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Effect of Wheat Germ Extract on the Viability of Probiotic Bacteria and Properties of Labneh Cheese.

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ABSTRACT

Effect of wheat germ extract (WGE) treated by heating at 60°C/15 min or sterilized at 121°C/15 min) on the viability of two probiotic strains (*Lactobacillus acidophilus* and *Bifidobacterium bifidum*) compared with MRS medium was evaluated. Both probiotic strains showed high viability in WGE than in MRS medium. In addition, sterilized WGE was more effective on the viability of probiotic strains than that heated at 60°C/15min. The viability of the two probiotic strains was also determined on MRS medium supplemented with different levels of wheat germ extract. High protective effect in sterilized MRS medium was gradually increase by increasing WGE percent for both probiotic strains when grew at low pH (3) and high bile salt concentration (3%). The utilization of WGE in the manufacture of Labneh cheese was also evaluated. Labneh cheese made with WGE was higher in total solid and hardness compared with control Labneh cheese. Also, using of WGE improved the viability of starter culture and probiotic bacteria during the storage period. Labneh cheese sample prepared by WGE was marked by the quality of taste, odor, body and texture and overall acceptability among cold storage period at 5±2˚C for 15days.

Keywords: Wheat germ extract, Probiotic, Functional Labneh cheese.

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INTRODUCTION

Wheat germ is the nutrient-rich embryo of the wheat kernel, or seed and it constitutes approximately 2.5% of the total weight of the wheat kernel. It is high in protein and provides essential vitamins and minerals, such as B vitamins, and vitamin E potassium, iron, zinc, [1, 2]. Fermented wheat germ extract (FWGE, Avemar) was invented by Hungarian biochemist Mate Hidvégi in the early 1990s, where it is approved as a "medical nutrient" for cancer patients. Scientific evidence suggests that FWGE may have anticancer effects. FWGE may also improve immune function-associated conditions such as rheumatoid arthritis and systemic lupus erythematosus. Also, laboratory experiments at National Institute of Health and Medical Research, Marseille, France have proved that fermented wheat germ extract has reduced chemotherapy-induced febrile neutropenia in pediatric cancer patients [3].

On the other hand, probiotic microorganisms are increasingly recognized for their beneficial effects on human health. Thus, microorganisms recognized as probiotics, mainly members of the *Lactobacillus* and *Bifidobacterium* genera, are increasingly being used in food preparations and for the development of novel functional foods [4]. Probiotic bacteria are also claimed to prevent cancer, reduce the cholesterol level and improve the lactose utilization [5].These bacteria must be absolutely safe for human health, able to produce bacteriocines and vitamins, and survive during passage through the upper part of the GI (gastro-resistant) to allow their entry in large amounts to the intestines, resistance to bile, and active lactic acid producers, the tolerance to lactic acid, and sustainable viability during the storage of a product [6 , 7].

Beyond the assessment of probiosis and the development of methods to identify new probiotic microorganisms, the concept of prebiosis, *i.e.*, the enhancement of probiotic function has become as important as the motion of probiosis. Prebiosis consists in the selective stimulation of growth and/or activity of one or a limited number of beneficial microbial species in the gut microbiota, thus enhancing probiotic-deriving health benefits to the host [5, 7]. Moreover, prebiotic properties have been related to improved efficiency in intestinal functions, mineral absorption, immune functions, and cancer prevention [6, 8].

Several food components, including wheat germ extract (WGE), fructo-oligosaccharides (FOS) and galacto-oligosaccharides (GOS), have been shown to positively influence growth and metabolism of bifidobacteria and lactobacilli, as well as the overall composition of the gut microbiota, thus performing a prebiotic action. Wheat germs are remarkable for their valuable composition of amino acids, vitamins, bioelements and polyunsaturated fatty acids with hypocholestrolemic effect [9]. Considering that functional foods are defined as “foods that through specific beneficial physiological action contribute to the health of the consumer” [10, 11].Therefore, the aim of this work was to study: (1) the effects of wheat germ extract on the viability of probiotic bacteria compared with MRS medium, and (2) changes in the physiochemical properties of Labneh cheese made with wheat germ extract during storage at 5±2ºC for 15 days.

