

Properties of Bio-Fermented Milk as Influenced with the Addition of Chicory (*Cichorium intybus* L) Roots Powder

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ABSTRACT

In an attempt to improve the properties of free-fat yogurt, 3, 6% of Chicory (*Cichorium intybus* L) root base powder (CRP) or their extracted inulin (3 and 6%) were added to defatted milk. A combined culture of *Streptococcus thermophilus*-St-36, *Lactobacillus delbrueckii* subsp. *bulgaricus*- Lb-12 and *Bifidobacterium bifidum*(Bb-11) was used in the fermentation process. The obtained results revealed that protein, total solids and ash significantly increased; also the pH and acidity were affected by the addition of CRP and inulin powder during the storage. CRP and inulin treatments resulted in the highest levels of acetaldehyde and total volatile essential fatty acid (TVFA) which increased by prolonging the storage period. Addition of CRP and inulin to fermented milk significantly increased the survival of *Lb. delbrueckii* spp. *bulgricus* and *B. bifidum* bacteria. The numbers of *Lb. delbrueckii* spp. *bulgricus* showed a clear fall which was statistically significantly different ($p < 0.05$) from the initial counts after 8 days. Nevertheless the addition of inulin (3 and 6%) to milk was compared milk more effective than the addition of CRP (3 and 6%) during the storage period. Addition of CRP increased curd tension and lowered the syneresis of bio-fermented milk. Regarding organoleptic properties, insignificant similarities were found among the 3% fat control and 6% of CRP or inulin treatments.

Keywords:- bio-fermented milk, *Cichorium intybus*, Roots powder, inulin, free-fat yoghurt.

INTRODUCTION

One of the important kinds of functional food is reduced fat products, particularly, low fat dairy food in order to combat obesity, cardiovascular disease and hypertension (NRC. 1989). Chicory (*Cichorium intybus* L) is an abundant source of inulin which represents 44.69% of its dry weight. Massoud *et al.*, (2009). Inulin is a polymer of fructose with (2 -1) glycosidic linkage. Inulin act as a functional substance because it has many attributes such as its sugar and fat replacement, texturizing, and bulking agent. Also, it is used for its physical features of being solucionable dietary fiber and having prebiotic properties (Causey *et al.* 2000). On the other hand, inulin is a dietary fiber with limited calorie value, subsequently, suited to diabetics and is regarded as beneficial to health for its prebiotic properties. Inulin has been determined as an ingredient which it has been termed as prebiotic and plays a role in the elimination and inhibition of digestive tract and breast cancer (Taper *et al.*, 1995 and 1997). Furthermore to calorie and fat loss, it had a fiber effect, lipid modulation and bifibus stimulation. Intended for these reasons, chicory is widely used as a functional food throughout the world for their health promoting and technological properties.

Inulin has a pleasant taste and not has any abnormal colours, so, it has minimal effect on the sensory properties of a product. Moreover, the use of inulin giving a significantly improve of the taste properties because of its combining with high intensity sweeteners. Inulin strongly used for dairy products fortification over the other classical fiber due to its high solubility. This fortification can be take place in yoghurt, cheese, drinks and deserts, which have been normally quandary in it's fortify (Niness, 1999)

Plain unsweetened natural yoghurts containing inulin was preferred over samples without inulin in consumer tests. That yoghurt was determined to be creamier, having a less chalky and creamier texture, and

have pleasant sour fermented pre and after taste (Spiegel, *et al.*, 1994).

Yogurt considered as one of the dairy products, which should continue to increase in sales due to the creation on its types in the range of yoghurt-like products. Fermented foods consumed as probiotics when active live bacteria be add to it during its making. Many varieties of milk products can be contribute in this roll or as a functional foods such as soy milk yoghurt and yoghurt. Many beneficial promoting parameters expected to occur when fermented milk by common yoghurt starter or probiotic starter bacteria were consumed, one of these is the modification of the gut micro flora and the replacement of hazardous microbes by beneficial bacterias i. e. probiotics, which can be reflected in the health improvement which causes the prolong the age (Metchnikoff 1907, Yadav *et al.*, 2015 and Dello Staffoloa, *et al.*, 2004).

