP%	WSN/TN%	NPN/TN%	TVFA(ml 0.1NaOH/100 gm)
Control	0	3.80	30.201	3.851	6.0
	7	3.90	31.046	4.023	6.5
	15	4.10	31.578	4.495	7.0
M1(0.5%)	0	3.81	30.325	3.985	6.5
	7	3.92	31.253	4.325	6.7
	15	4.13	32.215	5.201	7.1
M2(2.0%)	0	3.82	30.453	3.995	7.3
	7	3.94	31.562	4.521	7.5
	15	4.15	32.363	5.323	8.0
K1(0.2%)	0	3.90	30.202	3.854	6.7
	7	4.10	32.120	5.010	7.0
	15	4.35	33.023	6.200	7.5
K2(0.4%)	0	3.99	30.652	3..996	6.9
	7	4.45	32.321	5.023	7.5
	15	4.56	34.052	7.650	8.0

Data illustrated in(table 4) showed the effect of different dietary fiber on some bacterial strains in yoghurt during storage. lactic acid bacteria count gradually decreased with the progress of storage periods , Similar results were found by El-Tahra (1997).

Decreasing rate (D.R) in the number of viable bacteria in the examined functional yoghurtwas lower than control.

Moreover, the D.R was varied between the streptococci and lactobacilli strains, and the type of dietary fiber used in production process, So, the D.R for streptococci was decrease from (46.66%) at control to ~ (42%) at maltodextrin treatments, and it was (57.14 to ~ 40%) for lactobacilli.

In addition , the D.R for functional yoghurt with konjac fiber was less than those occurred in maltodextrin treatments or control yoghurt and these rats was (46.66 to ~38%) for streptococci and (57.15 to ~ 39%) for lactobacilli.

Table 4. Effect of dietary fibers on some microbial groups of yoghurt.

Treatment	Storage period Days)(	Strain count x 10^6cfu/ml	
		Lactobacilli	Streptococci
Control (T)	**0** **7** **15**	70 50 30	30 22 16
D.R		57.14	46.66
TM1(0.5%)	**0** **7** **15**	75 50 45	35 23 20
I.R		7.14	16.66
D.R		40.00	42.85
TM2(2.0%)	**0** **7** **15**	80 60 50	40 25 23
I.R		14.28	33.3
D.R		37.50	42.50
TK1(0.2%)	**0** **7** **15**	79 52 48	32 25 20
I.R		12.85	10.00
D.R		39.24	37.50
TK2(0.4%)	**0** **7** **15**	76 65 47	32 25 19
I.R		8.57	6.66
D.R		38.15	39.39

$$Increasing\ Rate\ (I.R) = \frac{Number\ at\ zero\ for\ treatment - number\ at\ zero\ for\ control}{Number\ at\ zero\ for\ control} \times 100$$

$$Decreasing\ Rate\ (D.R) = 100 - \frac{Number\ at\ 15\ day}{Number\ at\ fresh} \times 100$$

The addition of maltodextrin or konjac fiber enhanced the increasing rate (I.R) of both lactic acid bacteria strains, This might be referred activation of starter culture by adding dietary fiber to yoghurt milk. Also, the addition of (0.5%) or (2.0%) Maltodextrin led to (7.14 , 14.28) for lactobacilli and (16.66 , 33.3) for streptococci , while the addition of Konjac fiber (0.2%) or (0.4%) led to an increase (12.85, 8.57) for lactobacilli and (10.00 , 6.66) for streptococci respectively , These results agreedt with Wichienchot et al .,(2010**),** who reported that dietary fiber were found capable of stimulating the growth of lactobacilli.

Results of the organoleptic scoring (Table5) show the sensory evaluation scores of different treatments of yoghurt. Some decrease in these properties were observed with the progress of storage. The addition of dietary fiber did not had makeable effect on the colour and appearance of the yoghurt , while it had a marked effect on the texture and body of the product. As the percentage of dietary fiber increased the consistency of the yoghurt increased, The konjac fiber addition led to higher texture and viscosity of the yoghurt, especially with (0.4%). Similar results were found by Akesowan (2010), who reported that konjac increased the apparent viscosity of yoghurt There were slight difference at the values of total score of organoleptic values among control and functional yoghurt in the beginning of storage until 7 days , but these values were different from one treatment to another specially on flavour score, and the functional yoghurt containing maltodextrin (2.0%) and konjac (0.4%) had the lower scores which reflected on total score of organoleptic values at the end of storage periods. The best treatments which had the highest evaluation were maltodextrin treatments, where, it had pleasant appearance and good flavour than other treatments.

Table 5. The Effect of dietary fibers on organoleptic properties of yoghurt.

Treatments	Storage periods (days)	Color & Appearance (15)	Body & Texture (35)	Flavour (50)	Total (100)
Control	0	15	33	48	96
	7	14	30	45	89
	15	13	29	40	82
M1(0.5%)	0	15	34	48	97
	7	14	32	43	89
	15	13	32	42	87
M2(2.0%)	0	14	35	45	94
	7	14	34	43	91
	15	13	34	40	87
K1(0.2%)	0	13	33	44	90
	7	13	33	42	88
	15	11	31	39	81
K2(0.4%)	0	13	34	43	90
	7	12	33	39	84
	15	11	31	36	78

CONCLUSIONS

The fortification of yoghurt with dietary fibers had a great interest to improve the functionality and create functional foods with health benefits. Dietary fibers gained pronounced effect on the properties of traditional

yoghurt and enhanced its body & texture and the viability of starter bacteria strain. This study has shown that fortifying yoghurt with maltodextrin and konjac fiber produced an acceptable functional product with potential beneficial health effects.

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تأثير الالياف الغذائية على خواص الزبادي الوظيفية

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تم استخدم نوعين من الالياف الغذائية بنسبتي اضافة لكلا منهما [المالتودكسترين(٠,٥ ،٢,٠٠ %) – الكونجاك (٠,٢ , ٠,٤ %) وزن/وزن] لدراسة تأثيرها علي خصائص وجودة الزبادي الطبيعي المخمر بالباديء التقليدي (ستربتوكوكس ثرموفيلس واللاكتوباسيلس بولجاريكس).حُفِظت جميع المعاملات وعينة المقارنة علي درجة حرارة ٤ درجة مئوية لمدة ١٥ يوماً قُيمت خلالها كيماويا وريولوجيا وميكروبيولوجيا وحسيا.اوضحت النتائج ان جميع المعاملات حققت زيادة ملحوظة في نسبة كلاً من المواد الصلبة الكلية والبروتين الكلي وشقوقه والاحماض الدهنية الطيارة مقارنة بالكنترول. اظهرت قيم الحموضة الكلية زيادة تدريجية مع التقدم في فترة التخزين. ولقد اظهر كلا النوعين من الالياف الغذائية تحسناً في قيم الشد الخثري وانخفاضاً في معدل طرد الشرش في جميع المعاملات مقارنة بالكنترول. كذلك ادي استخدام الالياف الغذائية الي زيادة حيوية بكتريا الباديء والذي ظهر بوضوح في انخفاض معدلات التناقص لكلا منهما خلال فترة التخزين.علاوةعلي ذلك ادي استخدام الالياف الغذائية الي تحسن الخصائص الحسية وخاصة القوام لجميع المعاملات مقارنةً بالكنترول.

قام بتحكيم البحث

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