MATERIALS AND METHODS

Materials

Skim milk powder (low heat, USA) was obtained from local market at Cairo, Egypt. Fresh wheat germ (variety 168 Giza) was obtained from North-Giza milling Company, Giza, Egypt. Average composition of raw wheat germ was 89.34, 10.46, 25.16 and 3.45% for total solids, lipids, crude protein (N×5.7) and ash, respectively. Probiotic bacteria (*Lactobacillus acidophilus* and *Bifidobacterium bifidum*) as well as, Starter culture (*Lactobacillus delbrueckii subsep bulgaricus* and *Streptococcus thermophiles*) were obtained from Chr. Hansene's Lab., Denmark.

Experimental

Wheat germ extract (WGE) preparation

Wheat germ (50g) was mixed with 450 ml tap water, and then heated at 60°C/15 min or sterilized at 121°C/15 min. Both resultant extracts were centrifuged at 5000 rpm for 20 min at room temperature (Sigma Laborzentrifugen.2K15, Germany). The supernatant fluids were collected and sterilized. Wheat germ extract had 4.7%**,** 0.63% and 0.03% for total solids, protein and ash respectively.

Preliminary study 1

The method described by [12] was used to prepare the fermentation medium. Probiotic strains (*Lactobacillus acidophilus* and *Bifidobacterium bifidum*) were inoculated at 2% (v/v) into the both resulting WGEs. The initial bacterial count was ~ 10^7 cfu/ ml. The fermentation process was carried at 37°C/ 18 hr. MRS broth served as control medium. Bacterial growth in both MRS and WGE at 60°C/15 min or 121°C/15 min was measured at zero, 2, 4, 6, 8, 12, 16 and 18 hr of incubation by measuring the pH value and The optical density at 600 nm using the spectrophotometer (CADAS 3Os Dr Lange, Germany). The references blank were MRS media and WGE without bacteria. All fermentation processes were performed in duplicates and reference blank was carried out as by [13].

Preliminary study 2

MRS medium fortified with wheat germ extract

According to the primary study 1, the MRS medium was substituted with 0.0, 20, 40, 60, 80 and 100% sterilized WGE (121°C/15min which was more effective on the probiotic strain viabilities) for determine the protection activity of WGE in the presence of bile salt (3.0%) or at low pH (3). MRS broth without wheat germ extract served as control. Fermentation processes were performed at 37°C for 24 hr.

Labneh cheese preparation

Skim milk powder (SMP) was reconstituted in water at ratio 1:8, served as control, or 1:8 (SMP: WGE) for the treatment. Both mixtures were heated to 85°C for 10 min and cooled to 40°C then inoculated with 2% (v/v) starter cultures and 1% (v/v) of each probiotic bacteria. The control and the treated samples were incubated at 40°C up to 4 hr. Fermented curd samples were filtered in cloth bags at 5±2˚C overnight without any pressing. The concentrated curd was removed out of the cloth bag, put on plastic container, stored at 5±2˚C for 15days. Analyses were carried out for one, 7 and 15 days in three replicate batches. The total solids, total protein and ash were 15.14, 8.04 and 1.45% for control Labneh cheese sample, or 19.18, 9.19 and 1.26% for Labneh cheese made with WGE, respectively.

Methods of analysis

Microbiological examination

The total bacterial count was determined on plat count agar medium. The count of starter cultures was carried out on MRS medium for *Lactobacillus delbrueckii subsp. bulgaricus* and M17 for *Streptococcus thermophilus*. *Lactobacillus acidophilus* was determined on lactobacillus selective agar plus 0.2% oxgall (LBSG) [14]. The count of *Bifidobacterium bifidum* was done according to [15] using modified MRS agar (Oxoid) supplemented with 0.05% L. Cysteine-HCL (Merck, Germany). All plates were incubated at 37°C for 48hr under anaerobic conditions except for *S. thermophilus* which incubated for 24hr under aerobic conditions. Colony forming units were counted (cfu/ml) and the results expressed as their $\log_{10}$values.