Therefore, this study aims to investigate the ability of producing free fat functional yoghurt by using Chicory (*Cichorium intybus* L) roots powder or extracted inulin as fat substitutes and study the chemical, Rheological, Microbiological and sensory properties of resultant bio- fermented milk.

MATERIALS AND METHODS

Fresh buffalo's milk was obtained from the herds of the Faculty of Agriculture, Kafr El-Sheikh University and defatted, Lyphilyzed cultures of yoghurt *Streptococcus thermophilus*-St-36 + *Lactobacillus delbrueckii* subsp. *Bulgaricus* - Lb-12) and *B. bifidum* (Bb-11) were obtained from Chr. Hansen Lab. Copenhagen, Denmark. Chicory (*Cichorium intybus*) roots were collected from Sakha Agric. Res. Station. Pure Inulin was obtained from Sigma Chemical. Co.

Preparation of Chicory (*Cichorium intybus* L) roots powder (CRP): Raw Chicory roots were carefully washed with tap water, and were cut into small pieces, heated in water 85°C for 30 min and blended, then

freeze dried. The recovered powder was kept in polyethylene bags, and stored at $7\pm 2^{\circ}\text{C}$ until use. The chicory roots were chemically analyzed. Inulin of chicory roots were extracted and determined according to the El-Farra (1989). Fresh chicory root contained, in dry weight, 67% inulin, 15% sucrose, 6.5% protein, 4.5% cellulose, 3.8% ash, and 3.2% other compounds. Dried chicory root extract contains, in weight, about 98% inulin and 2% other compounds.

Preparation of fermented milk : The fresh milk was defatted, heated at $95^{\circ}\text{C}/15$ min, cooled immediately to 40°C , then inoculated with 3% (w/v) of mixed bulk culture (1:1:1), of *Streptococcus thermophilus*- St-36, *Lactobacillus delbrueckii* subsp. *Bulgaricus* - Lb-12 and *B. bifidum* (Bb-11).

The cultured defatted milk was divided into 5 portions. The first portion was taken as control (without inulin or chicory root), chicory root powder 3% and 6%, inulin 3% and 6% individually were added to the other portions. A control with fat 3% and without additive was prepared. Every portion was inoculated with 3% w/v mixed culture (1:1:1) of *Streptococcus thermophilus*, St-36 and *Lactobacillus delbrueckii* Subsp. *bulgaricus*, Lb-12 and *B. bifidum* (Bb-11), and packaged in plastic cups (50 gm each), and incubated at $40\pm 2^{\circ}\text{C}$ until complete coagulation. The produced fat free Zabady-bifidum fermented milk was stored at $7\pm 2^{\circ}\text{C}$, and analyzed when fresh (after overnight cold storage) and after 4, 8 and 12 days of storage for chemical, microbiological, rheological properties and sensory evaluation.

Chemical analysis: Protein, total solids, titratable acidity, ash and pH value were determined according to Ling (1963). Total Volatile fatty acid (TVFA) was determined according to Kosikowski (1978), Acetaldehyde content was estimated according to the Conway micro diffusion semicarbazide method, as described by Lees and Jago (1969).

Rheological properties analysis: The curd tension (firmness) was determined as described by Chandrashekhara *et al.* (1957). Syneresis (whey separation) was determined as described by Hassan *et al.* (1999).

Enumeration of Lactic acid bacteria: *S. thermophilus* was enumerated on ST agar after incubating the plates aerobically at 37°C for 24h, using MRS agar at pH 5.2, and incubation at 40°C for 72 h were carried out for the enumeration of *L. delbrueckii* ssp. *bulgaricus*. The viable numbers of bifidobacteria were enumerated according to the method of Tharmaraji, and Shah (2003) using MRS-L (lithium chloride and L-cystein chloride) agar. The inoculated plates were incubated anaerobically at 37°C for 72 h. Plates containing 25 to 250 colonies were enumerated and recorded as colony forming units (CFU) per gram of sample.

