

Original Research Article

Implementing maltodextrin-, polydextrose and inulin in making a synbiotic fermented dairy product

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ABSTRACT

Synbiotic products contain both probiotic bacteria and prebiotic compounds. The aim of this study was to produce a symbiotic Fermented dairy product with the polysaccharides / fibers (maltodextrin, polydextrose and inulin) with a 3% concentration in combining them with *B. Longum* ATCC 15707, *St. thermophilus* Textl 5842 and *Lac. lactis* spp *lactis* ATCC 53214 in either skimmed or full fat fermented milk, and testing, the sensory and physicochemical and microbiological properties for fresh product and after incubation for 7 days. It was shown that the pH was having a clear decrease and acidity was showing an increase that was lowered by increasing the storage days at 5-7 °C as well as a significant decreasing in the syneresis and increase in $\log_{10}$ cfu/g of *B. longum* ATCC 15707 count and viscosity was markedly increased at maltodextrin treatment. Finally, it was concluded that Maltodextrin was found to have good results in stimulation the probiotic bacterial count and enhancing the sensory properties of fermented milk compared with inulin, and that is recommended by our work to use it in industry.

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Keywords: Synbiotic Polysaccharide, maltodextrin, polydextrose, inulin

1. INTRODUCTION

Synbiotics consist of both useful bacteria (probiotics) and indigestible carbohydrates (prebiotics) for stimulating beneficial bacterial growth (Shi et al., 2002; Khurana and Kanawjia, 2007). Synbiotics have antimicrobial, anticancer, anti-allergic and immune-stimulating properties. They improve absorption of minerals, prevent incidence of diarrhea, and optimize assimilation of nutrients (Buterikis et al., 2008).

An example of fermented milk products is the Misti dahi originated in eastern India, the traditional fermented dairy product dahi, has been elevated to a dessert by sweetening it. The sweetened variety of dahi is popularly known as misti dahi or misthi doi. Misti dahi has creamish to light brown color, firm consistency, smooth texture and pleasant aroma. Traditionally, it is prepared by boiling cow, buffalo or mixed milk with a required quantity of sugar and partially concentrated by simmering over a low fire during which milk develops a distinctive light cream to light brown caramel color and flavor. This is followed by cooling and culturing at ambient temperature using lactic culture and pouring into retail earthen cups and left undisturbed overnight for fermentation. When a firm body curd has set, it is stored at a low temperature 4°C and served chilled (De, 1980; Aneja et al., 2002 and Singh, 2007).

Yoghurt is among the most common fermented dairy products consumed around the world, and its sensory attributes have a large effect on consumer acceptability (Saint-Eve et al., 2006).

Drinkable yoghurt, categorized as stirred yoghurt with a low viscosity, is a growing area of interest based on its convenience, portability, and ability to deliver all of the health and nutritional benefits of stirred or set yoghurt (Eder, 2003 and Thompson et al., 2007). The low viscosity is obtained through high agitation, which breaks the coagulum after the fermentation period, before the product is bottled and refrigerated (Tamime and Robinson, 1999). Consumers began to look for low fat variants of yoghurt with acquainted sensory qualities available in full-fat yoghurts. However, too-much reduced or very low fat levels in milk can possibly result in the products with impaired physicochemical and sensory properties. Therefore, such prebiotics as inulin, maltodextrin and polydextrose can be used as fat substitutes in low-fat dairy-based products owing to their advantageous functionalities. Numerous researchers have tried to improve textural and functional properties of low-fat yoghurt by using these fat replacers. For example, (Staffolo et al., 2004) found that the yoghurt containing inulin had a stable color and water activity and syneresis did not prevail during storage, being similar to the other dietary-fiber containing yoghurts.

With regards to dairy products, an extensive amount of research has been done on the effectiveness of the three polysaccharides (inulin, polydextrose and maltodextrin) to be used as a fat replacer (Modzelewska-Kipitula and Klebukowska, 2009) or in comparison to other dietary fibers (Dellostaffolo et al., 2004) or other carbohydrate-based fat replacers (Brennan and Tudorica, 2008).

The addition of Inulin decreased the syneresis in low fat (Brennan & Tudorica, 2008 and Kip et al., 2006) and fat free yoghurt (Aryana and McCrew, 2007). The water activity, pH, color and appearance of these inulin-fortified yoghurt were stable over the storage period (Dellostaffolo et al., 2004 and Aryana and McCrew, 2007).

Several researchers have described the effects of inulin as a fat mimetic at a molecular level. Also, (Kip et al., 2006) suggested that the water soluble inulin could act as a thickener and formed hydrogen bonds with protein aggregates in the yoghurt during fermentation. The viscosities of stirred yoghurts were studied by (Van Marle et al., 1999). They suggested that inulin reduced brush friction by interacting with the extracellular polysaccharides that were located outside the protein aggregates. The mobility of protein aggregates thus increased when compressed by the tongue, which in turn provided the perceived improved airiness and creaminess in yoghurt.

Maltodextrin increased acidity, water activity and viscosity of ASDM while decreased syneresis compared to other bulking agents. Maltodextrin increased hardness, adhesiveness and gumminess values of ASDM compared to sorbitol and polydextrose. Maltodextrin was found to be the most suitable bulking agent in the preparation of ASDM using aspartame and acesulfame-K. Reported by (Raju and Pal, 2011).

~~The aim of this Aim of study was to determine studying the effects of using maltodextrin, polydextrose and inulin when added in preparation of full fat and skimmed fermented milk on , for their physicochemical, microbiological and sensory properties~~

2. MATERIALS AND METHODS

2.1 Milk

2.1.1 Whole Cow's Milk

Fresh milk was obtained from the dairy pilot plant of the Faculty of Agriculture that was obtained previously from the faculty's farm, Alexandria University. With total solids 12.39%, fat 3.5% and pH 6.7.

2.1.2 Skim milk

It was obtained by separation of whole milk using a milk separator, ~~With with~~ total solids of 9.33%, fat 0.2 % and pH 6.7.

2.1.3 Milk powder

A low heat treated milk powder made from fresh pasteurized cow's milk with a fat 1.25%, lactose 52%, protein 36% and ash 8%. Obtained from Valio Company Finland origin.

2.2 Tested cultures

St. thermophilus Textl 5842, *Lac. lactis* spp *lactis* ATCC 53214 and *B. Longum* ATCC 15707

They were obtained from cultures store of Dairy Science and Technology department, Faculty of Agriculture, Alexandria University.

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2.3 Polysaccharides

2.3.1 Polydextrose

Polydextrose is a randomly bonded condensation polymer of D-glucose with some bound sorbitol and a suitable acid with a molecular weight of 2200 was obtained from MENGZHOU TAILIJIE CO., LTD in town China. It has a white to cream white color, odorless and slightly sweet, soluble in water. pH range from 3.5-7.

2.3.2 Maltodextrine

Maltodextrine C*Dry MD 01915 was obtained from Cargill company, town France. It is a Spray-dried product obtained by enzymatic conversion of starch, with 6% moisture, DE 16, soluble in water, bulk density 440 g/l, pH 3.5 and Granulometry < 63 µm 35% .

2.3.3 Inulin

Long chain inulin was obtained from Fenchem Biotek LTD town China. It's botanical source Jerusalem Artichoke, used part is the root, having a white color, carbohydrate 99.6% min density 500 g/l, ash 0.5%, water 5%, good solubility in water and pH range from 5-7.

2.4 Fermented dairy product manufacture

Two kinds of milk were used in the preparation of fermented milk products;

- 1- whole fat milk +2% milk powder
- 2- skim milk +2% milk powder

The polysaccharides (3%) were mixed with the milk fortified with milk powder (2%) at 45°C and heated at 85°C for 30 min (Gustaw *et al.*, 2006 and 2009). The bacterial culture combinations (*Lac. lactis spp lactis* ATCC 53214, *St. thermophilus Texl* 5842 and *B. longum* ATCC 15707) were added at 42°C and mixed. The milk mixture was distributed in 130 ml plastic cups and incubated at 42 ±1°C until complete coagulation as shown in (fig. 1). The pH-, total acidity % and the log₁₀ cfu/g of *B. longum* were determined in fresh product and after 2 days, 4 days and 7 days of storage at 5- 7°C

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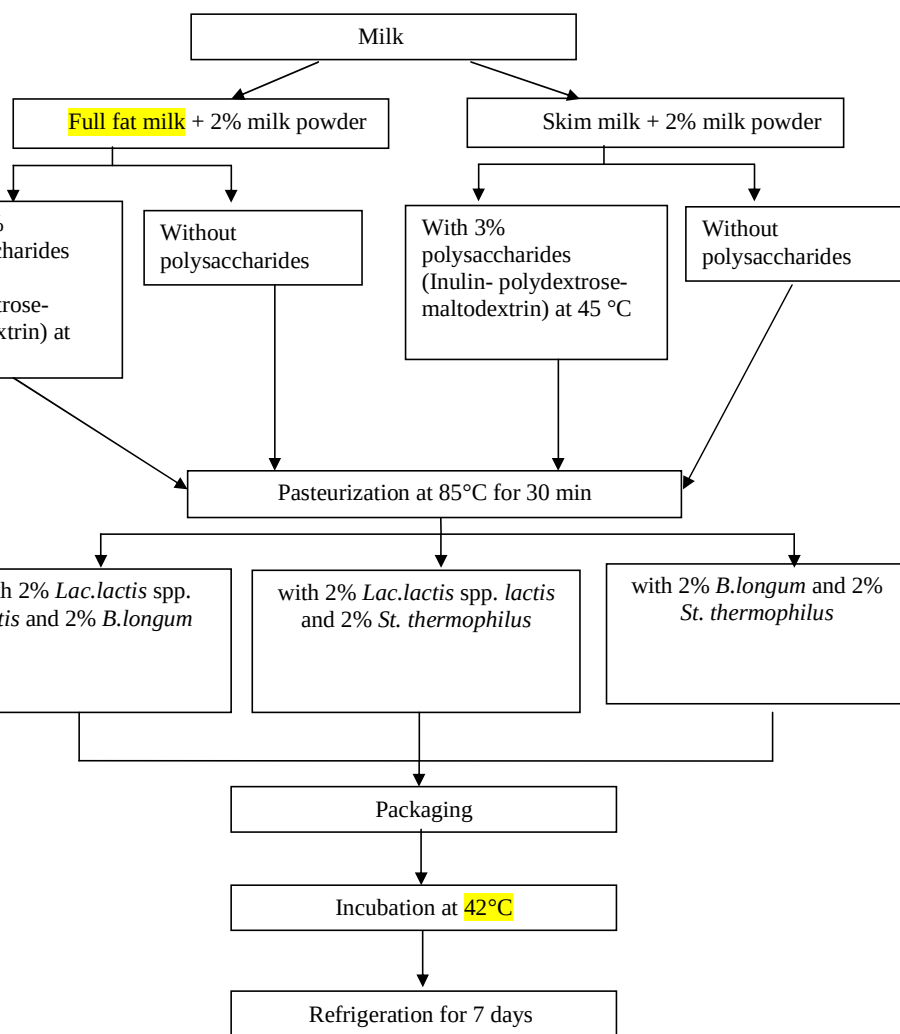


Fig. (1): Full fat and skimmed fermented dairy product flow chart

2.5 Chemical analysis

189 AppProximate analysis contents were analysis were carried out according AOAC (2000). Titriatable acidity
190 it was estimated as lactic acid %. The convenient Gerber method was used to determine fat %. The pH
191 was determined by using glass electrode pH meter 3310 Jenway, ~~city?~~ Germany.

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193 2.6 Syneresis

194 An amount of 20 g of sample was spread on a thin layer to cover the surface of the wattmann paper no 1
195 (that was pre- moistened by whey). The fermented milk product was filtered under vacuum via Buchner
196 funnel for 10 min. The liquid that passed through the filter paper was collected and recorded. The
197 percentage of syneresis was calculated as the weight of the filtrate been dropping down from the sample
198 was collected and divided by the weight of the initial sample multiplied by 100 (as demonstrated in the
199 following equation) (Wu et al., 2001).

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$$\text{Syneresis \%} = \frac{\text{weight of the collected filtrate}}{\text{initial weight (20 gm)}} \times 100$$

203 2.7 Viscosity determination

204 This test was carried out to determine the effect showed by adding the polysaccharides (maltodextrin,
205 polydextrose and inulin) to fermented milk. To study the effect of adding 3% of the selected
206 polysaccharides to full fat and skimmed milk used in the preparation of fermented milk made by 2% *B.*
207 *longum* ATCC 15707 and 2% *St. thermophilus* Textl 5842 (1:1) then incubated at 37°C till done NOT
208 CLEAR. Apparent viscosity of the test sample (130 g at 10°C) was evaluated using a Spanish origin
209 viscometer (MYR viscosoft plus V1.05) equipped with L1 spindle PE (yoghurt) head rotating at 100 rpm.
210 At test, the spindle head started moving and the apparent viscosity value was recorded as cp. (De Ancos
211 et al., 2000)

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213 2.8 Sensory evaluation

214 The sensory evaluation was used for appraising the sensory traits for the product. It was carried out by a
215 panel consisting of 5-7 panelists including staff members and assistants, engineers and post graduate
216 students at Faculty of Agriculture El-Shatby, Dairy Science Department and Food Science and
217 Technology Department. Each panel member assessed the fermented dairy product sample separately,
218 taking into account the following features; body and texture, flavor and finally appearance and color
219 (Larmond, 1982).