Chemical analysis

Total solids (TS), total nitrogen (TN) and ash contents of Labneh samples were determined according to [16]. The pH value was measured using digital pH meter with glass electrode (HANNA, Instrument, Portugal). The water soluble nitrogen (WSN/TN) was estimated as described by [17]. Acetaldehyde and diacetyl contents were estimated as described by [18]. All analysis were periodically analyzed after 1, 7 and 15 days and chemical measurements were carried out in triplicates.

Hardness

Penetration was estimated using Koehler K 19500, Penetrometer (Sycamore AVE, USA) as described by [19]. Penetration was measured as an indicator for cheese firmness (0.1 mm= penetrometer unit, PE).

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Sensory evaluation

Ten expert judges were selected from staff member of Dairy Science Department, National Research Center, Egypt, to evaluate the taste, odor, body & texture, appearance and overall acceptability of the Labneh cheese samples. They scored the sample on the basis of nine-point hedonic scale, ranging from like extremely = 9 through like or dislike = 5 to dislike extremely = 1 as described by [20].

Statistical analyses

Statistical analyses were performed using the GLM procedure with [21] software. Duncan's multiple comparison procedure was used to compare the means. A probability to $P \leq 0.05$ was used to establish the statistical significance.

RESULTS AND DISCUSSION

Microbiological examination

Data presented in Table (1) showed that, preparing WGE using two heat treatments (60°C or 121°C/15min) gave high viability for both probiotic bacteria when compared with control (MRS broth). Both probiotic bacteria were exhibited higher viability using wheat germ extract WGE treated by 121°C/15min than in wheat germ extract using60°C/15min or MRS broth medium. The log phase was observed after 6hr for *L. acidophilus* and 4hr for *B. bifidum* by WGE at 60°C/15min or 121°C/15min respectively, while it was observed after 8hr in MRS broth for both probiotic bacteria.

Table 1: The viability of *L. acidophilus* and *B. bifidum* on in MRS broth and wheat germ extract (WGE) at 60°C/15min or 121°C/15min.

Microorganism	Fermented Time (hr)	MRS broth		Wheat germ extract			
				60°C/15min		121°C/15min	
		pH	O.D	pH	O.D	pH	O.D
L. acidophilus	zero	5.5	0.05	5.6	0.01	5.8	0.026
	2	5.5	0.086	4.9	0.135	5.1	0.062
	4	5.3	0.040	4.8	0.321	4.8	0.276
	6	5.0	0.078	4.5	0.30	4.6	0.675
	8	4.7	0.131	4.4	0.33	4.5	0.722
	12	4.6	0.142	4.3	0.35	4.4	0.74
	16	4.5	0.132	4.2	0.35	4.3	0.83
	18	4.5	0.138	4.2	0.35	4.3	0.83
B. bifidum	zero	5.5	0.003	5.5	0.02	5.6	0.038
	2	5.4	0.069	5.1	0.132	5.1	0.073
	4	5.3	0.055	4.8	0.302	4.9	0.389
	6	4.9	0.093	4.5	0.323	4.6	0.597
	8	4.5	0.146	4.5	0.344	4.3	0.780
	12	4.4	0.171	4.4	0.346	4.3	0.814
	16	4.3	0.184	4.3	0.563	4.2	0.897
	18	4.2	0.189	4.2	0.553	4.2	0.896