Sensory evaluation: The sensory evaluation was assessed according to El-Shibiny *et al.* (1979) using the following points for different properties: Appearance (10 points), body & texture (30 points), and flavor (60 points).

Statistical analyses: Data analysis was carried out with SPSS Inc. software (version 10.0; SPSS Inc., Chicago,

IL), and statistically different groups were determined by the DUNCAN's Multiple Range test (Steel & Torrie, 1980). All data are presented as average \pm standard error.

RESULTS AND DISCUSSION

Chemical analysis: Total solid (%), protein (%) and ash % of fresh bio-fermented milk samples were shown in Table 1. High Significant differences were recorded in total solids and protein content of CRP (6%) and inulin (6%). Protein content ranged between 3.19-4.14%. In addition, CRP 6% and 3% gained the highest protein and Ash contents (0.8 and 0.88). Data of the total solids illustrated in the same Table reveal that there isn't significant difference between CRP 3% and control (3%fat). Also, there isn't significant differences in protein content of inulin 3% and control (free fat). These findings might be related to the increase in the protein and ash content of CRP, and these results were in harmony with Massoud *et al.*, (2009) who reported that the roots of chicory were of 4.65 and 4.25 % of crude protein and ash, respectively.

Table 1. Chemical composition of fresh Bio-fermented milk containing different levels of chicory roots powder or inulin.

Samples	Total solid (%)	Protein (%)	Ash (%)
Control (3%fat)	13.41 ^D	3.19 ^E	0.64 ^E
Control (free fat)	10.69 ^E	3.32 ^D	0.74 ^C
CRP 3%	13.50 ^D	3.72 ^B	0.80 ^B
CRP 6%	16.21 ^B	4.14 ^A	0.88 ^A
Inulin 3%	14.22 ^C	3.33 ^D	0.78 ^B
Inulin 6%	19.36 ^A	3.43 ^C	0.77 ^D

CRP: Fermented milk with 3% or 6% chicory roots powder. Data are means \pm SE for 3 replicates. Means with different superscript capital letters are significantly different at $p < 0.05$.

Titratable acidity (TA) and pH: Titratable acidity (TA) and pH- value of bio fermented milk during the cold storage are summarized in Table 2. The addition of CRP and inulin increased pH- values of fresh bio-fermented milk, compared with fat free control, even though inulin (3% and 6%) resulted in the highest pH-values. Data in at the same Table show that there were insignificant differences among CRP treatments and two types of control either with or without fat content. The pH values decreased with storage in all of the resultant treatments. The opposite trend of results was observed with respect to titratable acidity. Differences in pH values and TA were significant between treatment, but with less significance between storage intervals for each individual treatment. However, titratable acidity of samples containing CRP (3% and 6%), and those containing inulin (3% and 6%) reached >0.8 after about 8days. While the fat free control reached 0.9% after about 4days. Addition of CRP (3%) and inulin (3%) resulted in the lowest acidity, while the addition CRP of (6%) and inulin (6%) resulted in the highest acidity for fresh products. Titratable acidity increased during storage period in all treatments, which might be due to the starter culture activity. These results related are due to the activity of bacterial starter and the presence of inulin and CRP, which enhanced the activity of bacteria

started. On the other hand, the addition of fibers did not affect the development of acidity during the storage of yoghurt as apparent from the close acidity of the different treatments (El-Nagar and Brennan, 2001).

Table 2. Changes in pH and Titratable acidity (TA) of bio-fermented milk containing different levels of chicory roots powder or inulin.