221 2.9 Statistical analysis

222 The experimental design was a factorial experiment in a completely randomized design-test, with two
223 replications and analysis of variance of treatments difference was performed according to Steel and
224 Torrie (1980). Statistical analysis was done by, ANOVA, F-test, and L.S.D procedures available within the
225 SAS software package (version 9.13, 2008).

228 3. RESULTS AND DISCUSSION

230 3.1 Determination of pH value and total acidity in full fat and skimmed fermented milk made with 231 different cultures combinations and the selected polysaccharides

232 Concerning the effect of polysaccharide on the growth activity of tested cultures combination depending
233 on the changes in total acidity and pH values, Table (1) show the changes in pH during the
234 manufacturing of full fat and skimmed fermented milk made by starter composed of *B. longum* ATCC
235 15707 with *St. thermophilus* Textl 5842 or *lac. lactis. spp lactis* ATCC 53214 in comparison with those
236 made with *St. thermophilus* Textl 5842 and *lac. lactis. spp lactis* ATCC 53214 in the presence of 3%
237 polysaccharides. The results in Table (1) revealed that the addition of polysaccharides by 3% decreased
238 the pH in the fermented product made from full fat or skimmed fermented milk, the pH of the control (B.

239 *longum* ATCC 15707 + *St. thermophilus* Texl 5842) and that made with maltodextrin, polydextrose and
240 inulin were 4.68, 4.29, 4.52 and 4.31 respectively, in the full fat fermented milk , while the corresponding
241 pH values in skimmed fermented milk were 4.70, 4.32, 4.45 and 4.33 respectively almost the same trend
242 was noticed for all treatments with different culture combinations and selected polysaccharides which
243 concluded that the addition of polysaccharides may enhance the starter activity specially *B. longum*
244 ATCC 15707. Storing the product at 5-7°C decrease the pH values gradually as the storing time
245 increased the statistical analysis revealed a significant decrease in pH at (α 0.01), while there were no
246 significant difference between the full fat and skimmed fermented milk products either in fresh and after
247 storing at 5-7°C.

248
249 It was noticed that the culture combination containing *B. longum* ATCC 15707 and maltodextrin have a
250 significant effect on growth activity of starter combination in comparison with other polysaccharides and
251 starter free of *B. longum* ATCC 15707, which may be due to synergistic effect between *B. longum* ATCC
252 15707, *lac. lactis* spp *lactis* ATCC 53214 and *St. thermophilus* Texl 5842. **Fooks et al., 1999** reported
253 that the decrease in pH values may be due to short chain fatty acid which produced in varying quantities.
254 Polydextrose pH values were significantly lower than control and higher than the maltodextrin and inulin.
255 On contrary with (**Srisuvor et al., 2013**) concluded that polydextrose increased the acidity more than the
256 control where inulin results shown to be significantly lower than the control and Polydextrose same as pH.
257 For inulin it show a significant lower pH value than polydextrose and higher than maltodextrin where
258 different results were illustrated by (**Guven et al., 2005**) found that titratable acidity and pH values of set
259 type yogurt (low fat) added with (1-3%) inulin/100 ml milk were not significantly different ,possibly due to
260 no adverse change in activity of yoghurt culture . same results of inulin were highlighted by (**Raju and**
261 **Pal, 2011**) where they mentioned that the rate of pH decrease of fermented milk products was increased
262 by addition of inulin.

263
264 Also it was reported that 1% of inulin addition to yoghurt samples exhibited the lowest pH values
265 throughout the storage period (21 day) comparable to control (**Shah et al., 2000 and Akaline et al., 2004**
266 **and 2007**).

267
268 Different results were obtained by (**Baher et al., 2012**) where they showed that the pH values of
269 functional white soft cheese made with 3 probiotic strains in the presence of 3% polydextrose were
270 significantly lower than the control made without any prebiotic and had the highest titratable acidity
271 values at the end of storage period.

272
273 On the other hand the total acidity % of the full fat and skimmed fermented product showed a significant
274 increase in the presence of *B. longum* ATCC 15707 and selected polysaccharide specially maltodextrin ,
275 as shown in **Table (1) and Figure (2 a, b and c)**. The total acidity of polydextrose was significantly lower
276 than the maltodextrin but more than the control and there were no significant difference between inulin
277 and polydextrose, where composition of maltodextrin reveals that it contains a mixture of low molecular
278 weight polysaccharides, **oligosacchridoligosaccharide** and simple sugar previously reported by (**Xie, et al.,**
279 **2005**) these sugars might have been ready utilized by lactic acid bacteria and increased the acidity.
280 (**Oliveira et al., 2009**) illustrated that using polydextrose supplementation accelerated the acidification
281 and fermentation thus providing interesting prebiotics to improve the yoghurt, the results appears to
282 confirm the effect of polydextrose highlighted by (**Probert et al., 2004 and Jie et al., 2000**). Different
283 results were obtained by (**Oliveira et al., 2009**) where they mentioned that polydextrose led to lower the
284 pH and increase lactic acid release with respect to maltodextrin whose effect on the contrary where
285 almost negligible when compared to control.

286
287 Also, (**Raju and Pal, 2011**) observed that different bulking agents (polydextrose, maltodextrin and sorbitol
288) had a significant effect ($P < 0.01$) on the acidity of artificial sweetened Mistidahi ,there were a significant
289 ($P < 0.01$) increase with maltodextrin compared to control.

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291 **3.2 Measurement of syneresis percent for full-fat/skimmed fermented milk**
292 **made with different cultures combinations and polysacchrides after 7 days of storage at**
293 **5-7°C-**

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The results in **Table (2) and Figure (32)** revealed that the syneresis for control full fat fermented milk made by the 3 culture combinations were ranged between 13.37 to 15 % while it was ranged between 15-16% in the control skim milk fermented product. Adding 3% of maltodextrin to the milk fermented by the 3 culture combination decrease the syneresis % to be ranged between 9.25-9.75% in the full fermented milk and 10-11% for the skimmed fermented milk. In the case of polydextrose this value were ranged between 10.62-10.75 in the full fat products and about 11% in the skimmed fermented product respectively. The corresponding value when inulin added, a significant increase in ($\alpha = 0.01$) the syneresis % where 11.25-11.37% and 12.25-12.75 % respectively. It could be concluded that the polysaccharide tested could be arranged according to their effect on decreasing the syneresis as maltodextrin then polydextrose and finally inulin on which this difference is significant.

Maltodextrin treatments showed the significant lowest syneresis rate comparing to the other treatments specially the culture combination *B. longum* ATCC 15707 and *St. thermophilus* Texl 5842 that was significantly lower than the other 2 culture combinations under maltodextrin treatment where (**Nastaj and Gustaw, 2008**) stated that prebiotics added are water-structuring agents, hence act as a thickeners and can form complexes (H-bridge formation) with the protein aggregates in the yoghurt. Similar results were obtained by (**Raju and Pal, 2011**) were they stated that maltodextrin containing ASMD had significantly lower syneresis than the control. Also Syneresis value of polydextrose containing Misti dahi was significantly higher than maltodextrin containing Misti dahi.

Polydextrose treatments followed in the lower syneresis rate which was significantly higher than maltodextrin and significantly lower than the inulin at $\alpha = 0.01$. Similar results were obtained by (**Srisuvor et al., 2013**) were they stated that the polydextrose-added samples had lower values than those of the inulin-added ones. This might be due to different structures and chemical compositions of each prebiotic. Polydextrose (DP 12) comprises mainly glucose in its highly branched polymer and with small quantities of sorbitol and citric acid randomly distributed, whereas inulin (DP 23) comprises mainly fructose and possibly with small proportion of glucose in its polymer (**Roberfroid, 2006**). Thus, polydextrose, due to its shorter chain, might extend their branching structure more evenly into casein aggregates resulting in more extensive protein carbohydrate interactions. This would give the gel with better curd stability as reflected by lower syneresis. Increased syneresis might also be related to porosity of yoghurt (**Ünal et al., 2003**).

Inulin has significantly higher syneresis rate ~~significantly higher~~ than the maltodextrin and polydextrose but still significantly lower than the control may be due to the high dosage percent (3%) for the inulin addition that was explained by (**Bishay, 1998; Zimeri and Kokini, 2003**) were they stated that syneresis may increase with inulin concentration because inulin has a greater affinity for water than starch polysaccharides and as inulin has a lower molecular weight than the starch polymers, water bound to inulin is more mobile and more prone to syneresis.

Same outcome were shown by (Boeni and Pourahmad, 2012) on which they manufactured fermented milk with 2.5% inulin which gave high syneresis. Similar results was obtained by (Boeni and Pourahmad, 2012) were they reported that the highest syneresis value in fermented milk was for sample containing 2.5% inulin. NOT CLEAR The sample containing 1.5% inulin had the lowest syneresis, **It was also (Kip et al., 2006; Aryana and McCrew, 2007 and Brennan & Tudorica, 2008)** stated that inulin decreased the syneresis in low fat and fat free yoghurt (**Kip et al., 2006; Aryana and McCrew, 2007 and Brennan & Tudorica, 2008**). On the contrary (**Nastaj and Gustaw, 2008**) reported that addition of inulin and FOS to set yoghurt caused significant decrease in syneresis also different results were obtained by (**Waldemar et al., 2011**) were they stated that the 1% inulin addition caused decrease in set type yoghurt syneresis. The most significant decrease in syneresis was observed during refrigerated storage of yoghurt. Also different results obtained by (**Alvina and Art, 2011**) were the addition of inulin reduced the gelation time, and syneresis, with an effect of concentration and chain length. Long chain inulins significantly ($P < 0.05$) increased curd yield and decreased syneresis rate ($P < 0.05$) at 1% concentration and most effectively at 3% concentration.

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3.3 Effect of adding 3% of the selected polysaccharides on the viscosity of full fat and skimmed fermented milk products

As shown **table (3) and Figure (43)** it was illustrated that adding a 3% polysaccharide to either full fat and skimmed fermented milk has an significant effect at $\alpha=0.05$, on increasing the viscosity of the product. Maltodextrin addition revealed a higher viscosity in both full fat and skimmed fermented milk with values of 46526 and 30715 respectively. The high viscosity could be attributed to partial hydrolysis of starch from a variety of initiation and acceleration of maltodextrin gel formation. The outerlinear chains of amylopectin are thought to interact with amylose, thus reducing their self-association, and leading to the formation of a hydrated common network. While the nature of starch hydrolysis and the process used will influence the composition of maltodextrin, the concentration and temperature will affect the formation of gel in aqueous solutions (**Schierbaum et al., 1992**).

Also, **Loret et al., (2004)** observed that the dissolution temperature has a major influence on gelation behavior and reported that among the temperatures studied the gelation was much faster at (45°C). On the other hand, mechanism of the acid gels formed by the lactic acid fermentation of milk is well established and has been attributed to lowering of pH that reduces the repulsive forces and allows for hydrophobic interactions causing the casein micelles to coagulate (**Tamime and Robinson, 2007**). All ingredient were added, and subjected to 85°C for 30 min during pasteurization, with the rise in temperature, the gelation of maltodextrin might have occurred. Further, during incubation with starter cultures, pH of the mix decreased favoring formation of coagulum or gel. In the present study, the higher viscosity and lower syneresis of skimmed and full fat fermented dairy product containing maltodextrin could be attributed to entrapment of water in the gel due to the combined effect of gelation of maltodextrin and milk. On the other hand there were no significant differences between maltodextrin and polydextrose in viscosity results. Although maltodextrin showed a higher viscosity than polydextrose where polydextrose viscosity values in (cP) were as follows 45440 and 30118 for full fat and skimmed fermented milk, respectively.

Samples with inulin had significant lower viscosity values than maltodextrin and polydextrose counterparts and significantly higher than the control samples at $\alpha=0.05$, on which viscosity values were as follows 42500 and 28320 cP respectively. The lowest values were found in the control samples which lack of any polysaccharide, were values of viscosity were as follows 39362 and 27286 cP respectively. Same results were shown by (**Donkor et al., (2007)**) on which they found that the set-type yoghurts added with commercial inulin (0.5 and 1.5 g/100 g) had significantly higher apparent viscosities than the control. Also (**Raju and Pal, 2011**) showed that maltodextrin containing ASDM recorded the highest viscosity value (1.27 Pa s) in comparing to polydextrose, sorbitol and control samples of misti dahi. Also it was reported that viscosity of artificially sweetened frozen dessert increased when maltodextrin and sorbitol were used (**Verma, 2002**).

