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Application of Encapsulation to Improve Viability of *Bifidobacterium Bifidum* DSM20082 in Zabady Containing some Herbs

Sobhey M.S. Ghaly [1] , Nabil M. Safwat [2], Hamid M. Ziena [3] , Abeer M. Abd -Elhamid [3] and Eman T. A. Yousef [1]

ABSTRACT

The objective of this research is to incorporate microencapsulated *Bifidobacterium bifidum* DSM20082 in zabady. This fermented dairy products containing 2% cold or hot water extracted clove and cinnamon , in order to study the different effects of these extracts on chemical , microbiological , rheological and organoleptic properties of zabady during storage at 6 ± 2.0°C for 15 days. Extrusion technique was used to produce microencapsulated *Bifidobacterium bifidum* DSM20082 using three different carrier material (1.0 % k-carrageenan , 0.05 % xanthan gum and 2.0 % gelatin) in the presence of 2% sodium alginate and 0.5% inulin as a prebiotic source . The results showed that the addition of 2% cold or hot water cinnamon and clove extracts resulted in better compactness of viability of *Bifidobacterium bifidum* DSM20082 (free or encapsulated). Which increased significantly bacterial counts compared to control (0%) but viable counts of *Bifidobacterium bifidum* DSM20082 were slightly decreased at 10% compared to control (0%) . The titratable acidity of the examined treatments of zabady increased during the storage period with simultaneous decreasing trend of the pH values. Total viability of *Bifidobacterium bifidum* DSM20082 was higher in zabady samples containing cold extract of clove and cinnamon, and encapsulated cells showed better viability in comparison with non encapsulated. Coliform bacteria were not detected till the end of storage period in all treatments. Viable counts of *Streptococcus thermophiles* and *Lactobacillus delbrueckii* subsp. *bulgaricus* declined approximately (1.3 - 1.8 $\log_{10}$ cfu/g) after 15 days of storage period, but in all treatments viable cells remained above (10^6 cfu /g). Regarding organoleptically and instrumentally evaluated textural attributes, significant differences were observed among all zabady treatments. The total scores of organoleptic properties slightly decreased in all treatments. The treatment (x4) containing encapsulated *Bifidobacterium bifidum* DSM20082 with 0.05% xanthan gum and 2% cold water extract of cinnamon had the highest total scores point 95.81 (after 5 days) and 92.49 (after 15 days) of storage period.

Keywords: zabady, Bifidobacterium bifidum, cinnamon, clove .

INTRODUCTION

The FAO / WHO define probiotic bacteria as: "Live microorganisms that give the host a health advantage when managed in appropriate quantities." In the final product, items that claim to contain probiotic bacteria should have a concentration of 10^6-10^7 cfu per gram of feasible probiotic bacteria (FAO / WHO, 2001). These microorganisms contribute to microbial intestinal adjustment and lead to health maintenance. The probiotic microorganisms consist mostly of the strains of the genera Lactobacillus and Bifidobacterium. Together they play an significant role in protecting the organism from damaging microorganisms, as well as strengthening the immune system of the host. (Soccol *et al.* 2010) .They have a positive effect on gastrointestinal infections, antimicrobial activity, boost the immune system, reduce serum cholesterol, aid in the metabolism of lactose, possess antimutagenic characteristics, anti-carcinogenic properties, anti-diarrheal properties, relieve symptoms of inflammatory and intestinal disease, and suppress infection induced by *Helicobacter pylori*. (Christmas, 2007). Probiotic bacteria are currently primarily included in dairy products such as yogurt, fermented milk, milk powder, ice cream, cheese, frozen desserts and chocolate products (Ranadheera *et al.* 2010).

Prebiotics are non-digestible substances that have beneficial physiological effects on the host by specifically boosting the beneficial growth or activity of a restricted amount of native bacteria (Gibson and Roberfroid, 1995). Inulin may have a defensive effect on

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[1]Dairy Research Dept., Food Technology Research Institute, Agricultural Research Center , Egypt.

[2] Dairy Science & Technology Dept., Faculty of Agric. El-Shatby, Alexandria Univ., Egypt.

[3] Food, Dairy Science & Technology Dept., Faculty of Agric., Damanhour Univ., Egypt.

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probiotic crops, with extended survival and action counting (Aryana and Mcgrew, 2007).

Encapsulation is a mechanical or physiochemical method that traps materials that are susceptible to external environments. It offers a safety barrier between indoor and outdoor circumstances. (Mitropoulou *et al.* 2013). Microencapsulation method was frequently used in the past research including extrusion, emulsion, and spray drying methods that enhance probiotic bacteria's viability in negative circumstances compared to free cells (Kartheek *et al.* 2013). The selection of protective matrix components is an significant factor in enhancing probiotic bacteria stability, the most common among them being sodium alginate gels in the presence of divalent cations (Anal and Singh, 2007).

Zabady is the most popular yoghurt-like product in Egypt and Sudan. Due to excellent taste, strong nutritional and therapeutic values, zabady retained its popularity and daily consumption in the Egyptian diet. (Robinson and Tamime, 1999).

Herbs and spices are invaluable resources, useful in daily life as food additives, flavours, fragrances, pharmaceuticals, colours or directly in medicine . (Maroto-Diaz *et al.* 2002). Cloves are used as a carminative for increasing stomach hydrochloric acid and improving peristalis. It is also used in dentistry where the vital clove oil for dental emergencies is used as anadyne. The cloves are also antimutagenic, anti-inflammatory, antioxidant, antiulcerogenic, antithrombotic, antiparasitary, and antibacterial. (Singh and Pandey, 2011). In spices and food preservation, *cinnamomum zeylonium* (cinnamon) has been commonly eaten. In the form of vital oils and multiple extracts, cinnamon is added to food goods. Cinnamon has both antimicrobial and antioxidant activities. It also demonstrates prospective antipyretic and antiallergenic activity. (Amirdivani, 2008)

Therefore, the objectives of this study were to encapsulate *Bifidobacterium bifidum* DSM20082 by using extrusion technique and incorporating into zabady supplemented with herbal extracts clove and cinnamon and the influence of these additives on the chemical, microbiological, rheological and organoleptic properties of zabady.

MATERIALS AND METHODS

MATERIALS

Bifidobacterium bifidum DSM20082 was obtained from Egyptian Microbial Culture collection (Cairo MIRCEN), Faculty of Agriculture, Ain Shams University.

Yogurt starter (*Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*), was obtained from CHR. HANSAN, Denmark (DVS culture, Express 0.1) .

Clove and cinnamon powders were obtained from the local spices market of Damanhour, Bihera Government, Egypt .

METHODS

a - Microencapsulation procedure

Preparation of microcapsules: Microcapsules were prepared using extrusion technique. Sodium alginate solution was prepared by mixing the dry powder of sodium alginate (matrix) (CAS No : 9005- 38-3/MB114-100G) in distilled water using magnetic stirrer . The encapsulated microcapsules were prepared using extrusion technique as described by Donthidi *et al*. (2010) and El-Abd *et al*. (2018).