The maximum log phase was reached after 16hr in WGE at 121°C/15min and after 12hr in WGE at 60°C/15min or MRS broth medium for *L. acidophilus*; while it was for *B. bifidum* after 16hr in WGE at 60°C/15min or 121°C/15min, and after 18hr in MRS broth (Table 1). At the end of the fermentation time (after 18 hr), the pH values were dropped from 5.5, 5.6 and 5.8 to 4.5, 4.2 and 4.3 for MRS and WGE using 60°C/15min or 121°C/15min respectively. The decrease of pH was due to the presence of organic acid such as lactic and acetic acid produced through metabolic pathway. Little differences in pH values were observed for *B. bifidum*. From the previous results it could be observed that wheat germ extract prepared by using two temperature 60°C/15min or 121°C/15min well supported the growth of *L. acidophilus* and *B. bifidum* which showed increases in their cell viability through the fermentation time. This could be attributed to simultaneous presence of potassium, iron and also great quantities of riboflavin, calcium, zinc, magnesium and Vitamins A, E, B1 and B3 and protein 28% in wheat germ extract as reported by [22]. *L. acidophilus* and *B. bifidum* have

complex growth requirements, they exhibited poor growth in media without the addition of supplements, such as yeast extract and peptone [23]. On the other hand, the bile and acid tolerance of *L. acidophilus* and *B. bifidum* were also studied by using MRS broth medium fortified with different concentrations of WGE (Table2and 3). The results indicate that, *L. acidophilus* and *B. bifidum* did not grow in the presence of bile (3% w/v oxgall) for bile tolerance test in MRS broth medium and no results were obtained, while *L. acidophilus* and *B. bifidum* grew well in the presence of different amounts of wheat germ extract in MRS medium with 3% bile salt when compared to control (MRS broth with 3% bile).

The maximum protective effect of wheat germ extract was observed at the concentration of 100% wheat germ extract. The viability of *L. acidophilus* (8.4 logcfu/ml) and *B. bifidum* (9 logcfu/ml) were increased when compared to control (7.99 and 8.2 log cfu/ml respectively). It could be noticed that wheat germ extract stimulated the growth of *B. bifidum* more than *L. acidophilus*, (Table 2).Table (3) showed the acid tolerance of *L. acidophilus* and *B. bifidum* in MRS broth medium contained different concentrations of wheat germ extract prepared at121°C/15min.Both strains showed the same ability to grow in acidified medium. However, the results revealed that using 100% WGE gave protective effect and increasing the viability of *L. acidophilus* and *B. bifidum* from 7.8 and 7.5 log cfu/ml to 8.9 and 8.4 log cfu/ml respectively. An important characteristic of a probiotic is its survival at low pH [24]. Wheat germ extract is known to be a growth-promoting factor for bacteria. [12] showed that malt, wheat, and barley extracts exhibited a significant protective effect on the viability of human-derived *L. plantarum* and *L. acidophilus* strains under acidic conditions mimicking the stomach, which based on supporting experiments with dietary constituents could be mainly attributed to the presence of soluble sugars in the cereal extracts and to a less extent to the free amino nitrogen content, depending on the strain.

Table 2: The protective effect of wheat germ extract (WGE) prepared at 121°C/15min on the viability of *L. acidophilus* and *B. bifidum* in MRS broth medium fortified with different amounts of WGE in the presence of 3% bile salt after 24 hr of incubation period.

Media	Strains (log_{10}cfu/ml)	
	L. acidophilus	*B. bifidum*
MRS broth (control)1	7.99	8.2
MRS broth+3% bile(control)2	ND	ND
MRS+ 20%wheat germ extract+3% bile	ND	ND
MRS+ 40%wheat germ extract+3% bile	4.0	6.9
MRS+ 60%wheat germ extract+3% bile	4.3	7
MRS+ 80%wheat germ extract+3% bile	4.9	7
100%wheat germ extract+3% bile	8.4	9

Table 3: The protective effect of wheat germ extract(WGE) on the viability of *L. acidophilus* and *B.bifidum* in MRS broth medium fortified with different amounts of wheat germ extract at pH 3 after 24 hr of incubation period.

