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Applications of Inulin and Mucilage as Stabilizers in Yoghurt Production

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ABSTRACT

The present study aimed to test some of natural products as stabilizers for yoghurt containing inulin and mucilage for enhancement its properties as a functional foods. Yoghurt containing natural stabilizers was manufactured and mucilage was added to yoghurt with ratio of 0.2% but inulin was added to yoghurt with ratio of 4 and 6%. Chemical compositions such as pH value, titratable acidity, wheying off, ash, protein, lactose, total carbohydrate, total solid, acetaldehyde and diacetyl of the tested yoghurt with and without stabilizers were carried out using the official methods. The data concluded that the pH values of tested yoghurt showed significant changes and decreased with the increasing of the storage period in the all of yoghurt treatments. On the other hand, Titratable acidity values of tested yoghurt showed significant changes and increased with the increasing of the storage period in the all of yoghurt treatments. The Wheying off of the set yoghurt was significantly lower in the yoghurt containing inulin at 4, 6% and mucilage at 0.2% compared with control yoghurt. The reduction percentages in the wheying-off were 30, 58 and 50%, respectively compared to control. None of the stabilizers used in ($p = 0.05$) affect on the ash content of yoghurt However, a decrease in lactose content was observed with the increase in the storage period. There was a substantial decrease in lactose content from 2 to 0.78% on the 10th day of storage. The protein content of yoghurt treated with inulin 6%, mucilage 0.2% and control were significantly different ($p = 0.05$) and gave value of 4.56, 4.37 and 4.19%, respectively. Based on the findings of this study, mucilage and inulin are potential stabilizers to be used in yoghurt processing.

Key words: Yoghurt production, inulin, mucilage, stabilizers

INTRODUCTION

The growing awareness of the relationship between diet and health has led to an increased demand for food products that support health above and beyond providing basic nutrition. One of these products, yoghurt is made from milk. Yoghurt essentially has all the nutritive components of milk (Vedamuthu, 1993).

The word yoghurt is derived from the Turkish word jugurt for milk fermented by a lactic culture. The product has many local names, it is known in Armenia as matzoon, in Lebanon and some Arab countries as leben, in Bulgaria as naja, in Italy as gioddu, in Iraq as roba, in Egypt and Sudan as zabady, in India as dahlia and busa in Turkistan (Tamime and Deeth, 1980). Also, in Sudan the common name is zabadi (Dirar, 1993).

Yoghurt is a popular fermented milk product consumed in many parts of the world. It is produced in different forms such as whole milk yoghurt, skim milk yoghurt, cream milk yoghurt, fruit yoghurt and liquid yoghurt.

Yoghurt (zabadi) is not a truly indigenous food of the Sudan. The product is only known to urban populations. Until 1950s, zabadi was only known to the inhabitants of Khartoum and a few relatively large towns. It is believed that the art of zabadi making came to the Sudan from Egypt through the Egyptians, Greeks, Syrians and Turks. Its introduction most likely took place with Anglo-Egyptian invasion and subsequent colonization (1898-1956) (Dirar, 1993).

Yoghurt is used by all family members as a daily meal or supplements particularly for children, old people and pregnant women. It is also highly used by people suffering from most of the gastrointestinal problems. In parallel the dairy industry is coping with these requirements in their forms to satisfy different consumer needs. People who don't drink milk because they can not digest lactose; consume yoghurt which contains less lactose. Yoghurt is considered a healthy food because it contains viable bacteria.

Yoghurt is one of the most, unique yet universal dairy products. The uniqueness of yoghurt is attributable to the symbiotic fermentation involved in its manufacture.

Yoghurt may be defined as the solids, custard-like fermented milk product made from fortified high-solids milk using a symbiotic mixture of *Streptococcus salaivarius* subsp. *Thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* as starters (Vedamuthu, 1993).