The conditions used in the experimental work for the probiotic cells encapsulation were:

1 - (2% sodium alginate + 0.5 % inulin + 0.05 % xanthan gum)

2- (2% sodium alginate + 0.5% inulin + 1% k-carrageenan)

3 - (2% sodium alginate + 0.5 % inulin + 2% gelatin)

Briefly, 2 g sodium alginate and inulin (0.5 %) were added to 100 mL distilled water and boiled until gel a formation. Then 1.0 % probiotic cultures were added to the mixture at 42 °C under sterile conditions.

To form capsules, the mixture was dripped into a solution containing $CaCl_2$(0.1 M) and dripping was achieved with a sterile syringe. The distance between syringe and $CaCl_2$ solution was 10 cm. The droplets formed gel spheres instantaneously. Microspheres were hardened 30 min in $CaCl_2$, and then rinsed with sterile NaCl (8.5 g/L) and stored in sterile 0.1% peptone solution at 4 °C.

b- Preparation of clove and cinnamon extracts

Cold water extract was prepared by adding 10 g of dried spices in 250 ml flask containing 100 ml of sterile distilled water (Abdelfadel *et al*. 2016) .The mixture was kept in the refrigerator at 6 ± 2.0°C for 24 h. then stirred and centrifugated at 4000 xg /10 min (Abd El-Khalek *et al*. 2016). The extract was then sterilized by membrane filtration (0.45 µm) (Farag and Sahar ,2001) and stored in the refrigerator at 6 ± 2.0°C .

Hot water extract was prepared by adding 10g of dried spices with 150 ml of sterile distilled water in a 250 ml flask and boiled for 5 min. Then stirred , centrifugated at 4000 xg /10 min and filtered using filter paper (Abd El-Khalek *et al*. 2016). The extract then was sterilized at 121 °C for 15 min, and stored in the refrigerator at 6 ± 2.0°C.

Table 1. Preparation of control and herbal zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082

Treatments			
F1	Free bacteria (control)	X1	encapsulated with xanthan gum (control)
F2	Free bacteria + 2% clove cold water extract	X2	encapsulated with xanthan gum +2% clove cold water extract
F3	Free bacteria + 2% clove hot water extract	X3	encapsulated with xanthan gum + 2% clove hot water extract
F4	Free bacteria + 2% cinnamon cold water extract	X4	encapsulated with xanthan gum + 2% cinnamon cold water extract
F5	Free bacteria + 2% cinnamon hot water extract	X5	encapsulated with xanthan gum +2% cinnamon hot water extract
K1	encapsulated with kappa-carrageenan (control)	G 1	encapsulated with gelatin (control)
K2	encapsulated with kappa-carrageenan +2% clove cold water extract	G 2	encapsulated with gelatin + 2% clove cold water extract
K3	encapsulated with kappa-carrageenan + 2% clove hot water extract	G 3	encapsulated with gelatin + 2% clove hot water extract
K4	encapsulated with kappa-carrageenan + 2% cinnamon cold water extract	G 4	encapsulated with gelatin + 2% cinnamon cold water extract
K5	encapsulated with kappa-carrageenan +2% cinnamon hot water extract	G 5	encapsulated with gelatin + 2% cinnamon hot water extract

c- Effect of clove and cinnamon extracts on growth of *Bifidobacterium bifidum* DSM20082

Bifidobacterium bifidum DSM20082 was separately activated twice in 10 ml of MRS broth. Then 1% inoculated of strain was transferred into MRS broth containing (0, 2 % , 6 % and 10 %) of clove or cinnamon extract and incubated as mentioned later (El-Abd *et al*. 2018)). Pour plate count technique was performed using MRS agar to assess bacterial counts which were expressed as $\log_{10}$ cfu/ml.

d-Manufacture of zabady

Fresh buffalos' milk (standardized 4.1 % fat) was heated to 90 °C / 15 min rapidly cooled at 43 ±1°C then divided to 20 equal portions (see Table 1) . After that different herbal extracts were added with a 2% concentration. All treatments inoculated with 2% starter culture and 1 % free or encapsulated *Bifidobacterium bifidum* DSM20082. The mixture was filled into 100 ml plastic cups, all treatments were incubated at 37°C until the fermentation then cooled to 6 ± 2.0°C.The resulting zabady was stored in the refrigerator at 6 ± 2.0°C for 15 days .Samples were taken when fresh and after 5,10 and 15 days of storage and alanyzed chemically, microbiologically, rheologically and organoleptically.

3- Analysis

After that incorporating encapsulated *Bifidobacterium bifidum* DSM20082 into zabady supplemented with clove and cinnamon extracts. The chemical, microbiological , rheological and organoleptic properties were studied in tested zabady samples induplicate.

a- Morphology of microencapsulated probiotics

The morphology of microencapsulated probiotics was examined by scanning electron microscope (JEOL) (JSM-5300) at an accelerating voltage potential of 20 KV.

b- Chemical analysis

1- Titratable acidity

Titratable acidity of the samples was determined as lactic acid % according to AOAC (2005).

2- pH value

The pH values of the samples were measured using a glass electrode pH meter, type Digital (Model 3305 , Jenway) .

c- Microbiological tests: all these tests were done in duplicates **.**

1 -Total bacterial count

Total bacterial count was enumerated as described by Foster *et al*., (1957) using plate count agar (P.C.A) medium according to (Difco, 1984). Plates were incubated at 37 °C for 48 h.

2 –Enumeration of coliform bacteria

Coliform bacteria were enumerated as described by Foster *et al*., (1957) using endo agar (E.A) medium

according to (Difco, 1984). Plates were incubated at 37 °C for 48 h.

3 –Enumeration of *Streptococcus thermophilus*

Streptococcus thermophilus was enumerated as described by Norme (1991) using M17 medium . plates were incubated at 37 °C for 48 h.

4- Enumeration of *Lactobacillus delbrueckii* subsp. *bulgaricus*

Lactobacillus delbrueckii subsp. *bulgaricus* was enumerated as described by Shah, (2000) using MRS adjusted at pH 5.2 at 37 °C for 48 h under anaerobic incubation.

5–Enumeration of *Bifidobacterium bifidum*

Bifidobacterium bifidum was enumerated as described by Ruben *et al.*(1996) using modified MRS + L-cysteine (0.05% w/v) + (0.3 % lithium chloride) + (0.002 % resazurin) . Filter-sterilized L-cysteine (0.05% w/v) was added to lower the oxidation reduction potential of the medium and to enhance the growth of anaerobic *Bifidobacterium bifidum*. Plates were incubated in duplicates anaerobically at 37°C for 48-72h.

d- Rheological properties

Instrumental textural characteristics of zabady treatments were evaluated in terms of hardness, consistency, cohesiveness and viscosity index using Texture Analyzer TPA (M / s Stable Micro Systems, Surrey, UK) with 10 kg load cell .A back extrusion test using 40mm cylinder probe was used for texture profile analysis of the samples. The product was subjected to compressive force by probe up to the distance of 30 mm (Rosenthal 2010).

e- Organoleptic properties

Zabady samples were organoleptically evaluated according to El-Garawany, (2004)). Organoleptic properties (flavor, body and texture & appearance) were measured at 5 and 15 of storage by 15 test panels from the department staff. The panelists judged the samples according the following points : Flavor (60 points), body & texture (30 points) and appearance (15 points) with a total acceptance of 100 points.

f-Statistical analysis

SPSS 16 .0 (Statistical Package for the Social Science) was the statistical programs used for this study. Data were statistically analyzed using the multivariate tests of variance. Significant differences among individual means were determined at $p< 0.05$ level of significance. The differences among means were tested using Duncan's multiple range tests.