Media	Strains (log_{10}cfu/ml)	
	L. acidophilus	*B. bifidum*
MRS broth (control)	7.99	8.2
MRS broth pH 3	7.8	7.5
MRS+ 20%wheat germ extract pH 3	7.6	7.5
MRS+ 40%wheat germ extract pH 3	7.6	7.5
MRS+ 60%wheat germ extract pH 3	7.6	7.9
MRS+ 80%wheat germ extract pH 3	7.7	7.7
100%wheat germ extract pH 3	8.9	8.4

Microbial analysis of Labneh cheese samples

The viability of probiotic bacteria (*L. acidophilus* and *B. bifidum*) and starter cultures (*Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophilus*) in Labneh cheese samples during storage period were shown Figure (1). Data indicate that the counts of both *L. acidophilus* and *B. bifidum* was increased in Labneh cheese made by WGE during the first 7 days of storage period and then slightly decrease till the end of storage period when compared with control sample. The maximum cell counts of *L. acidophilus* and *B. bifidum* reached log_{10} 9.8 at 7^{th} day of storage period. However, the viable cells of *L. acidophilus* were still at 10^8 cfu/ml after 15 days of storage, while the viable cells of *B. bifidum* were 10^9 cfu/ml after 15 days of storage (Fig.

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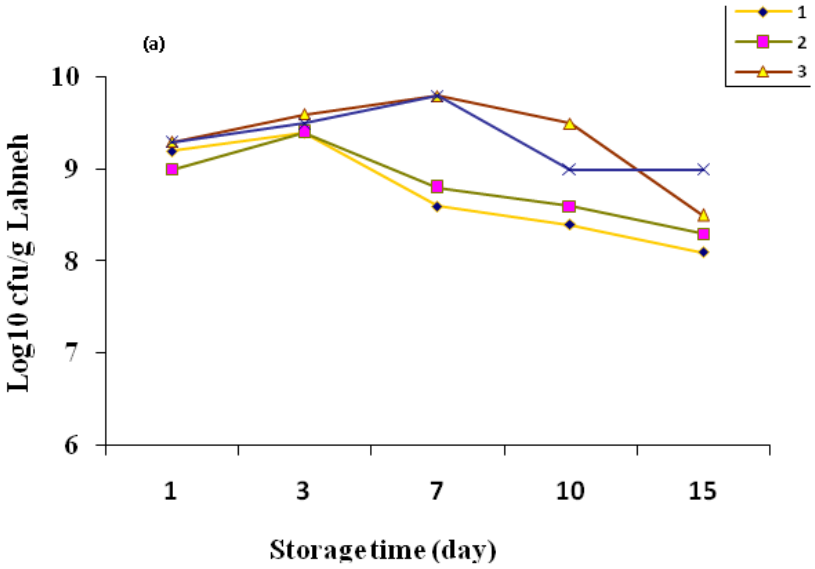
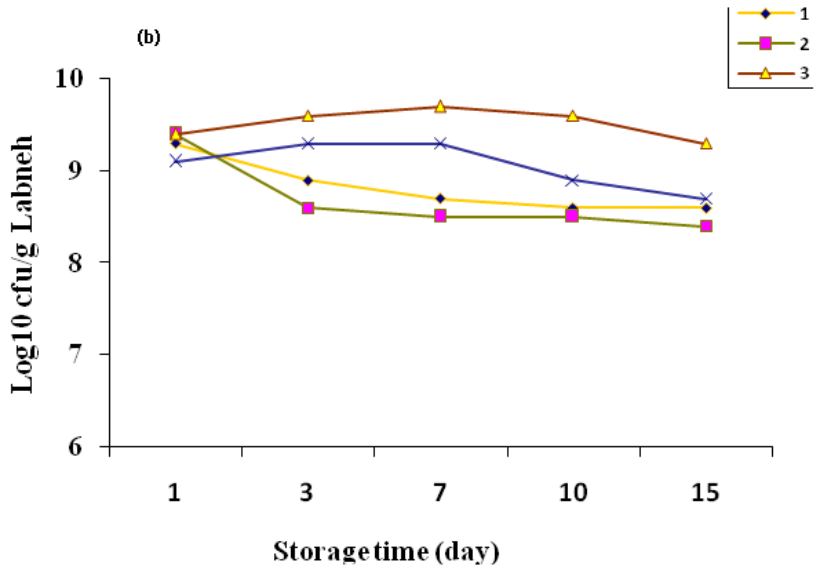
1a).These counts are higher than 10^7 cfu/ml, which is the level suggested by some authors to have health promoting effect [25, 26]. Same behavior of starter cultures viability was observed and the maximum counts were after 7 days of storage period in Labneh cheese prepared with WGE (Fig. 1b). It was observed that *L. acidophilus*, *B. bifidum*, *L. bulgaricus* and *Streptococcus thermophilus* had stimulatory activity in Labneh cheese prepared by WGE during the 15 days of storage. These results indicated that WGE was suitable for these bacteria that were kept viable up to the end of fermentation (15 days).