Product	Storage period (days)			
	Fresh*	4	8	12
	pH			
3% fat control	4.14 ^{Aa}	4.08 ^{Aa}	4.04 ^{Aa}	4.02 ^{Aba}
Fat free control	4.09 ^{Ab}	4.12 ^{Ac}	4.09 ^{ABb}	4.05 ^{ABCa}
CRP 3%	4.14 ^{Aa}	4.06 ^{Aa}	4.08 ^{ABa}	4.06 ^{BCa}
CRP 6%	4.16 ^{Aa}	4.04 ^{Aa}	4.13 ^{Ba}	4.07 ^{Ca}
Inulin 3%	4.50 ^{Bc}	4.42 ^{Bbc}	4.30 ^{Cb}	4.12 ^{Da}
Inulin 6%	4.72 ^{Cc}	4.52 ^{Bb}	4.10 ^{ABa}	4.01 ^{Aa}
	Acidity (%)			
3% fat control	0.71 ^{ABa}	0.81 ^{ABab}	0.96 ^{BCb}	1.00 ^{BCb}
Fat free control	0.63 ^{Aa}	0.75 ^{Aab}	0.83 ^{Abc}	0.91 ^{Ac}
CRP 3%	0.77 ^{Ab}	0.94 ^{Bb}	1.00 ^{Bcb}	0.96 ^{ABCab}
CRP 6%	0.91 ^a	0.94 ^{Bab}	1.08 ^{Cb}	1.02 ^{BCb}
Inulin 3%	0.82 ^{ABa}	0.89 ^{ABb}	0.93 ^{Bb}	0.94 ^{ABb}
Inulin 6%	0.91 ^{Ba}	0.88 ^{ABb}	1.00 ^{BCb}	1.03 ^{Cb}

*After overnight cooling. CRP: Fermented milk with 3% or 6% chicory roots powder

. Data are means ± SE for 3 replicates. Means with different superscript capital letters (between groups at the same storage period "column") and small letters (within group at different storage period "row") are significantly different at p<0.05.

Total volatile fatty acids (TVFA) and acetaldehyde content: The changes in TVFA during storage period are shown in Table (3). It could be observed pronounced gradual increase in the total volatile fatty acids (TVFA) in all treatments of fermented milks during 12days of cold storage. Addition of CRP(6%) and inulin (6%) in the preparation of synbiotic-fermented milk increase of the TVFA in the fresh products. The TVFA gradually increased in synbiotic- yoghurt of different treatments with extending the storage period. The rate of increase in TVFA was much higher in treatments with 6% of CRP or inulin, compared to other treatments. There was a gradual increase in the TVFA, which could be attributed to the of bifidobacteria, which is unique in the production of 1.5 moles of acetic acid, as well as 1 mol of lactic acid as the end products of the fermentation process of 1 mol of glucose (Tamime, *et al.*, 1995). Data illustrated in Table (3) also revealed that the addition of chicory roots powder at different levels (3 and 6%) or inulin at the levels of (3 and 6 %) to synbiotic fermented milk significantly increased the acetaldehyde content during the first days of storage period. After 4 days of cold storage all samples showed a gradual reduction of the acetaldehyde content till the end of the storage period, which confirms the stimulatory effect of inulin or polysaccharides and minerals in chicory roots powder and strongly encouraged the production of flavor compounds.

The addition of inulin (6%) and 3% to fatty control had more acetaldehyde content than treatments with turn were higher than fat free control. Acetaldehyde content slightly increased during storage for about 4 days, and then decreased thereafter. However, this might be due to the ability of numerous lactic acid bacteria to reduce

acetaldehyde to ethanol (Amer, *et al.*,1991 and Salama, 1993).

Table 3 . Changes in total volatile fatty acids (TVFA) and acetaldehyde content of bio-fermented milk containing different levels of chicory roots powder or inulin.