RESULTS AND DISCUSSION

a- Effect of clove and cinnamon extracts on growth of *Bifidobacterium bifidum* DSM20082

Data in Table (2) showed that the addition of 2 and 6% clove or cinnamon extract increased significantly bacterial counts of *Bifidobacterium bifidum* DSM20082 compared to control but viable counts of *Bifidobacterium bifidum* DSM20082 strongly significantly decreased at 10% . Maximum counts of *Bifidobacterium bifidum* DSM20082 were found in the treatment containing encapsulated cells with 0.05 % xanthan gum and 2 % cold water extract of cinnamon (9.91 $\log_{10}$ cfu/ ml) compared to non encapsulated cells (9.64 $\log_{10}$ cfu/ ml). The viable counts decreased slightly at 6 % extracts but there was strongly decreased at 10 % . It might be due to the presence of some antimicrobial components such as Eugenol and Cinnamaldehyde in clove and cinnamon ,respectively. The elevated concentrations of eugenol in clove gives it powerful biological and antimicrobial activities . This phenolic compound can denature proteins and react by altering their permeability with cell membrane phospholipids (Guan *et al.* 2007). While cinnamaldehyde-induced cell death was characterized by changes in nuclear morphology, DNA fragmentation and cell morphology (Huang *et al*. 2007). Hammad (2016) reported that water extracts of clove and cinnamon had strong antimicrobial effects, as concentration of 10% from clove and cinnamon made a high inhibition of *Staphylococcus aureus*(18 mm zone).

b-Morphology : Scanning electron microscopy" SEM" of microencapsulated *Bifidobacterium bifidum* DSM20082

Scanning electron microscopy showed that the shape of all microcapsules was generally spherical and uniform. Microencapsulation of *Bifidobacterium bifidum* DSM20082 with gelatin and xanthan gum in the presence of sodium alginate and inulin better shape than kappa carrgeenan . These results agreed with (Livney, 2012) who mentioned that alginate is high mechanical stability , high porosity and tolerance against salts . Xanthan gum have high resistance against acidic conditions , gelatin is amphoteric substance ,while the gel of kappa carrgeenan is very fragile and cannot support mechanical stress conditions.

b- Chemical analysis of zabady

1- Titratable acidity

It is clear from the results given in Table (3) that the titratable acidity of the control and the examined treatments of zabady increased during the storage period at 6 ± 2.0°C for 15 days with simultaneous decreasing trend of the pH values.

Table 2. Effect of different concentrations of clove and cinnamon extracts on the growth of free and encapsulated *Bifidobacterium bifidum* DSM20082 (log_{10} cfu / ml)

Strains	Type of extract	Concentration of extract (%)			
		0 %	2%	6%	10%
Non encapsulated	cold water clove	9.64 ^{c}	9.75 ^{h}	9.65 ^{e}	9.21 ^{d}
	hot water clove		9.78 ^{fgh}	9.67 ^{e}	9.27 ^{c}
	cold water cinnamon		9.82 ^{cdef}	9.71 ^{d}	9.31 ^{bc}
	hot water cinnamon		9.76 ^{gh}	9.65 ^{e}	9.26 ^{c}
Encapsulated with xanthan gum	cold water clove	9.75 ^{a}	9.84 ^{bcde}	9.77 ^{bc}	9.32 ^{bc}
	hot water clove		9.88 ^{b}	9.79 ^{ab}	9.38 ^{a}
	cold water cinnamon		9.91 ^{a}	9.82 ^{a}	9.39 ^{a}
	hot water cinnamon		9.86 ^{bc}	9.74 ^{cd}	9.31 ^{bc}
Encapsulated with Kappa-carrageenan	cold water clove	9.72 ^{ab}	9.81 ^{def}	9.72 ^{d}	9.31 ^{bc}
	hot water clove		9.85 ^{bcd}	9.74 ^{cd}	9.35 ^{ab}
	cold water cinnamon		9.86 ^{bc}	9.75 ^{cd}	9.37 ^{a}
	hot water cinnamon		9.79 ^{fgh}	9.71 ^{d}	9.32 ^{bc}
Encapsulated with Gelatin	cold water clove	9.69 ^{b}	9.80 ^{efg}	9.71 ^{d}	9.29 ^{c}
	hot water clove		9.86 ^{bc}	9.73 ^{d}	9.32 ^{bc}
	cold water cinnamon		9.84 ^{bcde}	9.75 ^{cd}	9.35 ^{ab}
	hot water cinnamon		9.78 ^{fgh}	9.67 ^{e}	9.28 ^{c}

Different superscripts(a,b,c,d,e,f, g, h) in the same column are significantly different ($p < 0.05$). cfu = Colony forming unit

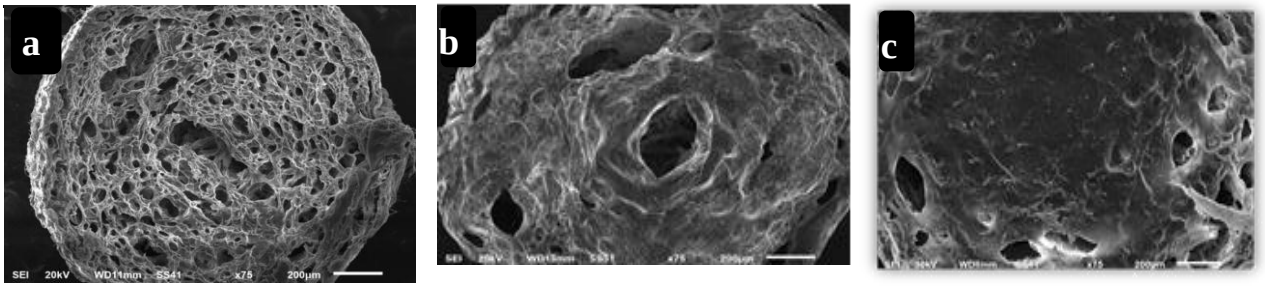

Figure 1. The SEM photography of microencapsulated *Bifidobacterium bifidum* DSM20082 with :

a- (2% Sodium alginate + 0.5 % inulin + 1% kappa-carrageenan).

b-(2% Sodium alginate + 0.5 % inulin + 0.05 % xanthan gum).

c- (2% Sodium alginate + 0.5 % inulin + 2 % gelatin)

Table 3. Changes in titratable acidity (%) of zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082 during storage at 6 ± 2.0°C for 15 days