(1)The viability of ***L. acidophilus*** in control Labneh cheese.
(2) The viability of ***B. bifidum*** in control Labneh cheese.
(3) The viability of ***L. acidophilus*** in Labneh cheese made with wheat germ extract.
(4) The viability of ***B. bifidum*** in Labneh cheese made with wheat germ extract.



1)The viability of ***St.thermophilus*** in control Labneh cheese.
(2) The viability of ***L.bulgaricus*** in control Labneh cheese.
(3) The viability of ***St.thermophilus*** in Labneh cheese made with wheat germ extract.
(4) The viability of ***L.bulgaricus*** in Labneh cheese made with wheat germ extract.

Figure 1: The viability of: (a) probiotic bacteria (*L. acidophilus* and *B. bifidum*) and (b) starter cultures (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) in Labneh cheese samples made with wheat germ extract compared to control sample during storage period at 5±2°C.

Lactobacilli and *bifidobacteria* have complex nutritional requirements such as carbohydrates, amino acids, peptides, fatty esters, salts, nucleic acid derivatives, and vitamins, which vary a lot from species to species [27]. The principal carbohydrate constituents of cereal grains are starch, water-soluble or -insoluble components of dietary fibre, and several free sugars, such as glucose, glycerol, stachyose, xylose, fructose, maltose, sucrose, and arabinose. The contents of these components depend on the variety, the processing, and the amount of water addition [28]. Cereals have higher content of some of the essential vitamins, higher content of dietary fibre, and increased amount of minerals, especially phosphorus [12].

Chemical properties of Labneh cheese samples

The changes in chemical properties of Labneh cheese samples throughout storage period were given in Table 4. Total solids (TS) of fresh treated Labneh cheese made with WGE was significantly ($p \leq 0.05$) higher (19.18±0.85%) than that of control Labneh cheese (15.14±0.52%). This result could be attributed to TS of WGE itself. Slight increase in TS ($P > 0.05$) of both control and treated Labneh cheese was observed as storage period increased. This increase may be attributed to the natural evaporation along storage period as mentioned by [29, 30]. Using WGE in the manufacture of Labneh cheese caused slight decrease in pH value compared with control cheese ($P > 0.05$) at different storage periods (Table 4). The decrease in pH value of Labneh cheese made with WGE could be attributed to that WGE may enhance the growth of starter culture and increased the acidity. Over storage period, both control and treatment showed gradual decrease ($P \leq 0.05$) in pH value; the decrease was significant only at 15th day ($p \leq 0.05$). These decrease of pH reached from 4.64 to 4.31 in control Labneh cheese and from 4.57 to 4.16 in Labneh cheese made by WGE with the end of storage period (15 day). A similar observation was found by [31] in the pH of yoghurts, containing 0.5–1.0 g 100 g^{-1} inulin and probiotics, to 4.27–4.42, during the 14 days storage period at 4°C. The water soluble nitrogen contents (WSN/TN) was higher in fresh control Labneh cheese and the difference was significant ($P \leq 0.05$) than that in treatment. A similar gradual increase in the WSN/TN was observed in both Labneh cheese with increasing the storage period. It could be due to proteolysis activity by starter cultures as mentioned by [32, 33]. WGE in the manufacture of Labneh cheese had no significant effect on the acetaldehyde content, while increase the diacetyl content ($P \leq 0.05$) compared with control Labneh cheese at different storage periods. Slight decrease in acetaldehyde content during cold storage was noticed, it could be attributed to the result of metabolic pathway (citric-acid fermentation) in which diacetyl is formed from it [34]. The results also showed no significant increase in diacetyl content in both samples during cold storage. The decrease of acetaldehyde and the increase of diacetyl were influenced by starter culture. The relatively high diacetyl content, at the beginning to the end of cold storage of both samples, may have substituted in part for the lacking acetaldehyde.

