Utilization of Microcrystalline Cellulose Prepared from Rice Straw in Manufacture of Yoghurt

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Abstract: In the present work, we prepared Microcrstalline cellulose from rice straw and utilized it in manufacture of yoghurt. Different concentration of Microcrstalline cellulose was used and compared with yoghurt (control) without addition. Microbiologically, organoleptically, chemically and physical properties of resultant yoghurt was studied. Addition of Microcrstalline cellulose had no significant on the viability of Total bacteria count, and *Lactobacillus delbrueckii* supsp *bulgaricus* and *Streptococcus salivarius* subsp *thermophilus* and all samples free from yeast, mould and coliform fresh and during cold storage (5 °c± 1 °c). Organoleptically showed that 0.1 % of Microcrstalline cellulose was best concentration that had a highest score for appearance, body and texture and flavor fresh and during storage. esults showed that the yoghurt manufacture by using 0.1% Microcrstalline cellulose had a high acidity, acetaldehyde, diacetyl and Total volatile fatty acids than control. Also treated samples had a higher viscosity and lower synerthesis than control. [Journal of American Science. 2010;6(10):226-231] SSN: 1545-1003).

Key words: Yoghurt, Stabilizer, Microcrstalline cellulose.

1. Introduction

Microcrystalline cellulose is an insoluble hydrocollide derived from cellulose typically found in fruits and vegetables. During UHT processing Microcrystalline cellulose forms a thixotropic three dimensional network that provides suspension of heavy particulates, without gelling or inhibiting flow. Microcrystalline cellulose has many applications in pharmaceuticals, foods preparation. It is a naturally derived stabilizer, texturizing agent and fat replacer. It is used extensively in reduced fat salad dressing, numerous dairy products including cheese, frozen desserts and whipped topping and bakery products. Microcrystalline cellulose molecules is made up of a chain of about 250 glucose molecules. Microcrystalline cellulose is a food stabilizer formed from natural components used in food products. Effective amounts of the natural components are provided to the food products to maintain physical stability during its shelf life.

Thus, we prepared Microcrystalline cellulose via bio-chemical processing of rice straw according to **(Galal *et al*., 2008)** then the obtained unbleached pulp was bleached and converted to its corresponding Microcrystalline cellulose accordance to **(Galal and Mohamed, 2009)**.

The aim of this work is studying the feasibility of using Microcrystalline cellulose in manufacture of yoghurt as a natural stabilizer and fat replacer.

2. Material and Methods

Materials

Milk. Fresh buffaloes' milk was obtained from the herd of faculty of Agriculture, Cairo University. The milk was skimmed by using a mechanical separator. Skim milk was analyzed for its chemical composition. Gross chemical composition of skim milk was Total Solids (11.1%), Total Protein (3.95%), Lactose (5%), Ash (0.93%) and Fat (1%).

Preparation of Microcrystalline cellulose. Microcrystalline cellulose was prepared from rice straw bleached pulp according to (Galal and Mohamed, 2009).

Starter cultures. Yoghurt starter *Lactobacillus delbrueckii* supsp *bulgaricus* and *Streptococcus salivarius* subsp *thermophilus* were obtained from Ch. Hansen. Copenhagen. Denmark.

The milk samples were inoculated with 2% starter culture and incubated at 42 °c for 2-3 hrs until a uniform coagulum. The yoghurt cups were then transferred to refrigerated storage and analyzed after 1, 3, 5, 7 and 15 days of storage for their microbiological analysis.

Preparation of yoghurt. Fresh skim buffaloes' milk was heated at 85°c for 15min. then divided into six portions, cooled to 42°c then inculated with 2% (*Lactobacillus delbrueckii subsp. Bulgaricus* and *Streptococcus salivarius subsp.thermophilus* (1:1)) then incubated at 42°+1°c for 2.5 hr until coagulation was completed. The products were stored at the refrigerator for 2 weeks.

Preliminary experiments. Fresh skim buffaloes' milk was heated at 82°C for15 min. then divided into six portions. The first portion let as control then five different concentration of Microcrystalline cellulose was added (0.1, 0.2, 0.3, 0.4, 0.5) respectively. All treatments &control cooled to 42°c then inculated with 2% (*Lactobacillus delbrueckii subsp. Bulgaricus* and *Streptococcus salivarius subsp.thermophilus* (1:1)) then incubated at 42°c for 2.5 hr until coagulation was completed. The products were stored at the refrigerator.