Also, (**Boeni and Pourahmad, (2012)**) demonstrated that the highest viscosity for yoghurt value was for sample containing 2% inulin. The sample containing 1.5% inulin had the lowest viscosity.

On contrary (**Aryana et al., (2007)**) evaluated the effect of three types of inulin with different chain lengths (short, medium and long) on fat-free yoghurt. Inulin chain length did not have any significant effect on viscosity. Also (**Donkor et al., 2007**) reported that addition of inulin and hi-maize to yoghurt increased viscosity in comparison to the control; however, supplementation with hi-maizes lightly decreased the viscosity of yoghurt during storage at 4°C, whereas inulin showed an increasing trend. Also (**Guggisberg et al., (2009)**) mentioned that beverages containing polydextrose at a high level and inulin at high and low levels were significantly more viscous than the control ($P < 0.05$). Increasing the concentration of prebiotics, especially inulin, has been shown to increase the viscosity and other mouth feel characteristics of products.

On contrary, (**Srisuvor et al., (2013)**) listed that addition of 3% polydextrose to a low fat set yoghurt results in lower apparent viscosity than the control samples. But they indicated that Polydextrose, at a

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suitably chosen level (2 g/100 mL) used in the storage trial, is a soluble polysaccharide capable of forming H-bonds with water. Thus, it could help reduce syneresis and, as being a thickener, it could also increase apparent viscosity of the yoghurt at the beginning of the storage period. However, if the storage time was extended from 14 to 21 days, these two parameters would be adversely affected. Also, (Aryana and McGrew, (2007) also found similar results regarding syneresis of the fat free plain yoghurts added with inulins of various chain lengths and revealed that the apparent viscosity decreased with time.

3.4 Effect of adding polysaccharides on the growth rate of *B. longum*, *Lac. lactis* spp *lactis* and *St. thermophilus* in the fermented products during cold storage

Table (42) and figure (5) illustrate that the viable cells of *B. longum* ATCC 15707 decreased as the storage period at 5-7°C increase either in full fat fermented milk or skimmed fermented milk free of polysaccharides where the mean log₁₀ cfu/g for fresh fermented milk was 7.6, 8.03 and 7.2, 6.7 after 7 days of storage. Same findings were obtained by (Akalin et al., (2007) and Paseephol and Sherkat, (2009) who stated that the lactobacillus and bifidobacteria growth declined in their viability during storage. Also (Dave and Shah, 1997; Bolin et al., 1998 and VinDerola et al., 2000) observed that the initial counts of bifidobacteria ranged from 10⁶ to 10⁷ cfu/ml, while final counts were lower than 10⁴ cfu/ml.

From Table (4) we can find out that maltodextrin was dominating all the other polysaccharides on which it exhibited the highest bacterial growth within the bacterial combinations *B. longum* ATCC 15707 + *Lac. lactis* spp *lactis* ATCC 53214, *B. Longum* ATCC 15707 + *St. thermophilus* Textl 5842, Where it's log₁₀ cfu/g for *B. longum* ATCC 15707 + *lac. lactis* spp *lactis* ATCC 53214 were as follows 9.66, 9.72, 8.09 and 7.68 for full fat fermented milk manufactured in the following durations fresh, 2 days, 4 days and 7 days respectively, and 8.82, 9.19, 8.32 and 7.73 for skimmed fermented milk manufactured in the following durations fresh, 2 days, 4 days and 7 days respectively. And for *B. longum* ATCC 15707 + *St. thermophilus* Textl 5842, 8.94, 9.45, 8.54 and 7.59 respectively for full fat fermented milk manufactured in the following durations fresh, 2 days, 4 days and 7 days, and for the skimmed ones were 9.05, 9.35, 8.94 and 6.30 in the following durations fresh, 2 days, 4 days and 7 days respectively, following the polydextrose where its count was significantly lower than the maltodextrin and significantly higher than the culture combination *B. longum* ATCC 15707 + *lac. lactis* spp *lactis* ATCC 53214 under inulin treatment where α=0.01 level of significance and showed no significant difference to culture combination *B. Longum* ATCC 15707 + *St. thermophilus* Textl 5842 lying under inulin treatment. The log₁₀ cfu/g for the cultures combinations under the polydextrose the *B. longum* ATCC 15707 + *lac. lactis* spp *lactis* ATCC 53214 and *B. longum* ATCC 15707 + *St. thermophilus* Textl 5842 in full fermented milk 8.77, 8.38, 8.30 and 7.75, for the former type and 8.51, 8.47, 7.94 and 7.45 for the latter type in the following durations fresh, 2, 4 and 7 days respectively. Same case was noticed concerning to skimmed fermented milk. For inulin counterparts log₁₀ cfu/g for culture combination *B. longum* ATCC 15707 + *lac. lactis* spp *lactis* ATCC 53214 and *B. longum* ATCC 15707 + *St. thermophilus* Textl 5842 in full fermented milk 9.27, 9.30, 7.70 and 7.12 for the former type and 8.74, 9.05, 8.45 and 7.45 for the latter type in the following durations fresh, 2, 4 and 7 days respectively, same trend was noticed in the skimmed fermented milk.

The polysaccharides tested can be arranged in descending according of their assimilation and activation of *B. longum* ATCC 15707 as maltodextrin then polydextrose and inulin on the bifidobacteria selective media (maltose MRS medium).

The culture combination *St. thermophilus* Textl 5842 + *lac. lactis* spp *lactis* ATCC 53214 under the 3 polysaccharides maltodextrin, polydextrose and inulin were shown to exhibit a low bacterial count, were significantly lower than the control culture's combinations *B. longum* ATCC 15707 + *lac. lactis* spp *lactis* ATCC 53214 and *B. longum* ATCC 15707 + *St. thermophilus* Textl 5842.

Polydextrose gave lower levels of growth when compared to maltodextrin. As polydextrose is a randomly-bonded polymer of glucose, where nonlinear structure is more difficult to break down than the linear structure of most prebiotic oligosaccharides that was previously explained by Peuranen et al., 2004 and Probert et al., 2004.

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Similar findings showed that higher concentration levels proved to have a beneficial effect on *B. longum* growth in 10% reconstituted milk (Akalin et al., 2004). Srisuvor et al., 2013 also stated that the number of *L. paracasei* were always higher the 8.0 log CFU/ l, by using polydextrose and inulin as a prebiotic source. (Aryana and Grew, (2007) reported that *L. casei* with the use of prebiotics short DP=5 medium DP= 10 and long DP = 23 of inulin were significantly ($P \leq 0.05$) higher than the control.

Also data agreed with (Lankaputhra et al., 1996 and Oliveira et al., 2009) who reported that polydextrose were shown to significantly accelerate either the acidification or the fermentation, thus proving interesting prebiotics to improve the production of yoghurts thus these results appear to confirm the prebiotic effect of polydextrose lighted by (Jie et al., 2000 and Probert et al., 2004).

For inulin similar findings were observed by (Olivera et al., 2009) where they reported that the acidification rate of probiotic cultures increased with inulin concentration increase and reduced fermentation time of *St. thermophilus* and *L. rhamnosus*, greater acidification was observed when inulin was added. Also (Salem et al., 2007) reported that addition of inulin showed a better growth and survival ($p < 0.05$) than control and they promoted the growth of *bifidobacterium* and *lactobacillus* but not for harmful bacteria as *Escherichia coli* and bacterioids. (Carderelli et al., 2007, 2008b and Modzelewska-kapitula et al., 2007) reported that the inulin with DP=23 promoted the growth of *L. plantarum* without promoting the growth of pathogenic bacteria salmonella and *Staphylococcus aureus*, coliform, yeast and molds in white cheese. Same findings by (Roberfroid et al., 1998 and Shin et al., 2000) they stated that inulin was the least effective in stimulating the growth of bifidobacteria among the used carbohydrate sources Also, (Ozer et al., 2005) stated that inulin do not stimulate the growth of acidophilus in acidophilus *B. longum*-yoghurts. Also Different results was shown by (Biedrzycka and Bielecka, 2004) whom highlighted that the lack of bifidobacteria growth was stimulated by feeding rats with diet containing inulin (DP=23). (Monika et al., 2010) stated that the application of synbiotic cheese failed to exert a significant effect on the gastrointestinal microflora of rats, the statistical insignificant changes observed might be due to the nature of inulin used in the study with a concentration of 2.5%.

Similar results obtained by (Boeni and Pourahmad, 2012) where they showed that using 2% of inulin in synbiotic yoghurt contain *L. acidophilus* and *L. casei*, increased the viability of probiotic bacteria. Also, (Donkor et al., 2007) sited that supplementation of set type yoghurt with prebiotic improved the retention and the viability of *L. acidophilus* and *L. paracasei* in yoghurt especially in presence of inulin.

Also similar results shown by (Waldemar et al., 2011) where they listed that inulin addition to yoghurt cause an increase in the number of all bacteria than the control, where *B. longum* growth reached to 7.5 Log cfu/g. Also (Allgeyer et al., 2010) stated that the polydextrose were an acceptable vehicle to deliver a probiotic culture in yoghurt drink.

Different findings were reported by (Olivera et al., 2009) on which they reported that Polydextrose behaved as the best prebiotic ensuring the highest counts in comparing it with maltodextrin counts, that was a little higher than the control.

On contrary results for inulin where (Sarker, 2010) listed that (inulin at a concentration of 1-5%) did not exhibited any significant influence on the survival *L. acidophilus*. Also (Ghoddusi et al., 2007) claimed that Polydextrose hardly showed selective growth towards *Bifidobacterium* and *lactobacillus* when used alone or in combination with other polysaccharides.

3.5 Sensory evaluation of full fat fermented milk manufactured with different culture combinations and polysaccharides

Table (5) and Figure (64) results showed that the addition of polydextrose gave the highest texture and body as well as appearance and color results, on which polydextrose added treatments where significantly higher than the control, but there were no significant difference between polydextrose, maltodextrin and inulin. on which the texture and body as well as the appearance score for the fermented milk made with cultures combination lying under the polydextrose treatment *St. thermophilus* Text 5842 + *B. longum* ATCC 15707, *B. longum* ATCC 15707 + *lac. lactis* spp *lactis* ATCC 53214, and *lac. lactis* spp

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lactis ATCC 53214 + *St. thermophilus* Texl 5842 were 8.6 and 4, 8.4 and 3.6 and finally 8.4 and 3.6 respectively. On the other hand texture and body scores for maltodextrin and inulin treatments revealed an insignificant differences between both of them and also with the control, however their texture scores were higher than the control ones. Where the scores for full fat fermented milk made with maltodextrin and culture combination *B. longum* ATCC 15707 + *lac. lactis. spp lactis* ATCC 53214, *B. longum* ATCC 15707 + *St. thermophilus* Texl 5842 and *St. thermophilus* Texl 5842 + *lac. lactis. spp lactis* ATCC 53214 were 7.4, 7.2 and 7.4 respectively, while inulin treatments were 7.6, 7.4 and 7.2 respectively. Regarding to appearance and color scores there were no significant difference within the results of the 3 added polysaccharides as mentioned previously but the 3 of them were significantly higher than control $\alpha = 0.01$. The maltodextrin treatments for *B. longum* ATCC 15707 + *lac. lactis. spp lactis* ATCC 53214, *B. longum* ATCC 15707 + *St. thermophilus* Texl 5842 and *St. thermophilus* Texl 5842 + *lac. lactis. spp lactis* ATCC 53214 values were 3.4 for all of them, while in case of inulin treatments the values were 3.4 for the 3 treatments examined. Control treatments values were 6.8, 6.4 and 6.6 for texture and for appearance 2.4, 2.4 and 2.4 respectively. The flavor scores showed insignificant differences within all treatments. On contrary to our results many studies have mentioned the effect of inulin in modifying the sensory attributes for dairy products (Guggisberg et al., 2009), where they illustrated that inulin have the ability to be a fat substitute, bulking agent, low-calorie sweetener and texture modifier when added to yoghurt, therefore potentially altering the sensory perception of the product. Also (Seydin et al. 2005), found that yoghurt containing inulin had a good flavor and a smooth texture. (Boeni and Pourahmad, 2012) mentioned that inulin with DP 25 showed a good and significant texture scores than the control as well as the flavor. Also, (Dello Staffolo et al., 2004) studied effect of inulin as a dietary fiber, positive sensory, sensory and textural attributed were found in cow's milk full-fat dairy dessert fortified, with 1.1% inulin. (Guven et al., 2005), reported that the addition of high molecular-weight inulins (DP $\geq$ 23) at 1, 2 and 3% negatively affect the quality of set-type low-fat yoghurt. More than 1% inulin negatively affected tyrosine and volatile fatty acid levels, appearance, color, taste, consistency and aroma of the yoghurt. Inulin have been used to improve the texture attributes in ice cream samples mentioned by (Akalin and Erisir 2008; Karaca et al., 2009).