Product	Storage period (days)			
	Fresh*	4	8	12
	Total volatile fatty acids (ml 0.1N NaOH/100g)			
3% fat control	6.55 ^{Aa}	8.05 ^{Ab}	10.31 ^{Ac}	13.37 ^{Ad}
Free fat control	7.61 ^{Ba}	9.54 ^{Bb}	12.23 ^{ABc}	14.19 ^{ABd}
CRP 3%	7.89 ^{BCs}	10.05 ^{Bb}	13.46 ^{Cc}	15.00 ^{Bd}
CRP 6%	8.44 ^{Ca}	9.61 ^{Ba}	13.31 ^{Cb}	15.02 ^{Bc}
Inulin 3%	8.01 ^{BCa}	10.04 ^{Bb}	11.90 ^{Bc}	14.90 ^{Bd}
Inulin 6%	8.54 ^{Ca}	10.05 ^{Bb}	12.31 ^{ABc}	14.20 ^{ABd}
	Acetaldehyde (µmol/100g)			
3% fat control	63.95 ^{Ab}	85.40 ^{Bb}	48.72 ^{Aa}	46.15 ^{Aa}
Free fat control	61.65 ^{Ab}	68.72 ^{Ab}	54.70 ^{ABa}	54.33 ^{Ba}
CRP 3%	64.33 ^{Aab}	62.00 ^b	50.92 ^{Aa}	55.71 ^{BCab}
CRP 6%	72.25 ^{Bc}	66.01 ^{Ab}	59.62 ^{BCb}	48.80 ^{Aa}
Inulin 3%	63.38 ^{Cab}	69.23 ^{Ab}	64.24 ^{Cab}	58.00 ^{BCa}
Inulin 6%	76.35 ^{Bb}	90.53 ^{Bc}	71.16 ^{Db}	59.01 ^{Ca}

*After overnight cooling. CRP: Fermented milk with 3% or 6% chicory roots powder.

Data are means ± SE for 3 replicates. Means with different superscript capital letters (between groups at the same storage period "column") and small letters (within group at different storage period "row") are significantly different at p<0.05.

Lactic acid bacteria count: The changes in the viable count of *Str. thermophilus*, *Lb. delbruekii* spp. *bulgricus* and *B. bifidum* used in making synbiotic-yoghurt with CRP and inulin (3 and 6%) during refrigerated storage are presented in Table (4). It could be observed that the addition of chicory roots powder (CRP) and inulin to fermented milk significantly increased the viability of *Lb. delbruekii* spp. *bulgricus* and *B. bifidum* bacteria. However, *Lb. delbruekii* spp. *bulgricus* were of the lowest counts, compared with *Str. thermophilus* (Table.4). After 8days of storage, the counts of *Lb. delbruekii* spp. *bulgricus* sharply decreased with significantly different ($p<0.05$) from its counts at zero time.

The counts of *Lb. delbruekii* spp. *bulgricus* decreased by 2 log in all treatments at the ending of its shelf life. The same trend was with , *Str. thermophilus* counts, which was higher by at least 2 log order than those for *Lb. delbruekii* spp. *bulgricus* in yoghurt containing *B. bifidum* bacteria (Vinderola, *et al.*, 2000). On average, the survival rate of *Str. thermophilus* was better than that of both *Lb. delbruekii* spp. *bulgricus* and bifidobacteria. These observations were in line with those of -Dave and Shah (1997). As given in Table (4) it could be noted that the addition of chicory roots powder and inulin to fermented milk significantly increased the viability of *B. bifidum* bacteria. However, the addition of inulin (3 and 6%) to the milk was more effective than the addition of CRP (3%) throughout the storage period. All of the resultant yoghurt were of a steady decline in the numbers *B. bifidum*. The decrease was more rapid for control with fat (CF) and control without fat (CNF). The viability of bacteria in bio-fermented milk during storage was higher in the presence