The regulation specify that yoghurt before addition of bulky flavors contains not less than 3.25% milk fat and not less than 8.25% Milk Solids-Non-Fat (MSNF) and has a titratable acidity not less than 0.9%, expressed as lactic acid.

Three categories of the product recognized are yoghurt, low fat yoghurt and non-fat yoghurt. A product to be labeled yoghurt should meet all the aforementioned criteria.

However, it is difficult to provide a universal make-procedure for yoghurt to suit every variation in the final product marketed by the industry. And what ever procedure is used, it is essential that the final product conforms to the requirements of the code of federal and state regulation, is safe for public consumption, has a satisfactory shelf-life and meets consumer demands with respect to body, texture and flavor characteristics.

Many studies on yoghurt and its fortification were carried out by the authors. They used whey protein concentrate, Glucono-Delta-Lactone and mango for manufacture of concentrated yoghurt (Mahfouz *et al*., 1992; El-Salam *et al*., 1991; EL-Etriby *et al*., 1997).

A major concern of the yoghurt industry is the production and maintenance of a product with optimum consistency and stability. The factors known to improve consistency are increasing total solids, manipulation of processing variables and characteristics of starter culture (Omer, 2003).

Stabilizers are used to produce a thick, cohesive body, smooth texture and to prevent wheying-off. Use of stabilizers also insures a uniform product with respect to body and texture from batch to batch according to Vedamuthu (1993). This study investigates some stabilizers of plant origin. These stabilizers include mucilage from psyllium ovata (*Plantago ovata* Forsk) (Sahay, 2004) and inulin (Villegas and Costell, 2007) from chicory roots (*Cichorium intybus* L.).

The objectives of the present study are to test some natural products as stabilizers for yoghurt include inulin and mucilage. Furthermore, the study will be assessed the properties of the yoghurt after using these stabilizers. The assumption is that if the stabilizers under investigation are effective, it will hopefully add a relatively new yoghurt stabilizer to the already existing ones.

MATERIALS AND METHODS

Materials: Skim milk powder, chicory roots and yoghurt culture were obtained from the National Research Center, Cairo, Egypt. Psyllium ovata seeds obtained from University of Khartoum, Faculty of Agriculture, Shambat, Sudan.

Preparation of the mucilage: Mucilage content of the seed was determined following the procedure of Khanna *et al.* (1988). Fifty grams of seeds were suspended in 200 mL distilled water resulting in the formation of viscous mucilaginous suspension which was treated with 25 mL of 10% NaOH (aqueous) at room temperature for 5 min. The liquefied mucilage was filtrated through muslin cloth and filtrate was acidified with 5 N HCl to pH 2.0. At this stage original high viscosity of mucilage returned with simultaneous precipitation of total mucilage. The precipitated mucilage was washed four times with distilled water using one liter each time, two times with 50 mL methanol and one time with acetone. The washed mucilage was dried at 80°C in oven and percentage was calculated with relevance to the air-dried sample.

Preparation of the inulin: Ten grams of chicory roots were washed with distilled water and heated in 200 mL distilled water for up to 70°C and left to cool overnight in refrigerator at 5°C to for maximum extraction. The mixture was filtrated by muslin cloth and the filtrate is known as inulin.

Yoghurt manufacturing: Yoghurt samples were made by adding 15 g of skim milk powder per 100 mL water. The yoghurt manufacturing was carried out using the method described by Tamime and Robinson (1999). The reconstituted milk was pasteurized in a water bath for an average of 15 min at 85°C. It is then cooled to 45°C. After cooling the inulin (4 and 6%) and the mucilage (0.2%) were added as stabilizers. The strains culture of Streptococcus salivarius subsp. thermophilus and Lactobacillus delbrueckii subsp. bulgaricus were inoculated at 3% and incubated at 45°C for 4-6 h. At the end of the incubation period, yoghurt was kept in a refrigerator at 5°C along with yoghurt manufactured without using stabilizers (control).