Inulin when tested its compatibility with probiotic bacterial growth, the addition of probiotic bacteria and inulin did not change taste or texture of the cottage cheese after 15 days of storage at 5°C in comparison with the control non-probiotic cheese (Araujo et al., 2010). For flavor scores there were different results listed by Ting-ning, (2012) where he mentioned that synbiotic ice-cream made with inulin had a stronger sour after taste than control. Polydextrose results coincide with those obtained by Buriti et al., (2005) and Baher et al., (2012), whom illustrated that sensory evaluation of functional white soft cheese behaved the same trend in all cheese treatments, as gradual enhancement was noticed during the first 20 days of the refrigeration period. Also it was reported that polydextrose provided excellent bulking ability in terms of texture in sweetened frozen dessert (Specter and Setser, 1994).

On contrary (Raju and Pal, 2011) showed that maltodextrin improved the body and texture score ($p < 0.05$) of ASDM compared with other bulking agents batches. Maltodextrins are frequently complex mixtures of molecular species ranging from glucose to long polymeric (linear and branched) chains (Roller, 1996). Saccharides, oligosaccharides and polysaccharides form complexes with proteins and lipids which are known to contribute to the texture of food stuffs, the increased body and texture scores of maltodextrin containing ASDM could be due to the water binding capacity of low molecular weight polymers (dextrans) present in maltodextrin (Tomasik, 2007).

3.6 Sensory evaluation of skimmed fermented milk manufactured with different culture combinations and polysaccharides after 7 days of cold storage

As shown in Table (6) and Figure (75), the sensory evaluation for the control samples of skimmed fermented milk revealed lower score for texture when compared to full fat fermented milk and that was ranged between 4, 4.5 and 6.4, 6.8 respectively. Maltodextrin treatments (3%) in the skimmed fermented milk was significantly higher than the inulin and control treatments in texture and body, where the score of cultures combination lying beneath maltodextrin were 7, 6.4 and 6.4 respectively for *B. longum* ATCC 15707 + *lac. lactis. spp lactis* ATCC 53214, *B. longum* ATCC 15707 + *St. thermophilus* Texl 5842 and *St. thermophilus* Texl 5842 + *lac. lactis. spp lactis* ATCC 53214. These results were nearly as the control

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results for the full fat fermented milk, whereas there is no significant difference between it and the culture combination lying beneath the polydextrose treatment which had the following values 6.4, 6.4 and 6.5 for *B. longum* ATCC 15707 + *lac. lactis. spp lactis* ATCC 53214, *B. longum* ATCC 15707 + *St. thermophilus* Texl 5842 and *St. thermophilus* Texl 5842 + *lac. lactis. spp lactis* ATCC 53214, respectively. Corresponding texture values for inulin treatment were 5.4 for *B. longum* ATCC 15707 + *lac. lactis. spp lactis* ATCC 53214, *B. longum* ATCC 15707 + *St. thermophilus* Texl 5842 and *St. thermophilus* Texl 5842 + *lac. lactis. spp lactis* ATCC 53214 on which its results significantly higher than the control.

Appearance results for polydextrose and maltodextrin show an insignificant differences between them which was 3.6 point out of 5 points these scores were higher than the control of the full fat fermented milk and contributed the highest scores within all the treatments, while the control showed the least score in appearance comparing with Inulin that was significantly higher than the control on which the 3 scores for inulin were 3.2 for *B. longum* ATCC 15707 + *lac. lactis. spp lactis* ATCC 53214, *B. longum* ATCC 15707 + *St. thermophilus* Texl 5842 and *St. thermophilus* Texl 5842 + *lac. lactis. spp lactis* ATCC 53214, respectively, for control the results were as follows 2.8, 2.8 and 2.6 for *B. longum* ATCC 15707 + *St. thermophilus* Texl 5842, *St. thermophilus* Texl 5842 + *lac. lactis. spp lactis* ATCC 53214 and *B. longum* ATCC 15707 + *lac. lactis. spp lactis* ATCC 53214, respectively.

Flavor scores was similar to the full fat fermented milk there were no significant difference between all the treatments

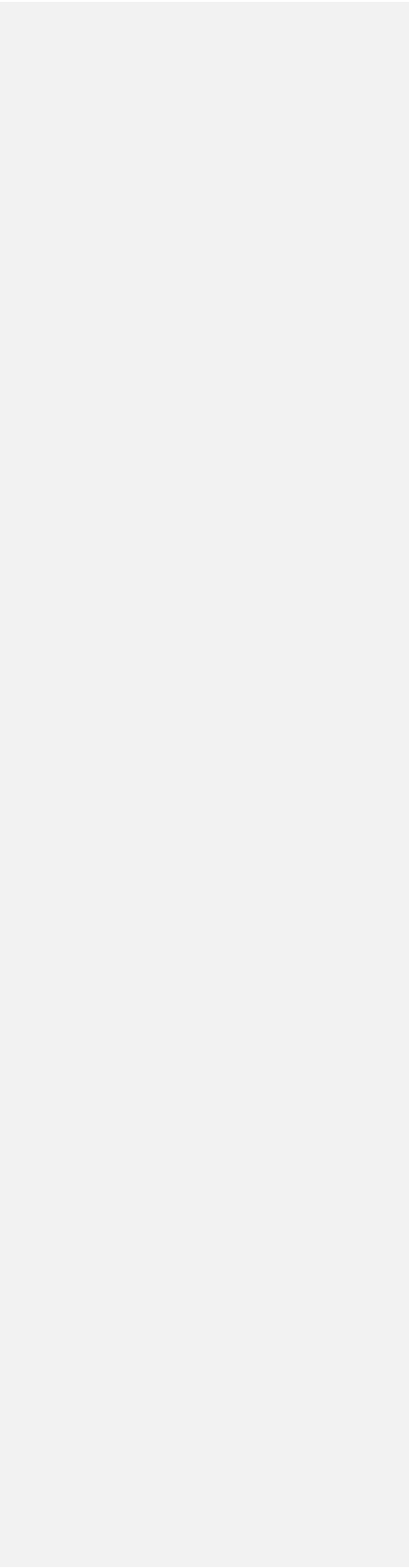
Our results agreed with **Ribeiro et al., (2003)** were they stated that polydextrose is a bulking agent used to provide body and texture in reduced-caloric foods also it was studied as a fat replacer in dairy products (**Prindiville et al., 2000**). Moreover **Hyvönen et al., (2003)** reported that polydextrose and maltodextrin working as bodying agents in the fat-free ice creams significantly increase flavor release, fattiness, creaminess, and melting rate of the ice cream. **Adapa et al., (2000)** mentioned that polydextrose has a relatively high viscosity in solution so that it can contribute to the mouth feel and creaminess of fat-reduced formulations. (**Koca and Metin, 2004, Hennelly et al., 2006 and Tarrega and Costell, 2006**) stated that long chain inulin would be more ideal as fat mimetic in low fat dairy products such as dairy desserts and fresh chesses. Furthermore (**Araujo et al., 2010**) stated that inulin when tested its compatibility with probiotic bacterial growth, the addition of probiotic bacteria and inulin did not change taste or texture of the cottage cheese after 15 days of storage at 5°C in comparison with the control non-probiotic cheese. (**Ranjeeta, 2011**) stated that low-fat cheddar cheese enriched with 5% inulin had improved textural properties. Moreover, adding fibers did not impact cheese flavor. On contrary (**Guven et al., 2005**) reported that the addition of high molecular-weight inulins (DP ≥ 23) at 1, 2 and 3% negatively affect the quality of set-type low-fat yoghurt. Also, more than 1% inulin negatively affected tyrosine and volatile fatty acid levels, appearance, color, taste, consistency and aroma of the yoghurt. (**Alvina and Art, 2011**) stated that a complete replacement of milk fat 4% inulin in both refrigerated and frozen mousse provided similar textural properties as the control, which is consistent with the findings of (**Guven et al., 2005**) in low-fat inulin fortified yoghurts.

Moreover (**Alvina and Art, 2011**) stated that the addition of inulin regardless of chain length provided positive sensory qualities: flavor, color consistency, appearance, texture and taste in synbiotic cheeses. Soft white cheese containing 2.5% (w/w) inulin (DP ≥ 23) received the highest texture score. Also (**Modzelewska-Kapitula et al., 2007**) worked on Low fat labneh cheese fortified with 1% short chain inulin and probiotic *L. reuteri* was the most preferred when consumed fresh and after a 10-day storage as it provided the most desirable flavor and a smoother consistency than other samples.

Furthermore (**Raju and Pal, 2011**) stated that the increased body and texture scores of maltodextrin containing misti dahi could be due to the water binding capacity of low molecular weight polymers (dextrins) present in maltodextrin.

Also, **Srisuvor et al., (2013)** stated that the addition of inulin or polydextrose significantly (p 0.05) affected positively appearance, color, texture and overall preference, but no such effect was found for odor or flavor. Also, polydextrose seemed to yield the product with better sensory properties, especially when added at higher levels (2- 3 g/100 mL).

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630 Table (1): Changes in pH and total acidity of full fat and skimmed fermented milk made with different cultures combinations
631 and the selected ~~polysaccharides~~ ~~mean~~ ~~polysaccharides mean~~ ~~±?? Standard error?~~
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Treatments			pH value		Titrate acidity					
			Full fat fermented milk	Skimmed fermented milk	Mean		Full fat fermented milk	Skimmed fermented milk	Mean	
					Treat ment	Times			Treatment	Times
B. Longum ATCC 15707 + St. thermophilus Texl 5842	Control	Fresh	4.68 ± 0.014	4.70 ± 0.00701	4.53 ^a	4.65 ^a	1.00 ± 0.070	1.01 ± 0.070	1.10 ^c	1.005 ^d
		2 days	4.60 ± 0.000	4.66 ± 0.00701		4.63 ^b	1.10 ± 0.003	1.05 ± 0.070		1.07 ^c
		4 days	4.46 ± 0.00701	4.48 ± 0.00701		4.47 ^c	1.10 ± 0.003	1.10 ± 0.003		1.10 ^b
		7 days	4.32 ± 0.00701	4.37 ± 0.00701		4.34 ^d	1.25 ± 0.070	1.20 ± 0.070		1.22 ^a
	Maltodextrin	Fresh	4.29 ± 0.00701	4.32 ± 0.00701	4.25 ^d	4.30 ^a	1.17 ± 0.000	1.16 ± 0.000	1.26 ^a	1.16 ^d
		2 days	4.25 ± 0.00701	4.27 ± 0.000		4.26 ^b	1.25 ± 0.141	1.25 ± 0.141		1.25 ^c
		4 days	4.23 ± 0.00701	4.24 ± 0.00701		4.23 ^c	1.32 ± 0.000	1.33 ± 0.000		1.31 ^b
		7 days	4.20 ± 0.021	4.22 ± 0.00701		4.21 ^d	1.30 ± 0.000	1.31 ± 0.000		1.30 ^a
	Polydextrose	Fresh	4.52 ± 0.014	4.45 ± 0.21	4.36 ^b	4.48 ^a	1.10 ± 0.003	1.10 ± 0.003	1.19 ^b	1.10 ^d
		2 days	4.48 ± 0.00701	4.42 ± 0.21		4.45 ^b	1.20 ± 0.070	1.19 ± 0.070		1.19 ^c
		4 days	4.29 ± 0.021	4.30 ± 0.00701		4.29 ^c	1.22 ± 0.070	1.22 ± 0.070		1.22 ^b
		7 days	4.20 ± 0.035	4.32 ± 0.014		4.26 ^d	1.27 ± 0.05606	1.26 ± 0.05606		1.26 ^a
	Inulin	Fresh	4.31 ± 0.00701	4.33 ± 0.014	4.28 ^c	4.32 ^a	1.15 ± 0.000	1.16 ± 0.000	1.20 ^b	1.15 ^d
		2 days	4.29 ± 0.00701	4.30 ± 0.00701		4.29 ^b	1.22 ± 0.141	1.22 ± 0.141		1.22 ^c
		4 days	4.26 ± 0.00701	4.28 ± 0.00701		4.27 ^c	1.26 ± 0.141	1.27 ± 0.141		1.26 ^b
		7 days	4.22 ± 0.035	4.26 ± 0.02803		4.24 ^d	1.30 ± 0.00	1.31 ± 0.00		1.30 ^a
Control	Fresh	4.71 ± 0.00701	4.77 ± 0.00701	4.59 ^a	4.70 ^a	0.90 ± 0.070	1.00 ± 0.070	1.12 ^e	0.95 ^d	
	2 days	4.68 ± 0.014	4.74 ± 0.00701		4.71 ^b	1.03 ± 0.070	1.03 ± 0.070		1.03 ^c	
	4 days	4.50 ± 0.00701	4.55 ± 0.00701		4.52 ^c	1.18 ± 0.141	1.19 ± 0.141		1.18 ^b	
	7 days	4.35 ± 0.014	4.42 ± 0.00701		4.38 ^d	1.32 ± 0.070	1.30 ± 0.070		1.31 ^a	
Maltodextrin	Fresh	4.30 ± 0.00701	4.33 ± 0.014	4.27 ^d	4.31 ^a	1.03 ± 0.070	1.04 ± 0.070	1.17 ^d	1.03 ^d	
	2 days	4.27 ± 0.00701	4.31 ± 0.00701		4.29 ^b	1.06 ± 0.070	1.05 ± 0.070		1.05 ^c	
	4 days	4.26 ± 0.00701	4.29 ± 0.00701		4.27 ^c	1.20 ± 0.070	1.23 ± 0.070		1.21 ^b	