Treatment	Storage period (day)			
	Fresh	5	10	15
F1	0.88 ^{ab}	0.94 ^{abc}	1.01 ^{abcd}	1.08 ^{abcd}
F2	0.87 ^{abc}	0.92 ^{abcd}	0.98 ^{bcd}	1.04 ^{cde}
F3	0.90 ^{a}	0.97 ^{a}	1.04 ^{a}	1.12 ^{a}
F4	0.87 ^{abc}	0.91 ^{bcd}	0.97 ^{cd}	1.03 ^{de}
F5	0.89 ^{ab}	0.95 ^{abc}	1.03 ^{ab}	1.08 ^{abcd}
X1	0.86 ^{abc}	0.93 ^{abcd}	0.99 ^{abcd}	1.03 ^{de}
X2	0.85 ^{bc}	0.92 ^{abcd}	0.99 ^{abcd}	1.02 ^{d}
X3	0.89 ^{ab}	0.94 ^{abc}	1.02 ^{abc}	1.08 ^{abcd}
X4	0.83 ^{c}	0.88 ^{d}	0.96 ^{d}	1.02 ^{d}
X5	0.87 ^{abc}	0.93 ^{abcd}	0.99 ^{abcd}	1.06 ^{bcde}
K1	0.86 ^{abc}	0.94 ^{abc}	0.98 ^{bcd}	1.04 ^{cde}
K2	0.88 ^{ab}	0.92 ^{abcd}	0.97 ^{abcd}	1.02 ^{d}
K3	0.89 ^{ab}	0.95 ^{abc}	1.03 ^{ab}	1.11 ^{ab}
K4	0.87 ^{abc}	0.90 ^{cd}	0.97 ^{cd}	1.02 ^{d}
K5	0.88 ^{ab}	0.92 ^{abcd}	0.98 ^{bcd}	1.04 ^{cde}
G 1	0.87 ^{abc}	0.93 ^{abcd}	0.99 ^{abcd}	1.03 ^{de}
G 2	0.87 ^{abc}	0.92 ^{abcd}	0.97 ^{cd}	1.02 ^{d}
G 3	0.90 ^{a}	0.96 ^{ab}	1.02 ^{abc}	1.09 ^{abc}
G 4	0.85 ^{bc}	0.91 ^{bcd}	0.97 ^{cd}	1.01 ^{d}
G 5	0.87 ^{abc}	0.94 ^{abc}	1.00 ^{abcd}	1.05 ^{cde}

Please refer to the Table 1 in which zabady treatments have been listed.

Different superscripts(a,b,c,d,e) in the same column are significantly different ($p < 0.05$).

These results were in agreement with those obtained by Kebary and Hussein (1999) & Akin and Guler-Akin (2005). Increasing of titratable acidity during storage was attributed to the harmony effect of relatively high acidity by lactic acid bacteria. Also, these increasing acidity in some samples containing clove and cinnamon extracts compared to the control due to the chemical composition of clove containing aromatic compounds (Jayaprakasha *et al*. 2006) who mentioned that the clove is rich in acids including phenolic acids (gallic acid and its derivatives), caffeic, ferulic, salicylic and elagic acids. Also, water extract of cinnamon has different phenolic compounds including cinnamtannin B-1, protocatechuic acid, urolignoside, rutin and quercetin

2- pH values

Data presented in Table (4) show the changes in pH values for the different treatments of zabady containing free and encapsulated *Bifidobacterium bifidum* DSM20082 . The titratable acidity and pH values are of great importance from stand point of the quality of the final product .Hence, the changes in pH and acidity depend on the changes in lactose or other carbohydrate and different phenolic compounds in clove and cinnamon extract .There were simple differences in pH value in all treatments till the end of storage period. Moreover, the samples made with the addition of cinnamon hot water extract had the lowest of pH values . It might be due to the water extract of cinnamon has different phenolic compounds including cinnamtannin B-1, protocatechuic acid, urolignoside, rutin and quercetin (Jayaprakasha *et al.*, 2006).

C- Microbiological tests

1 -Total bacterial count

As shown in Table (5), the total bacterial count decreased gradually in control and treatments containing clove or cinnamon extracts as storage period progressed. It can be noticed that the control had higher total bacterial count at all intervals of storage as compared with that of the other treatments also, total bacterial count decreased in the presence of the concentration of the clove extract as (Khadija *et al.*

Table 4. Changes in pH values of zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082 during storage at 6 ± 2.0°C for 15 days

Treatment	Storage period (day)			
	Fresh	5	10	15
F1	4.96 ^{ghij}	4.88 ^{efg}	4.80 ^{efg}	4.71 ^{de}
F2	4.98 ^{efgh}	4.91 ^{def}	4.82 ^{defg}	4.73 ^{bcde}
F3	5.04 ^{abcd}	4.97 ^{abcd}	4.89 ^{abc}	4.80 ^{abc}
F4	4.98 ^{efgh}	4.90 ^{defg}	4.83 ^{cdefg}	4.76 ^{abcde}
F5	4.92 ^{j}	4.85 ^{g}	4.78 ^{fg}	4.68 ^{f}
X1	4.99 ^{defg}	4.91 ^{def}	4.83 ^{cdefg}	4.74 ^{abcde}
X2	5.02 ^{cdef}	4.94 ^{bcde}	4.86 ^{bcde}	4.76 ^{abcde}
X3	5.09 ^{a}	5.02 ^{a}	4.92 ^{a}	4.82 ^{a}
X4	5.03 ^{bcde}	4.93 ^{cde}	4.87 ^{abcd}	4.78 ^{abcd}
X5	4.99 ^{defg}	4.90 ^{defg}	4.81 ^{defg}	4.72 ^{cde}
K1	4.97 ^{fghij}	4.88 ^{efg}	4.80 ^{efg}	4.73 ^{bcde}
K2	5.03 ^{bcde}	4.93 ^{cde}	4.84 ^{bcdef}	4.75 ^{abcde}
K3	5.07 ^{ab}	5.00 ^{ab}	4.90 ^{ab}	4.81 ^{b}
K4	4.98 ^{efgh}	4.91 ^{def}	4.85 ^{bcde}	4.76 ^{abcde}
K5	4.94 ^{hij}	4.86 ^{fg}	4.77 ^{g}	4.69 ^{f}
G 1	5.00 ^{defg}	4.91 ^{def}	4.81 ^{defg}	4.74 ^{abcde}
G 2	4.99 ^{defg}	4.90 ^{defg}	4.81 ^{defg}	4.76 ^{abcde}
G 3	5.08 ^{ab}	4.99 ^{abc}	4.89 ^{abc}	4.82 ^{a}
G 4	5.02 ^{cdef}	4.93 ^{cde}	4.85 ^{bcde}	4.78 ^{abcd}
G 5	4.93 ^{ij}	4.89 ^{defg}	4.80 ^{efg}	4.71 ^{de}

Please refer to the Table 1 in which zabady treatments have been listed.
Different superscripts(a,b,c,d,e …….,j) in the same column are significantly different ($p < 0.05$).