Methods of analysis: Hydrogen ion concentration (pH), Titratable acidity, ash Content, total nitrogen and total solids were estimated according to AOAC (2000).

Total Carbohydrates were determined according the methods described by Taylor (1995). Wheying off is made by a measuring cylinder taking the water separated from the set yoghurt. It was measured by sucking the water on the surface of the curd and pouring it in the cylinder according to AOAC (2000).

Lactose content was determined according to methods described by Dubois *et al.* (1956)

Acetaldehyde was estimated according to methods described by Lees and Jago (1969)

Diacetyl Concentration was estimated according to methods described by Lees and Jago (1970)

Statistical analysis: The data collected from the different treatments were subjected to analysis of variance and whenever appropriate the mean separation procedure of Duncan was employed (Steel and Torrie, 1980). The SAS programme (SAS, 1988) was used to perform the general linear model (GLM) analysis.

RESULTS AND DISCUSSION

The effect of the different stabilizers and storage periods on the pH value of set yoghurt is shown in Table 1. Regardless of the treatments the pH of yoghurt showed significant changes ($p \leq 0.05$) with the increase in the storage period. At any one treatment, the pH at day zero was significantly ($p \leq 0.05$) higher when compared to the pH of the samples stored for 3, 7 and 10 days. On the other hand the pH value of samples stored for 3, 7 and 10 days were similar ($p \leq 0.05$). The changes in the pH value differ according to the different stabilizers used. Regardless of the storage period, the lowest pH value ($p \leq 0.05$) was reported for the control (without stabilizer) while that of treated got the highest pH value. Within inulin treatments, yoghurt treated with inulin 4% had similar pH value ($p \leq 0.05$) to that treated with inulin 6%. Within the stabilizers treatments i.e., inulin 4, 6% and mucilage 0.2%, all the treatments showed similar pH values ($p \geq 0.05$).

Titratable Acidity (TA) values expressed as percentage of lactic acid is listed in Table 2. Titratable acidity was significantly higher $p \leq 0.05$ for samples stored for 10 days than that at the beginning of storage period (day zero). Generally within each stabilizer treatment TA increased significantly with the increases in storage period. A progressive increase in titratable acidity with storage period could be noticed. The rate of increase varies from one stabilizer to the other, such results agree with the findings of Jogdand *et al.* (1991). When the storage period was disregarded, the control yoghurt (no stabilizer added) had significantly lower TA values ($p \leq 0.05$). Yoghurt stabilized with 0.27% mucilage had higher TA values than the control yoghurt. When the effect of adding 4 or 6% inulin was compared with mucilage, the difference in titratable acidity value decreased with the inulin treatment. Titratable acidity of yoghurt treated with inulin 6% was significantly higher than that produced with inulin 4% however still less than that of mucilage 0.2%. When stabilizers treatments were disregarded, the TA increased by 11, 18, 26% at 3, 7 and 10 days, respectively when compared with that at day zero.

Table 1: Effect of stabilizers at different levels of treatment and the storage period on the pH of the yoghurt

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	4.27±0.05^{a}	4.23±0.02^{b}	4.21±0.03^{c}	4.14±0.03^{d}	4.21±0.06^{B}
Inulin 4%	4.43±0.03^{a}	4.37±0.07^{b}	4.23±0.04^{c}	4.20±0.04^{d}	4.31±0.11^{A}
Inulin 6%	4.38±0.03^{a}	4.30±0.02^{b}	4.32±0.05^{c}	4.24±0.04^{d}	4.31±0.06^{A}
Mucilage 0.2%	4.48±0.05^{a}	4.32±0.06^{b}	4.24±0.04^{c}	4.17±0.02^{d}	4.30±0.12^{A}
Storage time mean	4.39±0.09^{a}	4.31±0.06^{b}	4.25±0.05^{c}	4.19±0.05^{d}	

n = 3, A-D: Means the last row or last column bearing different superscript capital letter(s) are significantly different ($p \leq 0.05$)