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	Polydextrose	7 days	4.22 ± 0.00701	4.25 ± 0.00701		4.23 ^a	1.38 ± 0.003	1.37 ± 0.003		1.37 ^a
		Fresh	4.52 ± 0.024	4.55 ± 0.024	4.38 ^b	4.53 ^a	0.97 ± 0.000	0.98 ± 0.000	1.14 ^{de}	0.97 ^a
		2 days	4.48 ± 0.24	4.53 ± 0.024		4.50 ^b	1.04 ± 0.000	1.05 ± 0.000		1.04 ^c
		4 days	4.29 ± 0.00701	4.30 ± 0.00701		4.29 ^c	1.22 ± 0.070	1.23 ± 0.070		1.22 ^b
	Inulin	7 days	4.20 ± 0.035	4.22 ± 0.00701		4.21 ^a	1.35 ± 0.003	1.35 ± 0.003		1.35 ^a
		Fresh	4.34 ± 0.014	4.35 ± 0.014	4.30 ^c	4.34 ^a	0.99 ± 0.000	0.98 ± 0.000	1.14 ^{de}	0.98 ^a
		2 days	4.30 ± 0.00701	4.33 ± 0.014		4.31 ^b	1.05 ± 0.000	1.02 ± 0.000		1.03 ^c
		4 days	4.27 ± 0.02003	4.30 ± 0.00701		4.28 ^c	1.20 ± 0.000	1.22 ± 0.070		1.21 ^b
		7 days	4.23 ± 0.00701	4.24 ± 0.00701		4.23 ^a	1.36 ± 0.003	1.35 ± 0.003		1.35 ^a

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Table (2): Determination of syneresis percent for full fat and skimmed fermented milk made with different cultures combinations and polysacchrides after 7 days of storage at 5-7 °C

Treatment	Syneresis %		Mean
	Full fat fermented	Skimmed	

		milk	fermented milk	
<i>B. longum</i> ATCC 15707 + <i>Str. thermophilus</i> Tex1 5842	Control	13.37	16.00	14.68 ^{bc}
	Maltodextrin	9.25	10.00	9.62 ^b
	Polydextrose	10.75	11.00	10.87 ^e
	Inulin	11.25	12.75	12 ^a
<i>St. thermophilus</i> Tex1 5842+ <i>Lac. lactis</i> spp <i>lactis</i> ATCC 53214	Control	15.00	16.00	15.50 ^a
	Maltodextrin	9.25	11.00	10.12 ^f
	Polydextrose	10.62	11.00	10.81 ^e
	Inulin	11.37	12.62	11.99 ^d
<i>B. longum</i> ATCC 15707+ <i>Lac. lactis</i> spp <i>lactis</i> ATCC 53214	Control	14.50	15.00	14.75 ^b
	Maltodextrin	9.75	10.25	10.0 ^f
	Polydextrose	10.75	11.00	10.87 ^e
	Inulin	11.25	12.25	11.75 ^d
Mean		11.42 ^b	12.40 ^a	

Means followed by the same upper case letter(s) are not significant, but different letters are significant according to LSD procedure where $\alpha = 0.01$, the LSD treatment * type = 1.1284 levels of producer, L.S.D or treatments = 0.26, L.S.D for type = 0.03 levels of procedure

Table (3) Effect of adding 3% of the selected polysaccharides on the viscosity of full fat and skimmed fermented milk products

Treatments in fermented milk	Viscosity in (cP)
Control full fat	39362G

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Maltodextrin full fat	46526 A
Polydextrose full fat	45440 A
Inulin full fat	42500 B
Control skimmed	27286 F
Maltodextrin skimmed	30715 D
Polydextrose skimmed	30118 D
Inulin skimmed	28375 E

Means followed by the same upper case letter(s) are not significant, but different letters are significant according to LSD procedure where $\alpha = 0.05$. The LSD for viscosity = 1087.

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Table (42): Changes in (Log₁₀cfu/g) of fresh full fat and skimmed fermented milk during storage at 5-7°C for 7 days made with bifidobacteria and strains of lactic acid cultures and 3% of selected polysaccharides on bifidobacteria selective media

Culture	Log ₁₀ cfu/g ~~g~~ viable cell count	Mean
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			Full fat fermented milk	Skimmed fermented milk		
<i>B. longum</i> ATCC 15707 + <i>St. thermophilus</i> Text 5842	Control	Fresh	7.42	7.88	7.65 ^a	7.44 ^d
		2 days	7.17	7.49	7.33 ^c	
		4 days	7.61	7.47	7.54 ^b	
		7 days	7.31	7.18	7.24 ^a	
	Maltodextrin	Fresh	8.94	9.05	8.99 ^a	8.53 ^{ab}
		2 days	9.45	9.35	9.40 ^b	
		4 days	8.54	8.94	8.69 ^c	
		7 days	7.59	6.30	6.94 ^a	
	Polydextrose	Fresh	8.51	9.08	8.79 ^b	8.47 ^b
		2 days	8.47	9.37	8.92 ^a	
		4 days	7.95	8.91	8.43 ^c	
		7 days	7.45	8.08	7.76 ^a	
	Inulin	Fresh	8.74	8.75	8.74 ^b	8.43 ^b
		2 days	9.05	8.54	8.79 ^a	
		4 days	8.45	7.87	8.16 ^c	
		7 days	7.45	8.00	7.72 ^a	
<i>St. thermophilus</i> Text 5842+ <i>Lac. lactis</i> spp <i>lactis</i> ATCC 53214	Control	Fresh	5.46	4.00	4.73 ^a	3.20 ^f
		2 days	3.19	3.64	3.41 ^b	
		4 days	2.41	2.96	2.68 ^c	
		7 days	2.14	2.55	2.34 ^a	
	Maltodextrin	Fresh	4.76	4.10	4.43 ^a	3.53 ^f
		2 days	2.90	3.99	3.44 ^b	
		4 days	3.17	3.03	3.10 ^c	
		7 days	3.51	2.80	3.15 ^a	
	Polydextrose	Fresh	4.35	4.46	4.40 ^a	3.40 ^f
		2 days	3.48	3.75	3.61 ^b	
		4 days	2.67	3.19	2.93 ^c	
		7 days	2.37	2.99	2.68 ^a	
	Inulin	Fresh	6.39	3.77	5.08 ^a	3.48 ^f
		2 days	3.49	3.44	3.46 ^b	
		4 days	2.82	3.10	2.96 ^c	
		7 days	2.38	2.49	2.43 ^a	
<i>B. longum</i> ATCC 15707+ <i>Lac. lactis</i> spp <i>lactis</i> ATCC 53214	Control	Fresh	8.18	7.89	8.03 ^a	7.20 ^d
		2 days	6.85	7.35	7.1 ^b	
		4 days	6.86	6.96	6.91 ^c	
		7 days	6.70	6.75	6.72 ^a	
	Maltodextrin	Fresh	9.66	8.82	9.24 ^b	8.60 ^a
		2 days	9.72	9.19	9.45 ^a	
		4 days	8.09	8.32	8.20 ^c	

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	Polydextrose	7 days	7.68	7.73	7.70 ^a	8.43 ^b
		Fresh	8.77	9.38	9.07 ^a	
		2 days	8.38	8.94	8.66 ^b	
		4 days	8.30	8.98	8.64 ^c	
		7 days	7.75	7.76	7.75 ^a	
	Inulin	Fresh	9.27	8.53	8.90 ^a	8.17 ^c
		2 days	9.30	8.01	8.65 ^b	
		4 days	7.70	8.34	8.02 ^c	
		7 days	7.12	7.09	7.10 ^a	
	Mean		6.67 ^a	6.62 ^a		

Means followed by the same upper case letter(s) are not significant, but different letters are significant according to LSD procedure where $\alpha = 0.01$, the LSD for treatment = 0.116 and the LSD for duration = 0.018 levels of producer the interaction between type *duration * treatment is NS, the LSD for type *duration is N.S.

~~Table (5): Sensory evaluation of full fat fermented milk manufactured with different culture combinations and polysaccharides after 7 days of cold storage~~

Treatments	Mean square value for sensory evaluation
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		Texture and body (10 points)	Appearance and color (5 points)	Flavor (5 points)
<i>B. longum</i> ATCC 15707 + <i>St. thermophilus</i> Text15842	Control	6.40 ^c ±0.002	2.40 ^d ±0.003	2.60 ^a ±0.005
	Maltodextrin	7.20 ^{abc} ±0.002	3.40 ^{abc} ±0.000	2.60 ^a ±0.005
	Polydextrose	8.60 ^a ±0.000	4.00 ^a ±0.002	3.00 ^a ±0.007
	Inulin	7.40 ^{abc} ±0.003	3.40 ^{abc} ±0.000	3.00 ^a ±0.007
<i>St. thermophilus</i> Text15842+ <i>lac. lactis. spp lactis</i> ATCC 53214	Control	6.60 ^c ±0.006	2.40 ^d ±0.000	3.20 ^a ±0.004
	Maltodextrin	7.40 ^{abc} ±0.003	3.40 ^{abc} ±0.004	2.40 ^a ±0.000
	Polydextrose	8.40 ^a ±0.010	3.60 ^{ab} ±0.007	3.00 ^a ±0.007
	Inulin	7.20 ^{abc} ±0.003	3.40 ^{abc} ±0.006	2.60 ^a ±0.005
<i>B. longum</i> ATCC 15707+ <i>lac. lactis. spp lactis</i> ATCC 53214	Control	6.80 ^c ±0.010	2.40 ^d ±0.000	3.00 ^a ±0.007
	Maltodextrin	7.40 ^{abc} ±0.000	3.40 ^{abc} ±0.004	3.20 ^a ±0.004
	Polydextrose	8.40 ^a ±0.004	3.60 ^{ab} ±0.007	2.80 ^a ±0.005
	Inulin	7.60 ^{abc} ±0.001	3.40 ^{abc} ±0.004	3.00 ^a ±0.007
Mean-		6.83	3.2	2.86 ^a ±0.007
LSD		1.506	0.923	-

Means (± standard deviation) followed by the same upper case letter(s) are not significant, but different letters are significant according to LSD procedure where $\alpha = 0.01$, levels of producer the ignored L.S.D. indicates that **flavor** was not significant at the non-significant values

Table (6): Sensory evaluation of skimmed fermented milk manufactured with different culture combinations and polysaccharides after 7 days of cold storage

Treatments		Mean square value for sensory evaluation		
		Texture and body 10 points	Appearance and color 5 points	Flavor 5 points
<i>B. longum</i> ATCC 15707 + <i>St. thermophilus</i> Text 5842	Control	4.20 ^d	2.80 ^e	2.40 ^{ab}
	Maltodextrin	7.00 ^a	3.60 ^a	2.60 ^{ab}
	Polydextrose	6.40 ^{ab}	3.60 ^a	2.60 ^{ab}
	Inulin	5.40 ^c	3.20 ^b	2.60 ^{ab}
<i>St. thermophilus</i> Text 5842 + <i>lac. lactis. spp lactis</i> ATCC 53214	Control	4.00 ^d	2.80 ^e	2.60 ^{ab}
	Maltodextrin	6.40 ^{ab}	3.60 ^a	2.60 ^{ab}
	Polydextrose	6.50 ^{ab}	3.60 ^a	2.60 ^{ab}
	Inulin	5.40 ^c	3.20 ^b	2.40 ^{ab}
<i>B. longum</i> ATCC 15707 + <i>lac. lactis. spp lactis</i> ATCC 53214	Control	4.50 ^d	2.60 ^{cd}	2.40 ^{ab}
	Maltodextrin	7.00 ^a	3.60 ^a	2.40 ^{ab}
	Polydextrose	6.40 ^{ab}	3.60 ^a	2.40 ^{ab}
	Inulin	5.40 ^c	3.20 ^b	2.60 ^{ab}
Mean		5.71	3.30	2.50
LSD		0.811	0.32	-

Means followed by the same upper case letter(s) are not significant, but different letters are significant according to LSD procedure where $\alpha = 0.01$, levels of producer. The ignored L.S.D. indicates that **flavor** was not significant at the non-significant values