Methods

Chemical Analysis. Protein, fat, lactose and ash content were determined according to AOAC (1995). pH and titratable acidity were determined as outlined by Marshall (1993), Total solids measured according to IDF (1982). Acetaldehyde and diacetyle content was determined as described by Lees&Jago (1969) and Pack *et al.* (1964) respectively. Total volatile free fatty acids (TVFA) were measured according to Kosikowski (1978). Viscosity of yoghurt was determined using Zum viscosimeter type RN-50 HZ. Lactose was determined colourimetrically according to Nickerson *et al.* (1976).

Microbiological Analysis

Total bacterial count. The total bacterial count (TBC) was carried out as the conventional method (FDA, 2002) using plate count agar (Oxoid). After 48 ± 2h incubation at 35± 1°c colony forming units were accounted and calculated per gram of sample.

Molds and yeasts count. Enumeration and count of yeasts and molds were carried out in the samples using the media of acidified potato dextrose agar (Oxoid). The method recommended by (FDA 2002) was followed up. Plates were incubated at 22-25° c for 3-5 days, and colonies of yeasts and molds were accounted and calculated per gram of sample.

Detection of coliforms. Coliform group was determined using solid medium method onto plates of violet red bile agar (VRBA) (Difco) according to the method reported by (FDA 2002). Plates were incubated 24h at 32- 35° c.

Lactic acid bacteria count. Yoghurt starter *Lactobacillus delbrueckii* supsp *bulgaricus* and *Streptococcus salivarius* subsp *thermophilus* were counted on MRS agar medium for 48h at 37°c anaerobically and on M17 agar medium for 48h at 37°c aerobically, respectively, according to Marshall and Tamime (1997).

3. Results and Discussion

Total bacterial count

Data obtained in Fig. 1 illustrate that the log counts of TBC in fresh control and treatment (yoghurt supplemented with 0.1% Microcrystalline cellulose) were 7.0 and 7.0 log CFU/g, respectively and increased to 8.9 and 7.9 log CFU/g at the 5th day of the storage, then decreased slightly to reach 8.0 and 7.6 log CFU/g respectively at the end of storage.

Lactic acid bacteria count (LAB)

Data shown in Fig. 2 and 3 the viability of *Lactobacillus delbrueckii* supsp *bulgaricus* and *Streptococcus salivarius* subsp *thermophilus*, respectively. The data in Fig. 2 indicate that Microcrystalline cellulose had no significant effect on the viable count of *Lactobacillus delbrueckii* supsp *bulgaricus* when compared with control, and the viability of *Lactobacillus delbrueckii* supsp *bulgaricus* during the storage was constant. However, the same results were shown with *Streptococcus salivarius* subsp *thermophilus* Fig. 3. The viable count of *Streptococcus salivarius* subsp *thermophilus* had no significant differ when compared with control in fresh or at the end of storage.

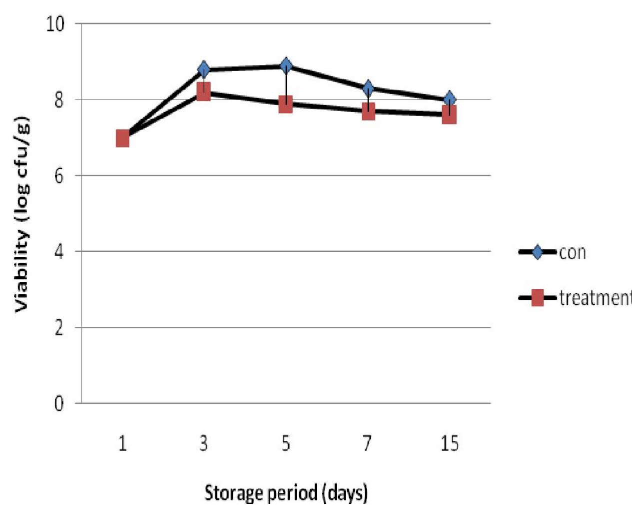

Fig. (1): Viability of total bacterial counts(log CFU/g) in yoghurt supplemented with Microcrystalline cellulose during the storage period at 5±1 °C

However, the presence of Microcrystalline cellulose in yoghurt had no significant effect on the viability of TBC and LAB. Bianchi and Capurso (2002) reported that dietary fibres are carbohydrates that resist hydrolysis by human intestinal enzymes but are fermented by colonic microflora. Soluble dietary fibres are fermented by anaerobic bacteria with production of gases, short chain fatty acids and other metabolic products believed to cause symptoms such as bloating, abdominal distension, flatulence. Insoluble fibres are only partially fermented, serving almost exclusively as bulking agents that result in shorter transit time and increased faecal mass. Microcrystalline cellulose caused fewer symptoms than guar gum and ispaghula probably due to the insoluble nature and the dimensions of the particles of this Microcrystalline cellulose.