Table 2: Changes in titratable acidity of yoghurt treated with different stabilizers stored for up to 10 days

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	0.97±0.07^{d}	1.04±0.02^{c}	1.12±0.02^{b}	1.21±0.02^{a}	1.09±0.10^{A}
Inulin 4%	0.98±0.02^{d}	1.43±0.01^{a}	1.21±0.00^{c}	1.27±0.01^{b}	1.15±0.11^{B}
Inulin 6%	1.07±0.02^{d}	1.09±0.01^{c}	1.13±0.01^{b}	1.24±0.01^{a}	1.13±0.07^{C}
Mucilage 0.2%	0.99±0.02^{d}	1.15±0.01^{c}	1.25±0.01^{b}	1.31±0.01^{a}	1.17±0.13^{A}
Storage time mean	1.00±0.05^{d}	1.11±0.05^{c}	1.18±0.06^{b}	1.26±0.04^{a}	

n = 3; A-D: Means in the last row or last column bearing different superscript capital letter(s) are significantly different ($p \leq 0.05$)

Table 3: Effect of stabilizers treatment and storage period on the wheying-off of yoghurt

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	0.17±0.06^{d}	0.27±0.11^{b}	0.23±0.06^{c}	0.37±0.06^{a}	0.26±0.09^{A}
Inulin 4%	0.13±0.06^{c}	0.17^{b}±0.06^{b}	0.17±0.06^{b}	0.23±0.06^{a}	0.18±0.06^{B}
Inulin 6%	0.13±0.06^{a}	0.10^{b}±0.00^{b}	0.10±0.00^{b}	0.10±0.00^{b}	0.11±0.03^{D}
Mucilage 0.2%	0.17±0.06^{a}	0.13^{b}±0.06^{b}	0.10±0.00^{c}	0.10±0.00^{b}	0.13±0.05^{C}
Storage time mean	0.15±0.05^{b}	0.17±0.09^{AB}	0.15±0.07^{B}	0.20±0.12^{A}	

n = 3; A-D: Means in the last row or last column bearing different superscript capital letter(s) are significantly different ($p \le 0.05$)

Table 4: Effect of stabilizers treatment and storage period on ash content

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	0.98±0.00^{a}	0.97±0.01^{b}	0.98±0.02^{a}	0.98±0.01^{a}	0.98±0.01^{A}
Inulin 4%	0.98±0.01^{b}	0.98±0.01^{b}	0.99±0.02^{a}	0.97±0.01^{c}	0.98±0.01^{A}
Inulin 6%	0.98±0.01^{b}	0.97±0.02^{c}	0.99±0.02^{a}	0.98±0.01^{b}	0.98±0.01^{A}
Mucilage 0.2%	0.98±0.01^{a}	0.97±0.01^{b}	0.98±0.02^{a}	0.98±0.01^{a}	0.98±0.01^{A}
Storage time mean	0.98±0.01^{A}	0.97±0.01^{B}	0.98±0.02^{A}	0.98±0.01^{A}	

n = 3 A-D: Means in the last row or last column bearing different superscript capital letter(s) are significantly different ($p \le 0.05$)

The Wheying off of the set yoghurt was expressed as volume per ml of whey water separated from yoghurt during the storage period is shown in Table 3. Wheying off was significantly higher for the control samples and lower for inulin 6% ($p \le 0.05$). All stabilizers investigated in this study, namely inulin and mucilage had marked effects on the wheying off of the set yoghurt. Apparently mucilage was much effective in reducing wheying off than inulin 4%, however both of them resulted in substantial reduction i.e., 50% and 33% respectively. Within inulin treatments, inulin 6% was more effective than inulin 4% in reducing the wheying off of set yoghurt. On the other hand, inulin 6% was more effective than mucilage 0.27% in reducing wheying off of set yoghurt, a reduction of 58% and 50% could be observed respectively for the two treatments. Regardless of the treatments, the highest whey separated is found to be at day 10 ($p \le 0.05$), while no difference was observed for storage periods 0, 3 and 7 days. No literature was sited to approve or disapprove these results. However, on the consumer point of view whenever the less wheying off the better yoghurt.