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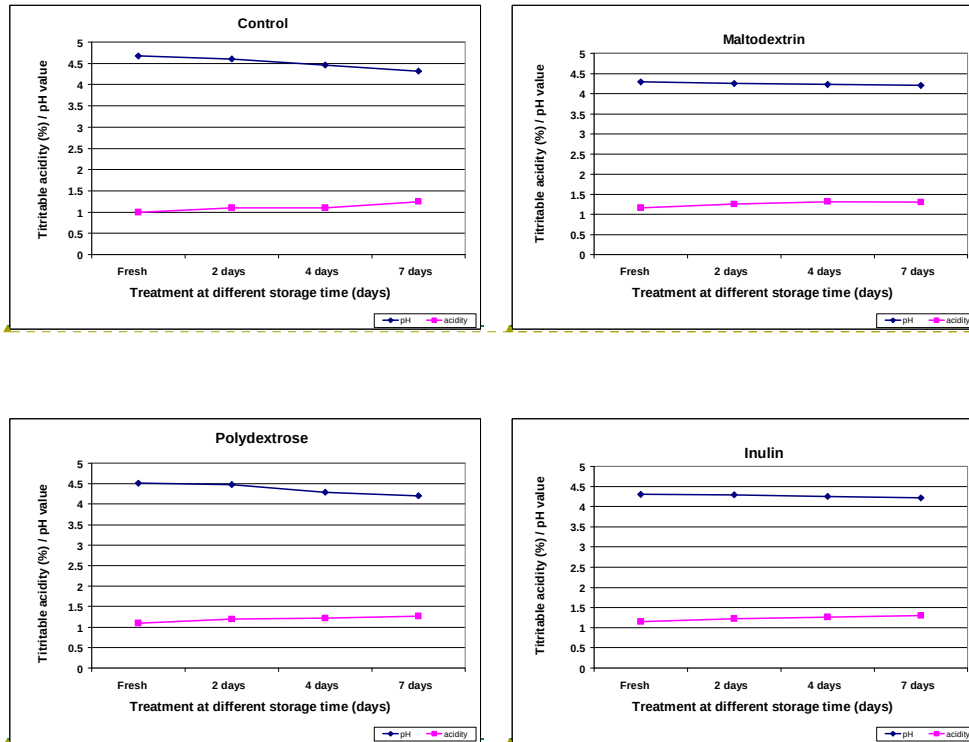
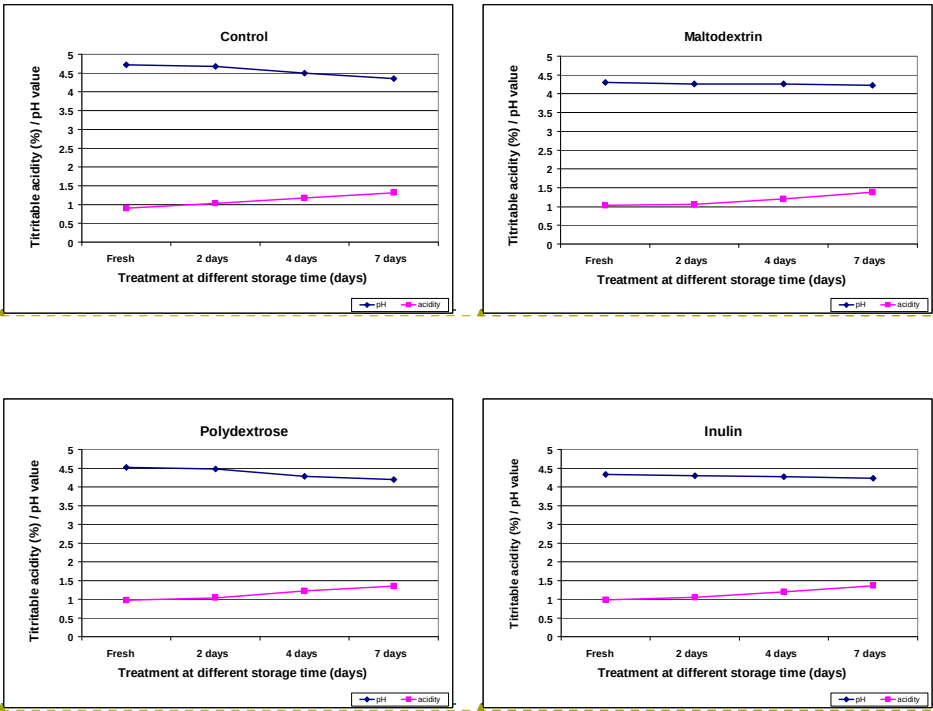


Figure (2) a: Changes in pH and titratable acidity of full fat fermented milk made with (*B. longum* + *St. thermophilus*) combinations and the selected polysaccharides

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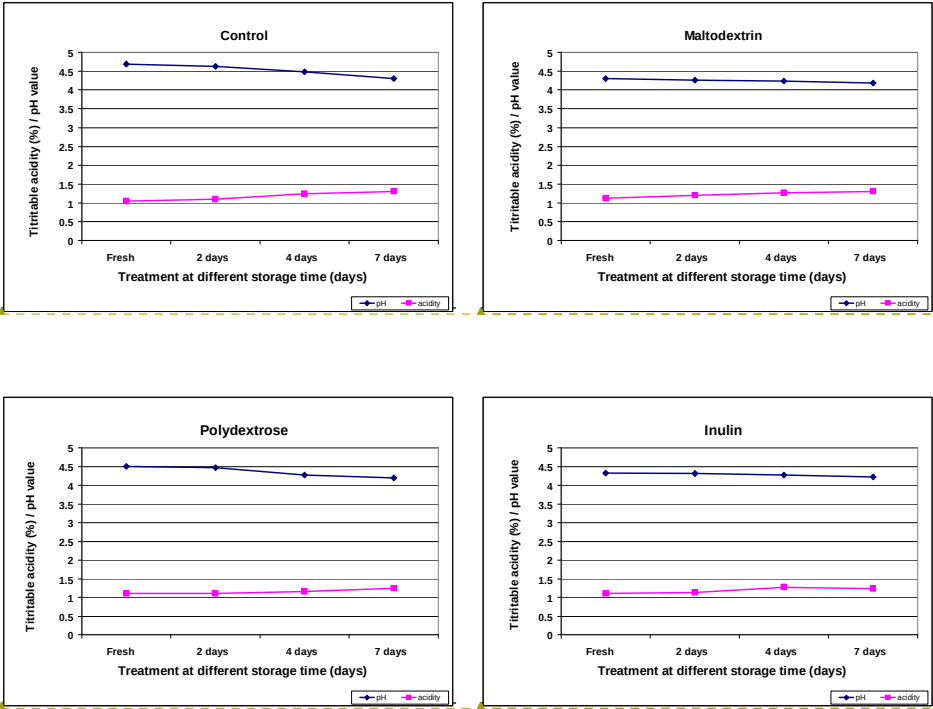
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Figure (2) b: Changes in pH and titratable acidity of full fat fermented milk made with (*St. thermophilus* + *Lac. lactis spp lactis*) combinations and the selected polysaccharides

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Figure (2) c: Changes in pH and titratable acidity of full fat fermented milk made with (*B. longum* + *Lac. lactis* spp *lactis*) combinations and the selected polysaccharides

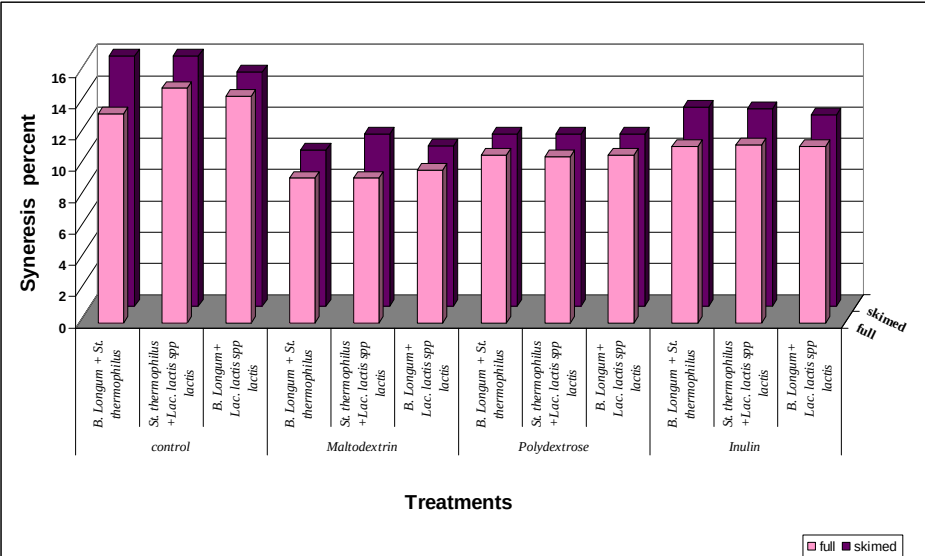


Figure (32): Determination of syneresis percent for full fat/skimmed fermented milk made with different cultures combinations and polysacchrides after 7 days of storage

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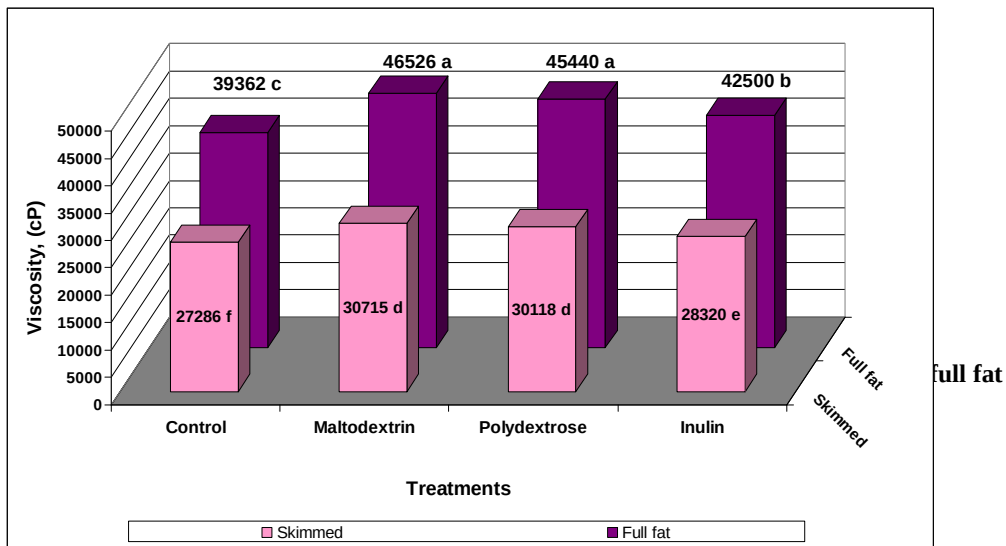
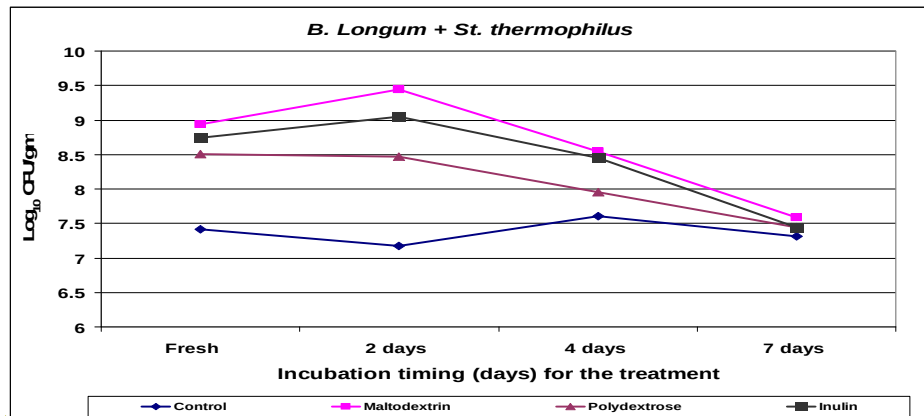
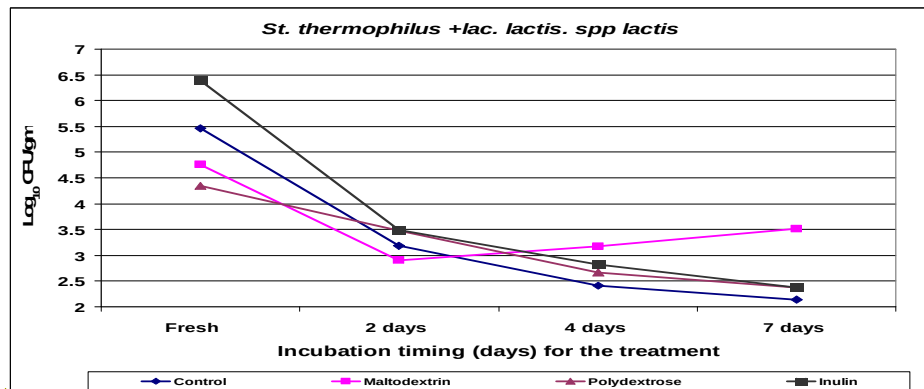


Figure (43) Effect of adding 3% of the selected polysaccharides on the viscosity of full fat and skimmed fermented milk products