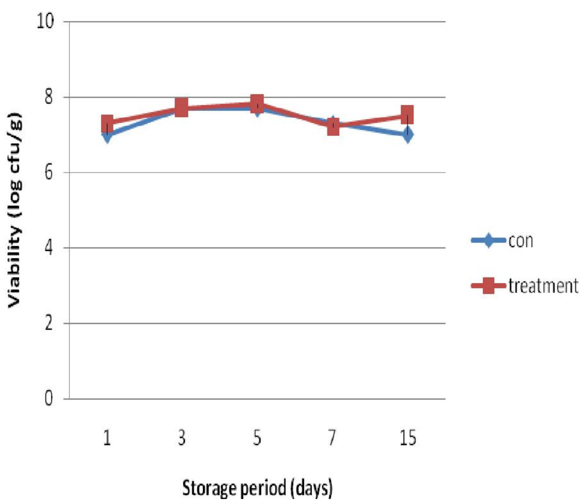

Fig. (2): Viability *Lactobacillus bulgaricas* (log CFU/g) in yoghurt supplemented with Microcrystalline cellulose during the storage period at 5±1 °c

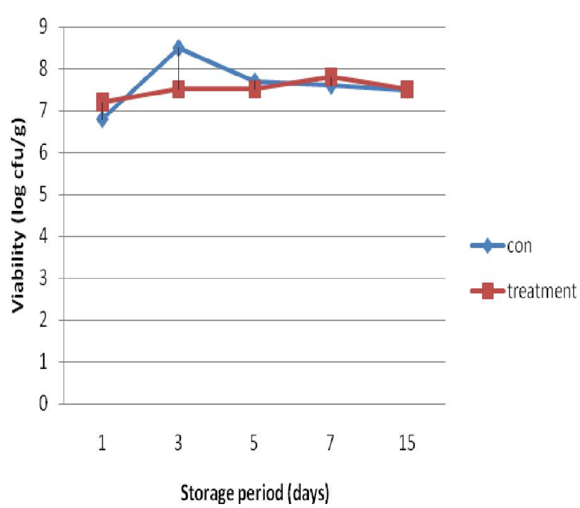

Fig. (3): Viability *Streptococcus thermophilus* (log CFU/g) in yoghurt supplemented with Microcrystalline cellulose during the storage period at 5±1 °c

Coliforms, Molds and yeasts count

Coliforms were not detected in yoghurt from all samples either when fresh or during the cold storage. This can be attributed to the hygienic practices followed during the preparation and storage of yoghurt. However, moulds and yeasts began to appear after 7th day in the control and 15th day in the treatment.

Table 1 shows the organoleptic properties of yoghurt prepared by using different concentration of Microcrystalline cellulose. It was clear that 0.1% microcrystalline cellulose had gained highest score than control and other treatments. On the other hand 0.5 % of microcrystalline cellulose had gained a lowest score than control and other treatment. 0.1 % of microcrystalline cellulose improved the appearance, body and texture and flavor of resultant yoghurt than control and other treatments. Microcrystalline cellulose is a food stabilizer maintains physical stability during its shelf life while improving good mouth feel.

Table 1. Organoleptic properties of yoghurt prepared by using different concentration of Microcrystalline cellulose.

Conc. %	Appearance (10)	Body & Texture (60)	Flavor (30)	Total (100)
0.1	9	58	28	95
0.2	8	50	24	82
0.3	7	42	22	71
0.4	6	35	20	61
0.5	5	30	18	53
Control	8	57	26	91

Table 2 illustrate the effect of cold storage (5° c ±1°c) on organoleptic properties of yoghurt prepared by using 0.1 % microcrystalline cellulose fresh and during storage until 2 weeks. We indicated that treatment had gained highest score for appearance, body & texture and flavour either fresh or during cold storage 5°c ±1°c until 2 weeks than control. On the other hand the degrees gradually decreased during storage for appearance, body& texture and flavour either control or treatment.

Table 2: Effect of cold storage 5° c ±1°c on organoleptic properties of Yoghurt prepared by using 0.1% Microcrystalline cellulose.