Table 4 shows the results of the ash analysis. Irrespective of the storage periods the ash content of all yoghurt samples were similar, showing no differences ($p \le 0.05$). These results agree well with the findings of Tamime and Robinson (1999). Irrespective of the treatment, the ash content of yoghurt showed slight ($p \ge 0.05$) changes with the increase in storage period.

The protein content of yoghurt with or without stabilizer is shown in Table 5. Irrespective of the treatments, the protein content was found to be similar ($p \ge 0.05$) throughout storage periods tested. Regardless of the storage period, the different treatments showed significant differences ($p \le 0.05$), the highest protein content was found for inulin 6% followed by mucilage and the lowest protein content was reported for inulin 4% and the control. Generally the results obtained agree well with the finding of Tamime and Robinson (1999).

When the treatments were disregarded, the protein content of yoghurt was not effected ($p \ge 0.05$) by the storage period.

Table 5: Protein content (%) of yoghurt treated with different stabilizers and stored for up to 10 days

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	4.26 ± 0.04^{a}	4.26 ± 0.01^{a}	4.26 ± 0.02^{a}	3.97 ± 0.61^{b}	4.19 ± 0.29^{C}
Inulin 4%	4.09 ± 0.03^{c}	4.13 ± 0.02^{b}	4.16 ± 0.01^{a}	4.17 ± 0.01^{a}	4.14 ± 0.04^{C}
Inulin 6%	4.55 ± 0.02^{c}	4.57 ± 0.02^{a}	4.56 ± 0.02^{b}	4.57 ± 0.02^{a}	4.56 ± 0.02^{A}
Mucilage 0.2%	4.28 ± 0.02^{d}	4.35 ± 0.03^{c}	4.41 ± 0.03^{b}	4.43 ± 0.02^{a}	4.37 ± 0.06^{B}
Storage period mean	4.30 ± 0.17^{A}	4.33 ± 0.17^{A}	4.35 ± 0.16^{A}	4.29 ± 0.36^{A}	

n = 3; A-D: Means in the last row or last column bearing different superscript capital letter(s) are significantly different ($p\leq0.05$)

Table 6: Effect of stabilizers and storage period on yoghurt carbohydrate content (mg mL^{-1}) stored for up to 10 days

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	0.05 ± 0.00^{c}	0.05 ± 0.00^{c}	0.07 ± 0.00^{b}	0.08 ± 0.00^{a}	0.06 ± 0.02^{D}
Inulin 4%	0.06 ± 0.00^{d}	0.23 ± 0.00^{c}	0.29 ± 0.00^{b}	0.35 ± 0.00^{a}	0.23 ± 0.12^{C}
Inulin 6%	0.05 ± 0.00^{d}	0.34 ± 0.00^{c}	0.37 ± 0.00^{b}	0.42 ± 0.00^{a}	0.30 ± 0.15^{B}
Mucilage 0.2%	0.36 ± 0.00^{d}	0.48 ± 0.02^{c}	0.67 ± 0.00^{b}	0.81 ± 0.00^{a}	0.58 ± 0.18^{A}
Storage period mean	0.13 ± 0.14^{D}	0.28 ± 0.16^{C}	0.35 ± 0.22^{B}	0.42 ± 0.27^{A}	