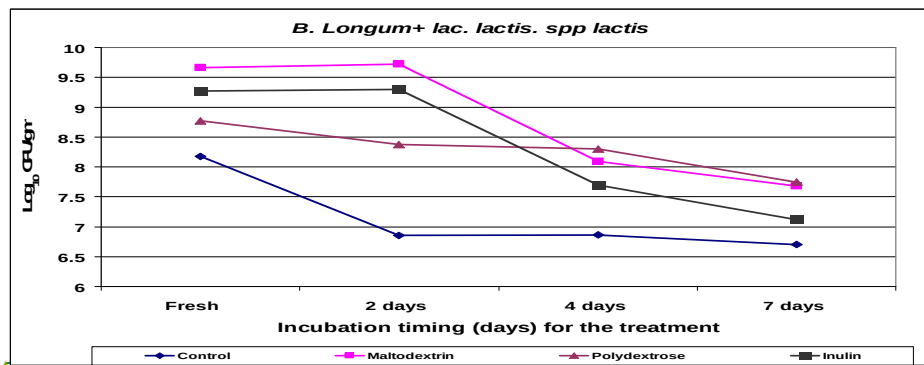
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Figure (5): Changes in viable cell counts in full fat fermented milk fresh and during storage made with probiotic bacterial cultures and different polysaccharides during 7 days of storage

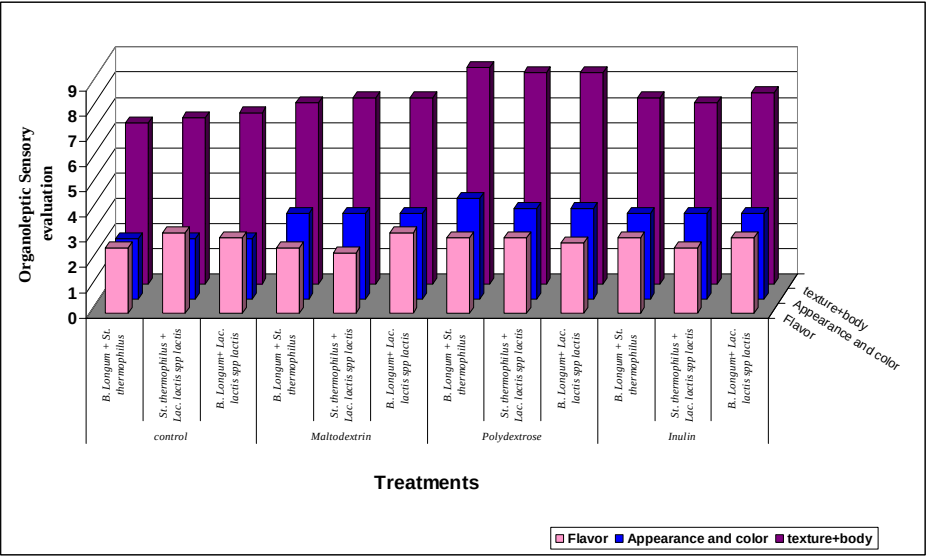


Figure (64): Sensory evaluation of full fat fermented milk manufactured with different culture combinations and polysaccharides after 7 days of cold storage

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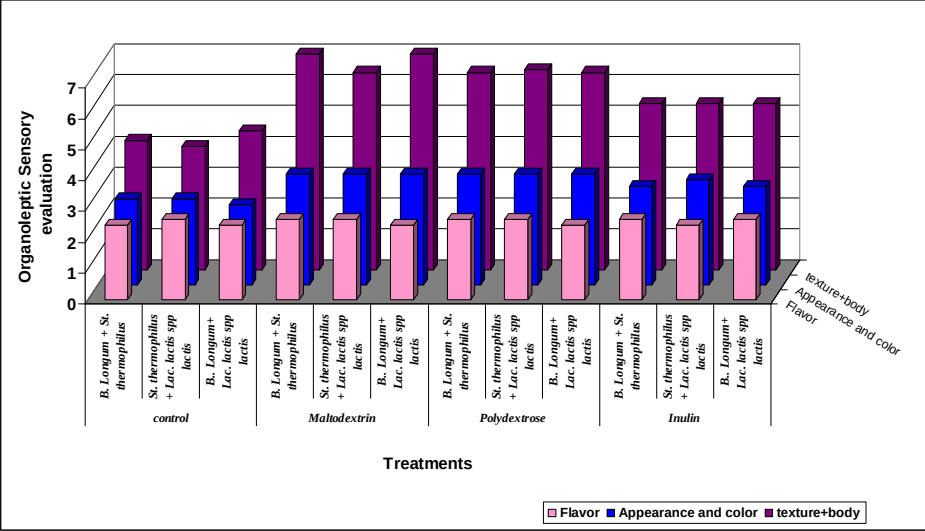


Figure (75): Sensory evaluation of skimmed fermented milk manufactured with different culture combinations and polysaccharides after 7 days of cold storage

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4. CONCLUSION

Maltodextrin showed the best results in increasing bifidobacterial count with a mean 8.53 cfu/g, viscosity was increased by 18 % comparing to the inulin treatment which increased it by 7.9% as well. Maltodextrin treatment lowered the syneresis by 34% comparing to inulin which lowered the syneresis by 18% also enhancing the organoleptic properties of full fat and skimmed fermented milk compared with inulin, and that is recommended by our study to use it in industry.

5. REFERENCES

- Adapa, S., Dingeldein, H., Schmidt, K.A. and Herald, T.J. (2000). Rheological properties of ice cream mixes and frozen ice creams containing fat and fat replacers. *Journal of Dairy Sciences*, 83: 2224–9.
- Akalin, A.S. and Erisir, D. (2008). Effects of inulin and oligofructose on the rheological characteristics and probiotic culture survival in low-fat probiotic ice cream. *Journal of Food Sciences*, 73: 184-8.
- Akalin, A.S., Fenderya, S. and Akbulut, N. (2004). Viability and activity of bifidobacteria in yoghurt containing fructooligosaccharide during refrigerated storage. *International Journal of Food Sciences Technology*, 39: 613-621.
- Akalin, A.S., Gong, S., Unal, G. and Fenderva, S. (2007). Effects of fructooligosaccharide and whey protein concentrate on the viability of starter culture in reduced-fat probiotic yoghurt during storage. *Journal of Food Sciences*, 72: 222-227.
- Allgeyer, L.C., Miller, M.J. and Lee, S.Y. (2010). Sensory and microbiological quality of yoghurt drinks with prebiotics and probiotics Department of Food Science and Human Nutrition, and Division of Nutritional Sciences, University of Illinois, Urbana 61801 *Journal of Dairy Sciences*, 93: 4471–4479.
- Alvina, P.Y.F and Art, R.H. (2011). The effects of different inulin types on rheology and ultrastructure of rennet-induced gels and cast-type feta cheese. These. MSc. University of Guelph.
- Aneja, R.P., Mathur, B.N. Chandan, R.C. and Banerjee, A.K. (2002). *Technology of Indian Milk Products*. A Dairy Indian Publication, Delhi, India. pp. 159-182.
- AOAC. (2000). Association of Official Analytical Chemists official methods of analysis, 15th ed. A.A.C. Benjamin Franklin Station, Washington. D.C. USA.
- Araujo, E. A., de Carvalho, A. F., Leandro, E. S., Furtado, M. M. and de Moraes. C.A. (2010). Development of a symbiotic cottage cheese added with *Lactobacillus delbrueckii* UFV H2b20 and inulin. *Journal of Functional Foods*, 2: 85–89.
- Aryana, K.J. and McCrew, P. (2007). Quality attributes of yoghurt with *Lactobacillus casei* and various prebiotics. *Food Science Technology/ Lebensmittel.-Wissenschaft und- Technologie*, 40: 1808- 1814.
- Baher, A.M.E., Ahmed, M.M.M., Zainab, I.S., Gehan, A.M.H. and Mohamed, N.I.M. (2012). Production of novel functional white soft cheese. *Journal of Microbiology, Biotechnology, Food Sciences*, 1: 1259-1278.
- Biedrzycka, E. and Bielecka, M. (2004). Prebiotic effectiveness of fructans of different degree of polymerization. *Trends in Food Science and Technology*, 15: 170–175.
- Bishay, I.E. (1998). Rheological characterization of inulin. In P.A. Williams & G.O. Phillips (Eds.), *Gums and stabilizers for the food industry*. Cambridge, United Kingdom; Royal Society of Chemistry, 11: 201-201.
- Boeni, S. and Pourahmad, R. (2012). Use of inulin and probiotic lactobacilli in synbiotic yoghurt production. *Annals of Biological Research*, 3: 3486-3491.

944
945 Bolin, Z., Libudzisz, Z. and Moneta, J. (1998). Survival ability of *Lactobacillus acidophilus* as probiotic
946 adjunct in low-pH environments. Polish Journal of Food Nutrition Science, 7:465-472.
947
948 Brennan, C.S. and Tudorica, C.M. (2008). Carbohydrate-based fat replacers in the modification of the
949 rheological, textural and sensory quality of yoghurt: comparative study of the utilization of barley beta-
950 glucan, guar gum and inulin. International Journal of Food Science and Technology, 43: 824- 833.
951
952 Buriti, F.C.A, Daroha, J.S., Assis, E.G.A and Saad, S.M.I. (2005). Probiotic potential of Mains cheese
953 prepared with the addition *Lactobacillus paracasei*. In *Lebensmittel –Wissenschaft U- Technology*, 38:
954 173 - 180.
955
956 Buterikis G, Matusevicius P, Januskevicius A, Jankowski J, Mikulski D, Blok J,
957 Cadieux P, Wind A, Sommer P, Schaefer L, Crowley K, Britton RA, Reid G. 2008. Evaluation of reuterin
958 production in urogenital probiotic *Lactobacillus reuteri* RC-14. *Applied and Environmental Microbiology* 74
959 (15): 4645-4649.
960
961 Dave, R.I. and Shah, N.P. (1997). Viability of yoghurt and probiotic bacteria in yoghurt made from
962 commercial starter culture. International Dairy Journal, 7: 31-41.
963
964 De, S. (1980). Outlines of dairy technology. New Delhi: Oxford University Press.
965
966 De Ancos, B., Gonzalez, E. and Pilar Cano, M. (2000). Effect of high-pressure treatment on the
967 carotenoid composition and the radical scavenging activity of persimmon fruit purees. Journal of
968 Agricultural & Food Chemistry, 48: 3542–3548.
969
970 DelloStaffolo, M., Bertola, N., Martino, M. and Bevilacqua, Y.A. (2004). Influence of dietary fiber addition
971 on sensory and rheological properties of yoghurt. International Dairy Journal, 14: 263- 268.
972
973 Donkor, O.N., Nilmini, S.L.I., Stolic, P., Vasiljevic, T. and Shah, N.P. (2007). Survival and activity of
974 selected probiotic organisms in set-type yoghurt during cold storage. *International Dairy Journal*, 17: 657-
975 665.
976
977 Eder, R. (2003). Drinkable yoghurt beats the bagel. *Drug Store News*, 25: 42-43.
978
979 Fooks, L.J., Fuller, R. and Gibson, G.R. (1999). Prebiotics-probiotics and human gut microbiology.
980 *International Dairy Journal*, 9: 53-61.
981
982 Ghoddusi, H.B., Grandison, M.A., Grandison, A.S., Tuohy, K.M., (2007). In vitro study on gas generation
983 and prebiotic effects of some carbohydrates and their mixtures. *Ecology/ Environmental Microbiology*, 13:
984 193–199.
985
986 Guggisberg, D., J. Cuthbert-Steven, P. Piccinali, U. Bütikofer, and P. Eberhard. (2009). Rheological,
987 microstructural and sensory characterization of low fat and whole milk set yoghurt as influenced by inulin
988 addition. *International Dairy Journal*, 19:107–115.
989
990 Gustaw, W., Glibowski, P. and Mleko, S. (2006). The rheological properties of yoghurt with incorporated
991 whey protein aggregates/polymers. *Milchwissenschaft*, 61: 415-419.
992
993 Gustaw, W., Glibowski, P. and Mleko, S. (2009). The rheological properties of yoghurt with the addition of
994 lyophilized polymerized whey protein. *Milchwissenschaft*, 64: 60-64.
995
996 Guven, M., Yasar, K., Karaca, O. B. and Hayaloglu, A. A. (2005). The effect of inulin as a fat replacer on
997 the quality of set-type low-fat yoghurt manufacture. *International Journal of Dairy Technology*, 58: 180-
998 184.