Table 5. Total bacterial count ($\log_{10}$ cfu/ g) of zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082 during storage at 6 ± 2.0°C for 15 days

Treatments	Storage period (day)			
	Fresh	5	10	15
F1	8.41 ^{b}	8.08 ^{bc}	7.87 ^{a}	7.43 ^{a}
F2	8.48 ^{a}	8.15 ^{a}	7.67 ^{d}	7.26 ^{cd}
F3	8.14 ^{hij}	7.90 ^{efg}	7.39 ^{hi}	6.92 ^{h}
F4	8.30 ^{cd}	8.04 ^{cd}	7.60 ^{e}	7.21 ^{de}
F5	8.19 ^{fgh}	7.95 ^{e}	7.46 ^{fg}	6.85 ^{i}
X1	8.25 ^{def}	7.94 ^{ef}	7.71 ^{cd}	7.34 ^{b}
X2	8.31 ^{cd}	8.06 ^{c}	7.50 ^{f}	7.20 ^{def}
X3	7.99 ^{l}	7.53 ^{l}	7.28 ^{j}	6.84 ^{jk}
X4	8.25 ^{def}	7.89 ^{fg}	7.42 ^{gh}	7.09 ^{g}
X5	8.07 ^{k}	7.83 ^{hi}	7.37 ^{hi}	6.78 ^{jkl}
K1	8.27 ^{de}	8.03 ^{cd}	7.78 ^{b}	7.38 ^{ab}
K2	8.35 ^{c}	8.08 ^{bc}	7.56 ^{e}	7.28 ^{c}
K3	8.08 ^{jk}	7.63 ^{k}	7.21 ^{k}	6.87 ^{hi}
K4	8.23 ^{efg}	7.85 ^{gh}	7.48 ^{f}	7.14 ^{fg}
K5	8.17 ^{ghi}	7.79 ^{i}	7.35 ^{i}	6.81 ^{jkl}
G 1	8.29 ^{cde}	8.00 ^{d}	7.74 ^{bc}	7.35 ^{b}
G 2	8.25 ^{def}	8.12 ^{ab}	7.58 ^{e}	7.19 ^{ef}
G 3	8.08 ^{jk}	7.61 ^{k}	7.14 ^{l}	6.81 ^{jkl}
G 4	8.18 ^{ghi}	7.79 ^{i}	7.34 ^{i}	7.08 ^{g}
G 5	8.12 ^{ijk}	7.73 ^{j}	7.23 ^{jk}	6.76 ^{l}

Please refer to the Table 1 in which zabady treatments have been listed.
Different superscripts(a,b,c,d,e …….,j) in the same column are significantly different ($p < 0.05$).

2003) mentioned that the mechanism of the antimicrobial action of clove (eugenol) was capable of inducing cell lysis of both Gram negative and Gram positive bacteria. Also, the cell wall and membrane of the treated bacteria were significantly damaged. (Guan *et al.* 2007) reported that the high levels of eugenol contained in clove had a strong biological activity and antimicrobial activity.

2-Coliform bacteria counts

Coliform bacteria counts have not been detected in all treatments until the end of the storage period. The pasteurized ordinance currently asked needs U.S. dairy processors to test grade "A" dairy goods for coliform appearance to assess the quality and hygiene of completed goods (US FDA, 2011).

3- *Streptococcus thermophilus* counts

Results in Table (6) clearly the viable counts (log $_{10}$ cfu / g) of *Streptococcus thermophilus* in zabady samples during storage at 6± 2.0°C for 15 days . *Streptococcus thermophilus* counts in all treatments were higher than *Lactobacillus delbrueckii* subsp. *bulgaricus* and they remained stable during storage at levels ranging between 10^7 and 10^9 (log $_{10}$ cfu /g) throughout the storage period .These results coincided with what was mentioned by (Kumar *et al* . ,1995) who found counts of *Streptococcus thermophilus* ranged from (7.9 to 8.68 log $_{10}$ cfu /g) .

4- *Lactobacillus delbrueckii* subsp. *bulgaricus* counts

Table (7) shows the viable counts log $_{10}$ cfu / g) of *Lactobacillus bulgaricus* in zabady samples during storage at 6± 2.0°C for 15 days. *Lactobacillus delbrueckii* subsp. *bulgaricus* counts decreased ~ 1.5 ($\log_{10}$ cfu/ g) after 15 days of storage. Previous reports indicated concentrations above(log 10^6 cfu/g) for probiotic and yogurt bacteria after 28 days of cold storage, using milk and milk supplemented with inulin (Donkor *et al*., 2007). These results coincided with what was mentioned by Medina and jordona (1995) found that numbers of *Lactobacillus delbrueckii* subsp. *bulgaricus* decreased faster than *Streptococcus thermophilus* in probiotic fermented milks .

Table 6. Viable counts ($\log_{10}$ cfu/ g) of *Streptococcus thermophilus* in zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082 during storage at 6 ± 2.0°C for 15 days

Treatments	Storage period (day)			
	Fresh	5	10	15
F1	10.61 ^{def}	10.13 ^{bcde}	9.40 ^{bcdefg}	8.52 ^{defghi}
F2	10.64 ^{cde}	10.15 ^{bcde}	9.39 ^{cdefg}	8.50 ^{fghi}
F3	10.56 ^{fg}	10.12 ^{bcde}	9.35 ^{g}	8.46 ^{i}
F4	10.69 ^{abc}	10.19 ^{ab}	9.44 ^{abcd}	8.57 ^{bcde}
F5	10.53 ^{g}	10.10 ^{de}	9.36 ^{fg}	8.50 ^{fghi}
X1	10.65 ^{bcde}	10.14 ^{bcde}	9.40 ^{bcdefg}	8.57 ^{bcde}
X2	10.67 ^{abcd}	10.17 ^{abcd}	9.42 ^{abcdef}	8.54 ^{defg}
X3	10.60 ^{ef}	10.13 ^{bcde}	9.37 ^{efg}	8.47 ^{hi}
X4	10.73 ^{a}	10.24 ^{a}	9.47 ^{a}	8.65 ^{a}
X5	10.64 ^{cde}	10.09 ^{e}	9.35 ^{g}	8.52 ^{defghi}
K1	10.70 ^{abc}	10.23 ^{a}	9.46 ^{ab}	8.58 ^{bcd}
K2	10.72 ^{a}	10.24 ^{a}	9.45 ^{abc}	8.57 ^{bcde}
K3	10.64 ^{cde}	10.17 ^{abcd}	9.38 ^{defg}	8.48 ^{ghi}
K4	10.72 ^{a}	10.23 ^{a}	9.46 ^{ab}	8.63 ^{ab}
K5	10.61 ^{def}	10.08 ^{e}	9.37 ^{efg}	8.48 ^{ghi}
G 1	10.68 ^{abc}	10.18 ^{abc}	9.42 ^{abcdef}	8.56 ^{cdef}
G 2	10.67 ^{abcd}	10.19 ^{ab}	9.39 ^{cdefg}	8.53 ^{defgh}
G 3	10.59 ^{efg}	10.15 ^{bcde}	9.34 ^{g}	8.51 ^{efghi}
G 4	10.71 ^{ab}	10.19 ^{ab}	9.43 ^{abcde}	8.62 ^{abc}
G 5	10.64 ^{cde}	10.11 ^{cde}	9.38 ^{defg}	8.50 ^{fghi}

Please refer to the Table (1) in which zabady treatments have been listed.

Different superscripts(a,b,c,d,e ……,j) in the same column are significantly different ($p < 0.05$).