The effect of stabilizers and storage period on the carbohydrate content of yoghurt is shown in Table 6. The content of carbohydrate at different storage periods showed significant differences, the highest ($p = 0.05$) content was reported for day 10 and the lowest value decreased for day 0. Irrespective of the storage periods, the highest ($p = 0.05$) carbohydrate content was observed for mucilage 0.2%. It had about 4, 2.5 and 2 higher carbohydrate compared to the control, inulin 4% and inulin 6%, respectively. It seems that the mucilage had a better performance in keeping higher carbohydrate content and that might be explained by the fact that mucilage has higher carbohydrate precursors according to Rizk (1986). Within the inulin treatments, inulin 6% resulted in significantly higher carbohydrate contents ($p\leq0.05$) than inulin 4%

The total lactose content is shown in Table 7. The results obtained for storage period showed decreased lactose content with the increase in storage period. The highest ($p\leq0.05$) content was observed in day 0 and the lowest in day 10, which shows the effect of the starter culture. The addition of the different ratio of stabilizers showed similar lactose content ($p\geq0.05$), these findings agree with the concept of reduced lactose and the ratio obtained was less than the results according to (Fellows, 2000).

The effects of stabilizers and storage period on the total solids content of yoghurt are shown in Table 8. The results obtained for the different treatments indicated significant differences in total solids content ($p\leq0.05$). A range of 13.56-14.26% was found for the different treatment the highest total solids were expressed by mucilage treatment followed by inulin 6, 4% and the control. These results agree well with the findings of Tamime and Robinson (1999) where they used skimmed milk for yoghurt manufacture. With respect to the storage period, the results showed a significant increase in total solids with the increase in storage periods ($p\leq0.05$). This increase in total solids can be explained partially by the increase in titratable acidity and the increase in total carbohydrates.

The concentration of acetaldehyde in yoghurt samples is presented in Table 9 with respect to storage period the results showed an increase in acetaldehyde concentration with the increase in

Table 7: Changes in lactose (%) of yoghurt treated with different levels of stabilizers and stored for up to 10 days

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	2.08±0.08^{a}	1.56±0.03^{b}	1.00±0.03^{c}	0.82±0.08^{d}	1.37±0.52^{A}
Inulin 4%	1.91±0.02^{a}	1.79±0.02^{b}	1.20±0.30^{c}	0.62±0.03^{d}	1.38±0.55^{A}
Inulin 6 %	2.06±0.06^{a}	1.69±0.02^{b}	1.13±0.03^{c}	0.79±0.01^{d}	1.42±0.52^{A}
Mucilage 0.2%	1.96±0.03^{a}	1.64±0.05^{b}	1.00±0.00^{c}	0.90±0.01^{d}	1.37±0.46^{A}
Storage period mean	2.00±0.09^{A}	1.67±0.09^{B}	1.08±0.16^{C}	0.78±0.11^{D}	

n =3 A-D: Means in the last row or last column bearing different superscript capital letter(s) are significantly different ($p\leq 0.05$)

Table 8: Effect of stabilizers and storage periods on the total solid content of yoghurt stored for up to 10 days

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	13.09±0.02^{d}	13.49±0.05^{c}	13.67±0.07^{b}	13.97±0.03^{a}	13.56±0.33^{D}
Inulin 4%	13.40±0.04^{c}	13.88±0.01^{b}	14.38±0.02^{d}	14.74±0.05^{a}	14.10±0.33^{B}
Inulin 6%	13.28±0.04^{d}	13.58±0.03^{b}	14.37±0.03^{c}	14.85±0.04^{a}	14.02±0.65^{C}
Mucilage 0.2%	13.62±0.08^{c}	13.98±0.03^{a}	14.53±0.03^{d}	14.91±0.03^{b}	14.26±0.52^{A}
Storage period mean	13.35±0.2^{D}	13.74±0.21^{C}	14.24±0.35^{B}	14.62±0.40^{A}	

n = 3 A-D: Means in the last row or last column bearing different superscript capital letter(s) are significantly different ($p\geq 0.05$)

Table 9: Acetaldehyde concentration (μmol/100 mL) in yoghurt treated with different stabilizers and stored for up to 10 days