999 Hennelly, P.J., Dunne, P.G., O' Sullivan, M. and O'Riordan, E.D. (2006). Textural, rheological and
 1000 microstructural properties of cheese containing inulin. *Journal of Food Engineering*, 75: 388- 395.
 1001
 1002 Hyvönen, L., Linna, M., Tuorila, H. and Dijksterhyist, G. (2003). Perception of melting and flavor release
 1003 of ice cream containing different types and contents of fat. *Journal of Dairy Science*, 86: 1130-38.
 1004
 1005 Jie, Z., Bang-Yao, L., Ming-Jie, X., Hai-Wei, L., Zu-Kang, Z., Ting-Song, W., (2000). Studies on the
 1006 effects of polydextrose intake on physiologic functions in Chinese people. *American Journal of Clinical*
 1007 *Nutrition*, 72: 1503–1509.
 1008
 1009 Karaca, O.B., Guven, M., Yasar, K., Kaya, S. and Kahyaoglu, T. (2009). The functional, rheological and
 1010 sensory characteristics of ice creams with various fat replacers. *International Dairy Technology Journal*,
 1011 62: 93-9.
 1012 Khurana HK, Kanawjia SK. 2007. Recent trends in development of fermented milks. *Current Nutrition &*
 1013 *Food Science* 3: 91-108.
 1014 Kip, P., Meyer, D. and Jellema, R. H. (2006). Inulins improve sensoric and textural properties of low-fat
 1015 yoghurts. *International Dairy Journal*, 16:1098-1103.
 1016
 1017 Koca, N., and Metin, M. (2004). Textural, melting and sensory properties of low-fat fresh kashar cheeses
 1018 produced by using fat replacers. *International Dairy Journal*, 14: 365-373.
 1019
 1020 Lankaputhra, W. E. V., Shah, N. P., &Britz, M. L. (1996). Survival of bifidobacteria during refrigerated
 1021 storage in the presence of acid and hydrogen peroxide. *Milchwissenschaft*, 51: 65-70.
 1022
 1023 Larmond, E. (1982). Laboratory methods for sensory evaluation of food Publication. Ottawa: Food
 1024 Research Institute, Canada Department of Agriculture, 1637-1662.
 1025
 1026 Loret, C., Meunier, V., Frith, W. J. and Fryer, P. J. (2004). Rheological characterization of the gelation
 1027 behaviour of maltodextrin aqueous solutions. *Carbohydrate Polymers*, 57:153-163.
 1028
 1029 Modzelewska-Kipitula, M. and Klebukowska, L. (2009). Investigation of the potential for using inulin HPX
 1030 as a fat replacer in yoghurt production. *International Journal of Dairy Technology*, 62: 209- 214.
 1031
 1032 Modzelewska-Kapitula, M., Klebukowska, L. and Kornacki, K. (2007). Influence of inulin and potentially
 1033 probiotic *Lactobacillus plantarum* strain on microbiological quality and sensory properties of soft cheese.
 1034 *Polish Journal of Food and Nutritional Science*, 57: 143-146.
 1035
 1036 Monika, M., Jan, K., Lucyna, K. and Danuta, W. (2010). The Influence of Feeding Diets Containing White
 1037 Cheese, Produced with Prebiotics and the Potentially Probiotic *Lactobacillus plantarum* Strain, on the
 1038 Gastrointestinal Microflora of Rats *Czech Journal of Food Science*, 28: 139–145.
 1039
 1040 Nastaj, M and Gustaw, W. (2008). Effect of some selected prebiotics on rheological properties of set
 1041 yoghurt. *ACTA Scientiarum Polonorum Alimentaria*, 15: 217-225.
 1042
 1043 Oliveira, R.P.S, Perego, P., Converti, A. and Oliveira, M.N. (2009). The effect of inulin as a prebiotic on
 1044 the production of probiotic fiber-enriched fermented milk. *International Dairy Technology Journal*, 62: 195-
 1045 203.
 1046
 1047 Ozer, D., Akin, S. and Ozer, B. (2005). Effect of inulin and lactulose on survival of *Lactobacillus*
 1048 *acidophilus* LA-5 and *Bifidobacterium bifidum* Bb-02 in acidophilus-bifidus yoghurt. *Food Science*
 1049 *Technology International*, 11:19–24.
 1050
 1051 Paseephol, T. and Sherkat, F. (2009). Probiotic stability of yoghurts containing Jerusalem artichoke
 1052 inulins during refrigerated storage. *Journal of Functional. Foods*, 1: 311-318.
 1053

1054 Peuranen, S., Tiihonen, K., Apajalahti, J.H., Kettunen, A., Saarinen, M. and Rautonen, N. (2004).
1055 Combination of polydextrose and lactitol affects microbial ecosystem and immune responses in rat
1056 gastrointestinal tract. *British Journal of Nutrition*, 91: 905–914.
1057
1058 Prindiville, E.A., Marshall, R.T. and Heyman H. (2000). Effect of milk fat, cocoa butter, and whey protein
1059 fat replacers on the sensory properties of low fat and nonfat chocolate ice cream. *Journal of Dairy*
1060 *Science*, 83: 2216–223.
1061
1062 Probert, H.M., Apajalahti, J.H.A., Rautonen, N., Stowell, J. and Gibson, G.R., (2004). Polydextrose,
1063 lactitol&fructo-oligosaccharide fermentation by colonic bacteria in three-stage continuous culture
1064 system. *Applied Environment Microbiology*, 70: 4505–4511.
1065
1066 Raju, N.P. and Pal, D. (2011). Effect of bulking agents on the quality of artificially sweetened mistidahi
1067 (caramel colored sweetened yoghurt) prepared from reduced fat buffalo milk. *Food Science and*
1068 *Technology*, 44: 1835-1843.
1069
1070 Ranjeeta,W. (2011). Investigating the strategies to improve the quality of low-fat mozzarella and cheddar
1071 cheeses. Ph.D.UTAH State University, Logan, Utah.
1072
1073 Ribeiro, C., Zimeri, J.E., Yildiz, E. and Kokini, J.L. (2003). Estimation of effective diffusivities and glass
1074 transition temperature of polydextrose as a function of moisture content. *Carbohydrate Polymers*, 51:
1075 273–280.
1076
1077 Roberfroid, M. B. (2006). Inulin-type fructans: functional food ingredients. *Trends in Food Science &*
1078 *Technology*, 17: 39-41.
1079
1080 Roberfroid, M.B. (1998). Prebiotics and synbiotics: concepts and nutritional properties. *British Journal of*
1081 *Nutrition*, 80: S197–S202.
1082
1083 Roller, S. (1996). Starch derived fat mimetics: maltodextrins. In S. Roller, & S. A. Jones (Eds.), *Handbook*
1084 *of fat replacers*. Boca Raton, FL: CRC Press, 99.
1085
1086 Saint-Eve, A., Levy, C., Martin, N. and Souchon, I. (2006). Influence of proteins on the perception of
1087 flavored stirred yoghurts. *Journal of Dairy Science*, 89:922–933.
1088
1089 Salem, M.M.E., Abd El-Gawad, M.A.M., Hassan, F.A.M. and Effat, B, A. (2007). Use of synbiotics for
1090 production of functional low fat labneh. *Polish Journal of Food and Nutritional Science*, 57: 151- 159.
1091
1092 Sarkar, S. (2010). Approaches for enhancing the viability of probiotics: A review. *British Food Journal*,
1093 112: 329-349.
1094
1095 Schierbaum, F. R., Radosta, S., Vorwerg, W., Yuriev, V. P., Braudo, E. F., & German, M. L. (1992).
1096 Formation of thermally reversible maltodextrin gels as revealed by low resolution H-NMR. *Carbohydrate*
1097 *Polymers*, 18: 155-163.
1098
1099 Seydin, Z. B. G., Sarikus, G., &Okur, O. D. (2005). Effect of inulin and Dairy-Lo as fat replacers on the
1100 quality of set type yoghurt. *Milchwissenschaft*, 60: 51-55.
1101
1102 Shah, N.P., Ali, J.F. and Ravula, R.R. (2000). Populations of *Lactobacillus acidophilus*, *Bifidobacterium*
1103 *spp.* and *Lactobacillus casei* in commercial fermented milk. *Bioscience Microflora*, 19: 35-39.
1104
1105 Shi J, Mazza G, Maguer ML. 2002. Functional foods, Biochemical and processing aspects. CRC press,
1106 New York, 1- 417.
1107
1108 Shin, H.S., Lee, J.H. and Pestka, J.J. and Ustunol, Z. (2000). Growth and viability of commercial
Bifidobacterium spp in skim milk containing oligosaccharides and inulin. *Journal of Food Science*, 65:
884–887.

1109
1110 Singh, R. (2007). Characteristics and technology of traditional Indian cultured dairy products. Bulletin of
1111 the International Dairy Federation, 415: 11-20.
1112
1113 Specter, S.E., and Setser, C.S. (1994). Sensory and physical properties of a reduced calorie frozen
1114 dessert system made with milk fat and sucrose substitutes. Journal of Dairy Science, 77: 708-717.
1115
1116 Srisuvor, N., Ninnart, C., Cheunjit, P. and Suwanna, S. (2013). Effects of inulin and polydextrose on
1117 physicochemical and sensory properties of low-fat set yoghurt with probiotic-cultured banana purée. Food
1118 Science and Technology, 51: 30-36.
1119
1120 | Staffolo, M. D., Bertola, N., Martino, M., [L. and Bevilacqua, y. A.](#) (2004). Influence of dietary fiber addition
1121 on sensory and rheological properties of yogurt. International Dairy Journal, 14: 263-268.
1122
1123 Steel, R.G.D. and Torrie, J.H. (1980). Principles and Procedures of Statistics. A biometrical approach. 2nd
1124 Ed., McGraw Hill Inter. Book Co. Tokyo, Japan.
1125
1126 Tamime, A. Y. and Robinson, R. K. (1999). Yoghurt: Science and technology (2nd ed.). Cambridge, UK:
1127 Woodhead Publishing Ltd.
1128
1129 Tamime, A. Y., and Robinson, R. K. (2007). Tamime and Robinson's yoghurt: science and technology.
1130 England: Woodhead Publishing Limited.
1131
1132 Tarrega, A. and Costell, E. (2006). Effect of inulin addition on rheological and sensory properties of fat-
1133 free starch-based dairy desserts. International Dairy Journal, 16: 1104- 1112.
1134
1135 Thompson, J.L., Lopetcharat, K. and Drake, M.A. (2007). Preferences for commercial strawberry
1136 drinkable yogurts among African American, Caucasian, and Hispanic consumers in the United States.
1137 Journal of Dairy Science, 90:4974–4987.
1138
1139 Ting-Ning Lin (2012). Sensory analysis, instrumental analysis and consumers' acceptance toward
1140 multifunctional ice creams. Ph.D. University of Missouri.
1141
1142 Tomasik, P. (2007). Saccharides. In Z. E. Sikorski (Ed.), Chemical and functional properties of food
1143 components USA: CRC Press-Taylor and Francis Group, (pp. 93).
1144
1145 Ünal, B., Metin, S., & Is, İklı, N. D. (2003). Use of response surface methodology to describe the
1146 combined effect of storage time, locust bean gum and dry matter of milk on the physical properties of low-
1147 fat set yoghurt. International Dairy Journal, 13: 909-916.
1148
1149 Verma, R.B. (2002). Technological studies on the manufacture of frozen desserts using artificial
1150 sweeteners. Ph.D. Thesis, National Dairy Research Institute, Deemed University, Karnal, India, 25:28-32.
1151
1152 Vinderola, C.G., Bailo, N. and Reinheimer, J.A. (2000). Survival of probiotic microflora in Argentinian
1153 yoghurts during refrigerated storage. Food Research International, 33: 97-102.
1154
1155 Waldemar, G., Monika, K.W. and Justyna, K. (2011). The influence of selected prebiotics on the growth of
1156 lactic acid bacteria for bio-yoghurt production. ACTA Science Poultry, Technology Aliment, 10: 455-466.
1157
1158
1159 Wu, H., Hulbert, G.J. and Mount, J.R. (2001). Effects of ultrasound on milk homogenization and
1160 fermentation with yogurt starter. Innovative Food Science and Emerging Technologies, 1: 211-218.
1161
1162 Xie, S. H., Liu, Q. and Cui, S. W. (2005). Starch modifications and applications. In S. W. Cui (Ed.), Food
1163 carbohydrates: chemistry, physical properties and applications. USA: Taylor and Francis. 39: 332–341.
1164

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1165 Zimeri, J.E. and Kokini, J.L. (2003). Rheological properties of inulin-waxy starch systems. Carbohydrate
1166 Polymers, 52: 67-85

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APPENDIX
(Please mention Appendix inside the Text)

1174 *Bifidobacterium longum*
1175 *Lactobacillus acidophilus*
1176 *Lactobacillus plantarum*
1177 *Lactobacillus rhamnosus*
1178 *Lactobacillus paracasei*
1179 *Lactobacillus reuteri*
1180 *Lactococcus lactis* spp *lactis*
1181 *Streptococcus thermophilus*
1182 CFU/ml
1183 CFU/g
1184 DP
1185
1186 MRS
1187 FOS
1188 CP
1189
1190 |
1191 |
1192 |
1193

Bifidobacterium longum
Lactobacillus acidophilus
Lactobacillus plantarum
Lactobacillus rhamnosus
Lactobacillus paracasei
Lactobacillus reuteri
Lactococcus lactis spp *lactis*
Streptococcus thermophilus
Colony-forming unit / milliliter
Colony-forming unit / gram
Degree of polymerization

de Man, Rogosa and Sharpe
Fructo oligosaccharides
Centipoise

Degree Celsius

Artificial sweetened misti dahi

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