Table 7. Viable counts (log_{10} cfu/ g) of *Lactobacillus delbrueckii* subsp. *bulgaricus* in zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082 during storage at 6 ± 2.0°C for 15 days

Treatment	Storage period (day)			
	Fresh	5	10	15
F1	9.32 h	8.87 j	8.32 fgh	7.94 cde
F2	9.38 fg	8.91 hij	8.35 cdefgh	7.96 bcde
F3	9.42 def	9.05 bcd	8.41 abc	7.93 cde
F4	9.45 cde	9.07 abc	8.44 ab	8.03 a
F5	8.40 i	8.96 fgh	8.37 cdefg	7.91 de
X1	9.35 gh	8.86 j	8.30 h	7.90 e
X2	9.41 ef	8.94 ghi	8.34 defgh	7.93 cde
X3	9.43 cdef	8.97 efg	8.31 gh	7.91 de
X4	9.49 abc	9.06 bc	8.43 ab	8.01 ab
X5	9.42 def	8.95 fghi	8.35 cdefgh	7.94 cde
K1	9.38 fg	8.90 hij	8.33 efgh	7.93 cde
K2	9.43 cdef	8.97 efg	8.36 cdefgh	7.94 cde
K3	9.48 bcd	9.04 cd	8.39 bcde	7.90 e
K4	9.54 a	9.10 ab	8.46 a	7.99 abc
K5	9.41 ef	8.93 ghi	8.33 efgh	7.91 de
G 1	9.42 def	9.02 cde	8.38 bcdef	7.96 bcde
G 2	9.43 cdef	9.06 bc	8.41 abc	8.01 ab
G 3	9.46 cde	9.07 abc	8.40 bcd	7.98 abcd
G 4	9.52 ab	9.12 a	8.44 ab	8.03 a
G 5	9.44 cdef	9.00 def	8.36 cdefgh	7.94 cde

Please refer to the Table (1) in which zabady treatments have been listed.
Different superscripts(a,b,c,d,e …….,j) in the same column are significantly different ($p < 0.05$).

5 - *Bifidobacterium bifidum* DSM20082 counts

It would be noticed from the data presented in Table (8) that counts of *Bifidobacterium bifidum* DSM20082 gradually decreased with prolongation of storage period .This decline was propably due to the development of acidity in zabady samples. The treatments containing encapsulated cells and cold or hot water extract of clove or cinnamon gave the highest viable *Bifidobacterium bifidum* DSM20082 compare with free cells treatments .On the other hand, the treatments containing encapsulated cells with xanthan gum have the highest viable cells followed by those encapsulated with gelatin. Generally, viability of *Bifidobacterium bifidum* DSM20082 in all treatments remined above 10^6 cfu/ ml until the end of storage period. These results agreed with (FAO/WHO, 2001).The increase in viable counts of bacteria could be attributed to the addition of herbal extract and inulin ,which my act as prebiotic (Aryana and Mcgrew 2007, Amirdivani 2008).

e- Rheological properties:

The rheological and texture characteristics of fermented dairy products rely on their structural structure and protein network microstructure (Delikanli and Ozcan, 2017). Texture is one of the important components of zabady quality and describes the rheological and structural attributes perceptible by means of mechanical, tactile, and visual receptors. Data presented in Tables (9, 10,11 and 12) illustrate the instrumental textural attributes of different zabady samples . Treatments (F5, x5, K5 and G5) which contained hot water extract of cinnamon were found to have higher hardness, gumminess and chewiness values than other treatments . Yogurt with high hardness value also has a high gumminess value (Yildiz *et al.*, 2015) .There were significant differences in parameters textural properties in all treatments.

f- Organoleptic properties :

Table13 indicates the changes in organoleptic-scoring points of different zabady samples. The total score points decreased slightly at 15 days of storage period compared with at 5 days .The best treatment was that made with 2% cold water extract of cinnamon and contained encapsulated cells with xanthan gum . Under ordinary fermentation circumstances, the primary metabolism products are lactic acid, acetic acid, acetaldehyde, ethanol and diacetyl, all contributing to fermented yogurt's particular sour flavor. Herbs contain phytochemicals and this may play important role in causing undesirable organoleptic properties of herbal yogurts. This is because most herbs contain a unique richness and diversity of metabolites responsible for their taste and flavour. Results agreed our with those

Table 8. Viable counts (log_{10} cfu/ g) of *Bifidobacterium bifidum* DSM20082 in zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082 during storage at 6 ± 2.0°C for 15 days

Treatments	Storage period (day)			
	Fresh	5	10	15
F1	10.03 ^{l}	9.64 ^{j}	9.11 ^{j}	7.92 ^{ij}
F2	10.15 ^{jk}	9.81 ^{i}	9.18 ^{hi}	8.04 ^{h}
F3	10.11 ^{k}	9.77 ^{i}	9.13 ^{ij}	7.86 ^{j}
F4	10.21 ^{ij}	9.89 ^{h}	9.24 ^{h}	8.10 ^{h}
F5	10.17 ^{jk}	9.80 ^{i}	9.17 ^{ij}	7.95 ^{i}
X1	10.32 ^{gh}	9.98 ^{g}	9.49 ^{def}	8.63 ^{bcd}
X2	10.50 ^{ab}	10.19 ^{ab}	9.60 ^{ab}	8.70 ^{a}
X3	10.41 ^{def}	10.12 ^{cdef}	9.52 ^{cde}	8.59 ^{cdef}
X4	10.56 ^{a}	10.21 ^{a}	9.62 ^{a}	8.69 ^{ab}
X5	10.47 ^{bcd}	10.14 ^{bcde}	9.56 ^{abcd}	8.61 ^{cd}
K1	10.26 ^{hi}	9.91 ^{h}	9.42 ^{g}	8.58 ^{cdef}
K2	10.43 ^{cdef}	10.14 ^{bcde}	9.51 ^{def}	8.63 ^{bcd}
K3	10.37 ^{fg}	10.06 ^{f}	9.45 ^{fg}	8.53 ^{fg}
K4	10.47 ^{bcd}	10.19 ^{ab}	9.55 ^{bcd}	8.60 ^{cde}
K5	10.39 ^{f}	10.09 ^{ef}	9.50 ^{def}	8.49 ^{g}
G 1	10.28 ^{h}	9.94 ^{gh}	9.46 ^{efg}	8.60 ^{cde}
G 2	10.49 ^{bc}	10.16 ^{abcd}	9.55 ^{bcd}	8.58 ^{cdef}
G 3	10.43 ^{cdef}	10.08 ^{ef}	9.49 ^{def}	8.54 ^{efg}
G 4	10.46 ^{bcde}	10.18 ^{abc}	9.58 ^{abc}	8.64 ^{abc}
G 5	10.40 ^{ef}	10.11 ^{def}	9.51 ^{def}	8.56 ^{def}

Please refer to the Table (1) in which zabady treatments have been listed.
Different superscripts(a,b,c,d,e ……,j) in the same column are significantly different ($p < 0.05$).