of CRP and inulin powder as compared with control samples (Table 4). However a significant decline ($P < 0.05$) well was observed after 8 days in chicory roots and inulin powder, the viable counts of *B. bifidum* recommended well above the recommended limit of cells per gram of fermented milk up to 8 days of storage period. These results were consistent with the previously mentioned reports on the ability of Fructooligosaccharide (FOS) to stimulate the viability of bifidobacteria in some of milk drink types (Shin *et al.*, 2000). Stimulation of bifidobacteria in the human colon by FOS has also been demonstrated in human feed trails (Gibson *et al.*, 1995; Roberfroid *et al.*, 1998). The degradation of FOS by Fructofuranosidases of bifidobacteria can increase growth and short-chain FOS are fermented more quickly by bifidobacteria (Perrin *et al.*, 2002).

Table 4. Effect of addition of chicory roots powder or inulin on lactic acid bacteria count in bio-fermented milk during storage period (days).

Product	Storage period (days)			
	Fresh*	4	8	12
<i>Str. thermophilus</i> (log CFU/gm)				
3% fat control	10.52 ^{Cb}	10.37 ^{Db}	10.37 ^{Db}	9.13 ^A
Fat free control	10.30 ^{Bc}	10.18 ^{CDbc}	9.36 ^{Cb}	6.50 ^A
CRP 3%	10.02 ^{Ad}	8.73 ^{Bc}	7.41 ^{Ab}	7.74 ^A
CRP 6%	10.42 ^{BCd}	9.49 ^{BCDc}	7.98 ^{Bb}	6.20 ^A
Inulin 3%	10.16 ^{ABb}	10.01 ^{Db}	7.28 ^{Aa}	6.51 ^A
Inulin 6%	10.14 ^{ABc}	9.23 ^{BCb}	7.20 ^{Aa}	7.00 ^A
<i>L.delbrueckii ssp. bulgaricus</i> (log cfu /gm)				
3% fat control	7.50 ^{Bc}	6.24	5.10 ^{Aa}	4.80 ^{Aa}
Free fat control	5.92 ^{Ac}	6.71 ^{Bc}	6.00 ^{Bb}	4.92 ^{ABa}
CRP 3%	7.82 ^{Cc}	6.16 ^{Ab}	6.00 ^{Bb}	4.13 ^{ABa}
CRP 6%	8.00 ^{Cd}	6.80 ^{Bc}	6.10 ^{Bb}	5.29 ^{ABa}
Inulin 3%	7.32 ^{Bc}	7.06 ^{Cc}	6.54 ^{Cb}	5.37 ^{Ba}
Inulin 6%	8.22 ^{Dd}	7.71 ^{Dc}	7.10 ^{Db}	5.86 ^{Ca}
<i>B. bifidum</i> (log cfu/gm)				
3% fat control	7.22 ^{Ac}	5.85 ^{Ab}	5.64 ^{Bb}	4.85 ^{ABa}
Free fat control	7.15 ^{Ac}	6.21 ^{Bb}	4.80 ^{Aa}	4.62 ^{Aa} ±
CRP 3%	8.20 ^{Bd}	6.75 ^{Cc}	6.00 ^{Bb}	5.12 ^{BCa}
CRP 6%	8.00 ^{Bd}	6.88 ^{Dc}	6.24 ^{BCb}	5.31 ^{Ca}
Inulin 3%	8.16 ^{Bc}	7.00 ^{Eb}	6.70 ^{Ca}	6.42 ^{Da}
Inulin 6%	8.61 ^{Cc}	7.56 ^{Fb}	7.53 ^{Db}	6.69 ^{Da}

*After overnight cooling. CRP: Fermented milk with 3% or 6% chicory roots powder.

Data are means ± SE for 3 replicates. Means with different superscript capital letters (between groups at the same storage period "column") and small letters (within group at different storage period "row") are significantly different at $p < 0.05$.