Samples	Appearance (10)	Body & Texture (60)	Flavour (30)	Total (100)
Fresh				
Control	8	57	26	91
Treatment	9	58	28	95
1week				
Control	7	55	24	86
Treatment	8	57	26	91
2week				
Control	6	53	22	81
Treatment	7	54	23	84

Table 3 indicated the chemical composition of yoghurt prepared by using 0.1 % Microcrytalline cellulose fresh and during cold storage (5°C ±1°C) until 2 weeks. It was clear that acidity, fat, TS, protein and ash is slightly high in treatment than control either fresh or during storage whereas pH took an opposite trend. Acidity increased gradually until 2 weeks in both control and treatment. This may be due to the fermentation of lactose. These results are in agreement to (Tamime and Deeth 1980), (Fatma *et al.*, 1999). TS, fat, protein and ash increased gradually during cold storage (5° C ±1°C) until 2 weeks (Abou Dawood *et al.*, 1993) either control or treatment.

Table 3. Some chemical composition of yoghurt manufacture by using 0.1% Microcrystalline cellulose during cold storage (5° c ±1°c)

Samples	Acidity			PH			Fat			T.S.			Protein			Ash		
	Fresh	1 W	2 W	Fresh	1 W	2 W	Fresh	1 W	2 W	Fresh	1 W	2 W	Fresh	1 W	2 W	Fresh	1 W	2 W
Control	0.80	1.12	1.42	6.2	6.0	5.8	1	1.2	1.4	11.57	11.6	11.6	4.8	4.82	4.82	0.90	0.92	0.92
Treatment	0.85	1.15	1.45	6.0	5.9	5.7	1.2	1.3	1.4	11.72	11.75	11.76	4.83	4.85	4.86	0.94	0.95	0.95

W= week

Table 4 shows the effect of cold storage 5° C ±1°C on viscosity (Cp/s) and whey synerthesis of prepared yoghurt by using 0.1 % Microcrystalline cellulose. Viscosity is higher in treatment than control either fresh or during cold storage whereas viscosity increased gradually in control and treatment during cold storage 5° C ±1°C. This may be due to the increased of acidity and the interaction between Microcrystalline cellulose as stabilizers and milk proteins (Guiseley *et al.*, 1980; Schmid and Smith 1992).

From the same table whey synerthesis increased in both control and treatment during storage up to 2 weeks. Yoghurt prepared by using 0.1 % Microcrystalline cellulose had lower whey synerthesis than control either fresh or during cold storage 5° C ±1°C. Microcrystalline cellulose improved the yoghurt whey off. These results are in accordance to (Abd El Salam *et al.*, 1996) & (Fatma *et al.*, 1999).

Table 4. Effect of cold storage (5° C ±1°C) on viscosity (Cp/s) and whey Synerthesis of prepared yoghurt by using 0.1% Microcrystalline cellulose.

Storage Period	Control		Treatment	
	Viscosity	Whey synerthesis	Viscosity	Whey synerthesis
Fresh	15300	6.6	18500	5.2
1 week	25600	6.9	30543	5.8
2 week	38530	7.5	45320	6.4

Table 5 show the effect of cold storage 5° C ±1°C on total volatile fatty acids, acetaldehyde & diacetyl of yoghurt prepared by using 0.1 % Microcrystalline cellulose. Total volatile fatty acids are higher in treatment than control either fresh or during storage for 2 weeks. It is increased gradually during storage. These results are agree by (Abou Dawood *et al.*, 1993), from the same table Acetaldhyde is higher in treatment than control. Gradually decreased during cold storage 5° C ±1°C until 2 weeks either control or treatment. Also, diacetyle took the same trend. These results are agreed by (Fatma *et al.*, 2001).

Table 5. Effect of cold storage (5° c ±1°c) on total volatile fatty acids (TVFA) (0.1N NaOH/100gm), acetaldehyde (µm/100 gm) & diacetyl (µm/100 gm) of yoghurt prepared by using 0.1% Microcrystalline cellulose.

Storage Period	Control			Treatment		
	TVFA	Acetaldehyde	diacetyl	TVFA	Acetaldehyde	diacetyl
Fresh	7.5	350	245	8.5	420	260
1 week	12.3	298	205	14.3	380	230
2 week	15.5	270	180	18.2	290	160

4. Conclusion

Microstalline cellulose prepared from rice straw was successful at 0.1% conc. In manufacture of yoghurt and improve body & texture and flavor and increased viscosity with low synerthesis.

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