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	0.14±0.02^{d}	0.22±0.02^{c}	0.26±0.01^{b}	0.36±0.02^{a}	0.25±0.08^{A}
Inulin 4%	0.14±0.01^{d}	0.20±0.01^{c}	0.23±0.02^{b}	0.33±0.01^{a}	0.22±0.07^{B}
Inulin 6%	0.12±0.00^{d}	0.17±0.02^{c}	0.23±0.01^{b}	0.33±0.01^{a}	0.21±0.08^{C}
Mucilage 0.2%	0.12±0.01^{d}	0.16±0.01^{c}	0.24±0.02^{b}	0.34±0.02^{a}	0.22±0.09^{BC}
Storage period mean	0.13±0.01^{D}	0.19±0.02^{C}	0.24±0.02^{B}	0.34±0.02^{A}	

n = 3; A-D: Means in the last row or last column bearing different superscript capital letters are significantly different ($p\geq 0.05$)

storage periods. This increase with storage period is significantly different from each other ($p\geq 0.05$). The highest concentration is found in the day 10 followed by 7 and day 3. The present results are in accordance with that reported by Lees and Jago (1976) who showed that Lactobacillus bulgaricus was able to produce acetaldehyde. In relation to the different treatments the results showed significant differences between the control, inulin 4% and inulin 6% ($p\leq 0.05$). Highest concentrations were reported for the control, inulin 4% and inulin 6%, respectively. However, the concentration of the mucilage was found similar to the inulin 4, 6% and significantly different from the control.

The diacetyl concentration in yoghurt is shown in Table 10. At any one treatment, the diacetyl concentration in yoghurt increased significantly ($p\leq 0.05$) with the increase in the storage period. The highest is reported for 10, 7, 3 and day 0. The results of the treatments on the diacetyl concentration revealed a similar performance with respect to inulin 4 and 6% ($p\geq 0.05$). Significant differences were observed for the control inulins and mucilage ($p\leq 0.05$).

Table 10: Diacetyl concentration (µmol/100 mL) of yoghurt treated with different stabilizers and stored for up to 10 days

	Storage period day^{-1}				
Yogurt	0	3	7	10	Treatment mean
Control	0.03±0.00^{d}	0.04±0.00^{c}	0.06±0.00^{b}	0.07±0.00^{a}	0.05±0.02^{C}
Inulin 4%	0.04±0.00^{d}	0.05±0.01^{c}	0.07±0.00^{b}	0.08±0.00^{a}	0.06±0.02^{B}
Inulin 6%	0.03±0.00^{d}	0.05±0.00^{c}	0.07±0.00^{b}	0.08±0.00^{a}	0.06±0.02^{B}
Mucilage 0.2%	0.09±0.00^{b}	0.09±0.00^{b}	0.09±0.00^{b}	0.10±0.00^{a}	0.10±0.01^{A}
Storage period mean	0.05±0.03^{D}	0.06±0.02^{C}	0.07±0.01^{B}	0.08±0.01^{A}	

n = 3; A-D: Means in the last row or last column bearing different superscript capital letters are significantly different ($p \geq 0.05$)

CONCLUSION AND RECOMMENDATIONS

Based on the results obtained from physical and chemical analysis of yoghurt made using different stabilizers; inulin 4%, inulin 6% and mucilage 0.2%, it was found that these stabilizers contain nutrients and flavor compounds suitable for yoghurt manufacture. Fiber content, acceptability evaluation, viscosity, digestibility and metabolism of this product not included since they are outside the scope of the present study. However, these parameters need further research and investigation.

There is a potential for the use of inulin and mucilage as stabilizers in the manufacture of yoghurt. Inulin and mucilage could be good substitutes or partial replaces to some of the well known stabilizers in yoghurt industry. Further research is recommended to study some stabilizer aspects of inulin and mucilage to address.

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