Table 9. Instrumental textural attributes of zabady samples prepared from buffaloes' milk and fermented with combination of mixed cultures of zabady starter and free *Bifidobacterium bifidum* DSM20082

Parameters	Treatments				
	F1	F2	F3	F4	F5
Hardness Cycle 1: (g)	223 ^{c}	184 ^{d}	190 ^{d}	244 ^{b}	367 ^{a}
Deformation at Hardness: (mm)	6.99 ^{a}	6.08 ^{d}	6.55 ^{b}	6.18 ^{c}	5.84 ^{e}
Adhesive Force: (g)	16 ^{d}	31 ^{b}	43 ^{a}	11 ^{e}	26 ^{c}
Adhesiveness: (m J)	0.6 ^{c}	1.2 ^{b}	3.0 ^{a}	0.50 ^{c}	1.3 ^{b}
Resilience:	0.10 ^{a}	0.10 ^{a}	0.13 ^{a}	0.11 ^{a}	0.12 ^{a}
Stringiness Length: (mm)	4.95 ^{d}	7.11 ^{b}	7.36 ^{a}	3.42 ^{e}	5.66 ^{c}
Hardness Cycle 2: (g)	183 ^{b}	104 ^{e}	120 ^{d}	139 ^{c}	241 ^{a}
Cohesiveness:	0.51 ^{a}	0.49 ^{a}	0.50 ^{a}	0.41 ^{b}	0.44 ^{b}
Total Work Cycle 2: (m J)	5.6 ^{b}	4.0 ^{e}	4.3 ^{d}	5.0 ^{c}	8.3 ^{a}
Springiness: (mm)	6.14 ^{c}	6.38 ^{b}	6.67 ^{a}	6.66 ^{a}	6.70 ^{a}
Gumminess: (g)	114 ^{b}	90 ^{c}	95 ^{c}	100 ^{c}	163 ^{a}
Chewiness: (m J)	6.8 ^{b}	6.2 ^{d}	6.2 ^{d}	6.5 ^{c}	10.7 ^{a}

Different superscripts(a,b,c,d,e) in the same row are significantly different ($p < 0.05$)

Table 10. Instrumental textural attributes of zabady samples prepared from buffaloes' milk and fermented with combination of mixed cultures of zabady starter and encapsulated *Bifidobacterium bifidum* DSM20082 with (2% Sodium alginate + 0.5 % inulin + 0.05 % xanthan gum)

Parameters	Treatments				
	X1	X2	X3	X4	X5
Hardness Cycle 1: (g)	211 [c]	140 [e]	168 [d]	233 [b]	406 [a]
Deformation at Hardness: (mm)	6.59 [c]	6.99 [a]	6.90 [b]	6.44 [d]	6.99 [a]
Adhesive Force: (g)	36 [a]	8 [e]	11 [d]	23 [b]	20 [c]
Adhesiveness: (m J)	2.6 [a]	0.3 [d]	0.2 [d]	0.9 [b]	0.5 [c]
Resilience:	0.12 [b]	0.12 [b]	0.14 [b]	0.12 [b]	0.36 [a]
Stringiness Length: (mm)	6.56 [a]	.90 [d] 0	0.54 [e]	5.35 [b]	1.21 [c]
Hardness Cycle 2: (g)	128 [d]	100 [e]	125 [c]	165 [b]	314 [a]
Cohesiveness:	0.44 [b]	0.56 [a]	0.58 [a]	0.43 [b]	0.59 [a]
Total Work Cycle 2: (m J)	4.2 [c]	3.3 [d]	4.2 [c]	5.1 [b]	12.2 [a]
Springiness: (mm)	6.48 [b]	6.30 [c]	6.59 [a]	6.28 [c]	6.21 [d]
Gumminess: (g)	94 [c]	78 [d]	98 [b]	100 [b]	165 [a]
Chewiness: (m J)	6.0 [b]	4.8 [c]	6.3 [b]	6.2 [b]	14.7 [a]

Different superscripts(a,b,c,d,e) in the same row are significantly different ($p < 0.05$)

Table 11. Instrumental textural attributes of zabady samples prepared from buffaloes' milk and fermented with combination of mixed cultures of zabady starter and encapsulated *Bifidobacterium bifidum* DSM20082 with (2% Sodium alginate + 0.5 % inulin + 1 % kappa-carrageenan)

Parameters	Treatments				
	K 1	K 2	K 3	K 4	K 5
Hardness Cycle 1: (g)	268 [d]	356 [b]	218 [e]	301 [c]	408 [a]
Deformation at Hardness: (mm)	6.99 [a]	6.94 [b]	6.13 [c]	5.38 [d]	7.00 [a]
Adhesive Force: (g)	12 [e]	20 [c]	42 [a]	16 [d]	28 [b]
Adhesiveness: (m J)	0.2 [e]	0.6 [c]	2.8 [a]	0.3 [d]	0.7 [b]
Resilience:	0.28 [a]	0.28 [a]	0.09 [c]	0.09 [c]	0.17 [b]
Stringiness Length: (mm)	1.2 [e]	2.12 [d]	6.21 [a]	2.25 [c]	5.25 [b]
Hardness Cycle 2: (g)	199 [d]	257 [b]	131 [e]	206 [c]	323 [a]
Cohesiveness:	0.54 [a]	0.55 [a]	0.39 [c]	0.41 [c]	0.50 [b]
Total Work Cycle 2: (m J)	7.3 [c]	9.8 [b]	4.5 [e]	6.5 [d]	10.6 [a]
Springiness: (mm)	6.49 [b]	6.35 [c]	6.39 [bc]	7.10 [a]	6.45 [bc]
Gumminess: (g)	146 [c]	195 [b]	85 [e]	123 [d]	205 [a]
Chewiness: (m J)	9.3 [c]	12.1 [b]	5.3 [e]	8.5 [d]	13.0 [a]

Different superscripts(a,b,c,d,e) in the same row are significantly different ($p < 0.05$).

Table 12. Instrumental textural attributes of zabady samples prepared from buffaloes' milk and fermented with combination of mixed cultures of zabady starter and encapsulated *Bifidobacterium bifidum* DSM20082 with (2% Sodium alginate + 0.5 % inulin + 2 % gelatin)

Parameters	Treatments				
	G1	G2	G3	G4	G5
Hardness Cycle 1: (g)	345 ^{b}	294 ^{d}	281 ^{e}	339 ^{c}	452 ^{a}
Deformation at Hardness: (mm)	5.93 ^{c}	4.77 ^{e}	5.07 ^{d}	6.14^{b}	6.99 ^{a}
Adhesive Force: (g)	20 ^{d}	33 ^{b}	45 ^{a}	11 ^{e}	26 ^{c}
Adhesiveness: (m J)	1.0 ^{c}	1.5 ^{b}	2.7 ^{a}	0.2 ^{e}	0.5 ^{d}
Resilience:	0.12 ^{b}	0.10 ^{bc}	0.08 ^{bc}	0.12 ^{b}	0.16 ^{a}
Stringiness Length: (mm)	5.35 ^{c}	6.11 ^{b}	6.66 ^{a}	0.3 ^{e}	1.16 ^{d}
Hardness Cycle 2: (g)	245 ^{b}	190 ^{d}	147 ^{e}	233 ^{c}	347 ^{a}
Cohesiveness:	0.43 ^{b}	0.40 ^{b}	0.36 ^{c}	0.41 ^{b}	0.47 ^{a}
Total Work Cycle 2: (m J)	7.6 ^{b}	6.5 ^{d}	5.2 ^{e}	7.1 ^{c}	10.9 ^{a}
Springiness: (mm)	6.42 ^{b}	6.74 ^{a}	6.44 ^{b}	6.27 ^{c}	6.26 ^{c}
Gumminess: (g)	150 ^{b}	118 ^{d}	101 ^{e}	139 ^{c}	211 ^{a}
Chewiness: (m J)	9.4 ^{b}	7.8 ^{d}	6.4 ^{e}	8.6 ^{c}	13.0 ^{a}