Rheological properties:

The effect of fortification with chicory roots powder (CRP) or inulin powder at different levels (3 and 6%) on curd tension and curd syneresis of fermented milk made of free fat milk are presented in Table (5). The given data indicated that the curd tension of treatments with CRP(6%) was higher than the control without fat treatment. On the other hand, control with fat treatment was higher than control without fat. Adapa and Schmicct (1998) reported that fat content greatly affects rheological and sensory properties. Fortification of yoghurt with chicory roots and inulin powder resulted in a significant ($p < 0.05$) increase in curd tension (Table

5). This increase might be due to the high content of inulin in chicory roots powder, which being highly soluble appears to enhance gel matrices. Blomsma (1997) found that the fat- substituting property of inulin is based on the products' ability to stabilize water into a creamy structure. Marshall and Rawoson (1999) proposed that the type of exopolysaccharide (EPS) and consequently the interaction of the polymer with the milk proteins during fermentation had an apparent effect on the rheological properties. Schaller-pvonly and Smith (1999) indicated that half of the amount of inulin may have the same desired effect as adding 100%inulin. The syneresis of yoghurt was affect by the addition chicory roots and inulin powder used as shown in Table (5). Increased separation of whey from the resultant yoghurt was observed in the control without fat, which may be to low total solids. In all treatments (Table 5) increased levels of chicory roots and inulin powder increased curd syneresis at both 30 and 120 minutes of holding time and their curd syneresis values were lower than those of the control samples. Similar results were reported by Kalab *et al*, 1983 and Cerning *et al.*, (1990) and El-Nagar and Brennen,(2001).

Table 5. Rheological properties of fresh bio-fermented milk manufactured using fat free milk containing different levels of chicory roots powder or inulin.

Product*	Curd Tension (gm)	Curd Syneresis (ml/100gm)			
		30 minutes	60 minutes	90 minutes	120 minutes
3%fat control	38.80 ^B	14.90 ^C	16.90 ^E	19.90 ^D	21.90 ^D
Free fat control	30.58 ^A	17.40 ^D	21.40 ^F	23.40 ^E	23.40 ^E
CRP 3%	54.16 ^E	9.90 ^B	14.40 ^D	19.40 ^D	19.40 ^C
CRP 6%	57.18 ^F	9.90 ^B	11.40 ^C	13.90 ^C	14.40 ^B
Inulin 3%	47.87 ^C	9.40 ^B	9.90 ^B	10.90 ^B	10.40 ^A
Inulin 6%	51.41 ^C	7.40 ^A	8.40 ^A	8.90 ^A	9.90 ^A

*After overnight cooling. CRP: Fermented milk with 3% or 6% chicory roots powder.

Data are means ± SE for 3 replicates. Means with different superscript capital letters (between groups at the same storage period "column") and small letters (within group at different storage period "row") are significantly different at $p < 0.05$.

These results might be due to the addition of CRP or inulin which lead to mechanism for shear-induced disruption of the network prevented by expolysaccharides associated with the casein matrix. The present results are also came in agreement with these reported by (Hess *et al.*, 1997) and Terry *et at.*, (1999).

Organoleptic properties :

Organoleptic properties of resultant fresh bio-fermented milk with different levels of chicory roots powder and inulin (3 and 6%) are shown in Table (6). The 3% fat control scored higher for flavour and body& texture than those with free fat control. Results emphasized the importance of fat as a flavour modifier (Ohmes, *et al.*,1998). The bio-fermented milk with inulin 6% and CRP 6% followed the control with fat in the total scores.

As given in Table (6), it should be noted that no significant sensory differences were found between the control with fat and fermented milk with 6% of CRP or inulin. The fat –substituting property of chicory roots

and inulin powder is based on the products ability to stabilize water into a creamy structure, which has an excellent fat like mouth feel and is almost taste free (Blomsma, 1997 and Adapa and Schmitt, 1998). However, El-Nagar and Brennan, (2001) indicated that fat-free yoghurt containing 2 % inulin superior to other treatments it has an acceptable consistency and smooth texture. The present results agree with those observed by Blomsma, 1997 and Tunland (2000).