Different superscripts(a,b,c,d, e) in the same row are significantly different ($p < 0.05$)

Table 13. Organoleptic-scoring points of zabady manufactured with combination of mixed cultures of zabady along with free or encapsulated *Bifidobacterium bifidum* DSM20082 during storage at 6 ± 2.0°C for 15 days

Treatments	Storage period (day)							
	5				15			
	FL (60)	B& T (30)	App. (10)	Total (100)	FL (60)	B& T (30)	App. (10)	Total (100)
F1	57.45	24.81	9.10	91.36 ^{h}	55.69	22.36	8.35	85.10 ^{k}
F2	57.52	25.08	9.20	91.80 ^{g}	55.70	24.22	8.40	86.82 ^{f}
F3	57.68	25.67	9.15	92.50 ^{f}	55.52	22.08	8.25	84.45 ^{l}
F4	58.45	26.94	9.25	94.64 ^{b}	56.62	26.71	9.10	90.68 ^{c}
F5	57.70	25.95	9.10	92.75 ^{f}	55.10	23.4	8.30	85.60 ^{j}
X1	58.08	25.35	9.10	92.53 ^{f}	54.76	23.34	8.30	86.40 ^{h}
X2	57.44	25.20	9.10	91.74 ^{g}	54.43	24.42	8.45	87.30 ^{e}
X3	57.87	26.45	9.15	93.47 ^{cd}	54.56	22.19	8.20	84.95 ^{k}
X4	58.93	27.58	9.30	95.81 ^{a}	56.69	26.95	8.85	92.49 ^{a}
X5	58.75	25.75	9.15	93.65 ^{c}	53.60	24.15	8.60	86.35 ^{i}
K1	57.53	24.92	9.10	91.55 ^{gh}	53.27	24.23	8.20	85.70 ^{j}
K2	56.28	25.42	9.15	90.85 ^{i}	53.13	25.82	8.40	87.35 ^{e}
K3	56.85	25.65	9.20	91.70 ^{g}	52.80	23.65	8.15	84.60 ^{l}
K4	58.51	26.84	9.25	94.60 ^{b}	56.35	26.70	8.80	91.85 ^{b}
K5	57.7	26.35	9.20	93.25 ^{de}	53.34	24.30	8.25	85.89 ^{j}
G 1	55.9	24.85	9.10	89.85 ^{j}	53.36	23.39	8.20	84.95 ^{k}
G 2	57.5	26.15	9.10	92.75 ^{f}	54.35	23.88	8.35	86.58 ^{g}
G 3	57.07	26.23	9.30	92.60 ^{f}	53.42	23.34	8.00	84.76 ^{l}
G 4	57.58	26.65	9.35	93.58 ^{c}	57.14	24.58	8.40	90.12 ^{d}
G 5	57.67	26.29	9.20	93.16 ^{e}	53.31	24.78	8.35	86.44^{h}

Please refer to the Table (1) in which zabady treatments have been listed.

Different superscripts(a,b,c,……,k, l) in the same column(total score) are significantly different ($p < 0.05$)

FL= Flavor , B& T= Body and texture , App.= Appearance

obtained by Marhamatizadeh *et al.(*2012) who mentioned that cinnamon yogurt was considered by the panelist as the most undesirable in overall taste followed by control yogurt in comparison with other treatments.

CONCLUSION

In conclusion encapsulation of *Bifidobacterium bifidum DSM20082* has been shown to be an effective method for maintaining its viability in zabady compared with non encapsulated bacteria. Addition of 2 % cold or hot water extract of clove or cinnamon promote the growth and viability of *Bifidobacterium bifidum* DSM20082 in zabady and improve the taste and flavor , appearance , and body and texture. Data reported in this study indicated that 2 % cold or hot water extracts of clove or cinnamon may be used as prebiotics.

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الملخص العربي

تطبيق الكبسلة لزيادة حيوية بكتريا ***Bifidobacterium bifidum* DSM20082** الداعمة للحيوية في الزبادي المحتوي على بعض الأعشاب الطبيعية

صبحي ميخائيل، نبيل صفوت، حامد زينه، عبير عبد الحميد وإيمان يوسف

تهدف هذه الدراسة إلى إدماج كبسولات سلالة *Bifidobacterium bifidum* DSM20082 وهي ضمن مجموعة االبكتريا الداعمة للحيوية (probiotic bacteria) في منتج الزبادي المحتوي على مستخلصات القرنفل والقرفة ٢% (على البارد والساخن) لدراسة تأثيراتهم المختلفة على الصفات الكيماوية والميكروبيولوجية والريولوجية والحسية أثناء التخزين على (٦ ± ٢ م) لمدة ١٥ يوم. ولإنتاج الكبسولات تم إستخدام تكنيك Extrusion بإستخدام ثلاث مواد مختلفة وهي (كابا كارجينان١% – صمغ الزانثان ٠,٥ % – جيلاتين ٢%) في وجود ٢% ألجينات صوديوم وأنيولين ٥, % كمصدر للـ(prebioti) أوضحت النتائج ما يلي :

- إضافة مستخلصات القرنفل والقرفة بتركيز ٢% (سواء على البارد أو الساخن) أعطت نتائج جيدة في حيوية بكتريا *Bifidobacterium bifidum* DSM20082 سواء في الصورة الحرة أوفي صورة كبسولات حيث حدثت زيادة معنوية بالمقارنة بالكنترول (بدون إضافات).
- زيادة تركيز المستخلصات إلى ١٠ % أدي إلى حدوث إنخفاض في حيوية *Bifidobacterium bifidum* DSM20082 بالمقارنة بالكنترول.
- نسبة الحموضة إرتفعت في جميع المعاملات بنهاية فترة التخزين مع حدوث إنخفاض متزامن في قيم الـ PH .
- عينات الزبادي المحتوية على المستخلص المائي (على البارد) للقرنفل والقرفة والمحتوية أيضاً على الكبسولات أعطت نتائج مرتفعة غي أعداد بكتريا *Bifidobacterium bifidum* DSM20082 بالمقارنة بالعينات المحتوية على البكتريا في الصورة الحرة .
- لم تكتشف مجموعة بكتريا الكوليفورم حتى نهاية فترة التخزين في جميع المعاملات .
- إنخفضت أعداد بكتريا *Lactobacillus delbrueckii* subsp. *bulgaricus* , *Streptococcus thermophilus* حوالي ١ , ٣ إلى ١ , ٨ (log_{10} cfu / g) بعد ١٥ يوم من التخزين لكنها ظلت متواجدة بأعداد أعلى من ($١٠^{٦}$ خلية / جم).
- وجدت فروق معنوية بين المعاملات المختلفة في تقدير الخواص الريولوجية للقوام وكذلك التقيم الحسي لعينات الزبادي .
- إنخفضت قيم total scores للتقيم الحسي لجميع المعاملات إنخفاض بسيط، حصلت المعاملة (X4) والمحتوية على كبسولات بكتريا *Bifidobacterium bifidum* DSM20082 بصمغ الزانثان والمستخلص المائي على البارد للقرفة على أعلى درجات التقيم حيث سجلت ٨١ , ٩٥% بعد ٥ أيام من التخزين وسجلت ٤٩ , ٩٢ % بعد ١٥ يوم من التخزين.