Table 6. Organoleptic properties of fresh bio-fermented milk manufactured using fat free milk containing different levels of chicory roots powder or inulin.

Fermented milks	Flavor (60)	body & texture (30)	Appearance (10)	Total (100)
3% fat control	53.08 ^B	24.74 ^B	8.25 ^B	88.27 ^B
Free fat control	47.40 ^A	22.23 ^A	7.34 ^A	76.97 ^B
CRP 3%	51.00 ^B	23.89 ^{AB}	7.57 ^A	82.46 ^B
CRP 6%	51.69 ^B	25.25 ^B	8.35 ^B	85.29 ^B
Inulin 3%	51.20 ^B	23.60 ^{AB}	7.40 ^A	82.20 ^B
Inulin 6%	50.40 ^B	25.60 ^B	8.16 ^B	84.16 ^B

*After overnight cooling, CRP: Fermented milk with 3% or 6% chicory roots powder.

Data are means ± SE for 3 replicates. Means with different superscript capital letters (between groups at the same storage period "column") and small letters (within group at different storage period "row") are significantly different at p<0.05.

CONCLUSION

The above mentioned results indicated that addition of chicory roots powder or inulin (especially addition of 6%) had a beneficial effect and improved the quality, the safety and the acceptability of the manufactured free fat control. So, it can be strongly recommended to use such materials (chicory roots powder and inulin) for preparing different types of bio-fermented milk for human consumption, especially for healthy effects.

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تأثير إضافة مسحوق جذور الهندباء (الشكوريا) كبديل للدهن على خواص اللبن المختمر الحيوي

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تهتم الدراسة الحالية بالأغذية الوظيفية لمالها من أهمية غذائية وصحية، حيث تم تدعيم اليوغورت المصنع من لبن خالى من الدهن باستخدام *B. bifidum* مع بادئ اليوغورت التقليدى بإضافة مسحوق جذور الهندباء (الشكوريا) والأنيولين المستخلص منها بنسب ٣%، ٦% وقد أوضحت النتائج أن استخدام مسحوق جذور الهندباء أو الأنيولين بالنسب المختلفة أدى إلى زيادة البروتين و الجوامد الصلبة و الرماد لليوغورت الناتج الطازج أما بالنسبة للحموضة و الـ pH فزادت معنوياً مع إضافة مسحوق جذور الهندباء أو الأنيولين بنسبة ٦%. أدى استخدام مسحوق جذور الهندباء و الأنيولين إلى زيادة محتوى اليوغورت الناتج من الاستالدهيد و الأحماض الدهنية الطيارة الكلية بالمقارنة باليوغورت الكنترول، أما خلال التخزين انخفض محتوى الاستالدهيد بعد ٤ أيام من التخزين والعكس بالنسبة الأحماض الدهنية الطيارة الكلية فكانت تزيد خلال فترات التخزين المختلفة. بالنسب لحيوية بكتريا *B. bifidum*، *Lb. bulgaricus* فكانت تزيد بإضافة الأنيولين بنسب ٣%، ٦% لاستخدامه كـ prebiotic مقارنة بالمعاملة بدون إضافة ولكن انخفضت قليلاً خلال فترات التخزين المختلفة إلا أنها احتفظت بالمستوى الحيوي المؤثر صحياً (١٠^٧). أدى التدعيم بمسحوق مسحوق جذور الهندباء أو الأنيولين بنسبة ٦% إلى زيادة قوة الجذب الخثرى و انخفاض معدلات انفصال الشرس في اليوغورت الناتج الطازج. و قد أظهرت نتائج التحكيم الحسى و التى اشتملت على القوام و المظهر بالإضافة إلى الصفات الربولوجية أن استخدام مسحوق جذور الهندباء و الأنيولين بنسبة ٦% حسنت من النكهة و القوام و التركيب لدرجة أنها تقاربت مع عينة المقارنة المصنع من لبن ٣%دهن.