Table 4: Changes of chemical properties in Labneh cheese samples made with wheat germ extract compared to control sample during storage period at 5±2°C.

Properties	Storage period(days)	Control	Treatment
Total solids (%)	**1**	15.14^{B} ±0.54	19.18^{A} ±0.60
	7	15.74^{B} ±0.52	19.42^{A} ±0.66
	15	16.72^{B} ±0.52	20.17^{A} ±0.85
pH	**1**	4.64^{A} ±0.06	4.57^{BA} ±0.06
	7	4.53^{BA} ±0.05	4.36^{BAC} ±0.08
	15	4.31^{BC} ±0.13	4.16^{C}±0.15
WSN/TN	**1**	6.71^{C} ±0.97	4.86^{D} ±0.37
	7	8.51^{BA} ±0.24	7.41^{BC} ±0.33
	15	9.65^{A} ±0.60	8.73^{BA} ±0.03
Acetaldehyde (µmol/100g)	**1**	8.63^{BA} ±2.49	9.77^{A}±2.23
	7	7.31^{BAC} ±1.45	5.80^{BC}±0.0
	15	3.68^{C} ±3.68	4.72^{BC}±0.08
Diacetyl (µmol/100g)	**1**	6.50^{B}±0.95	14.61^{BA}±2.58
	7	12.56^{BA}±0.74	17.47^{BA}±0.10
	15	12.77^{BA}±1.63	21.07^{A}±8.41

Means with the same letters are not significantly different ($p \leq 0.05$).

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Hardness

The depth of penetration is a function of the firmness of cheese curd (the higher record the less hardness). The hardness of Labneh cheese made with WGE was significantly higher ($P \leq 0.05$) than that of control sample (Table 5) during different storage period. [35] indicated that relative amounts of water, protein and fat contents were the dominant factors affecting cheese firmness. Positive correlation was observed between cheese hardness and protein content. Also, gradual increase was observed in the hardness of Labneh cheese as the time of storage increased, due to low moisture content as a result of lactic acid development which causes cured contraction and high acidity of the cheese [36, 37].

Table 5: Hardness of control Labneh cheese and Labneh cheese made with wheat germ extract during storage period at 5±2°C.

	Storage eriod(days)	Control	Treatment
Hardness (mm) (PE units)**	**1**	35.5^{AA}±0.71	25.87^{B}±0.47
	7	34.13^{A}±1.17	25.50^{B}±0.44
	15	27.43^{B}±0.52	22.03^{C}±1.68

Means with the same letters are not significantly different ($p \leq 0.05$).
** Penetrometer (The high PE unit means the less hardness).

Sensory properties

Results obtained from sensory evaluation showed that replacement of WGE instead of water in Labneh cheese made by skim milk powder had positive effect on the sensory properties (taste, odor, body & texture, appearance and over all acceptability) as mentioned in Table 6. The Labneh cheese made with WGE gained higher scores than the control in all sensory properties throughout the storage period. Storage time had no significant effects on sensory properties scores of treatment, except for taste which had lower score at the end of storage periods ($P \leq 0.05$). While, gradual decrease in all sensory properties scores, except appearance, was observed in control prolonged time, the decrease was significant only at day 15^{th}. In general, Labneh cheese made with WGE was characterized by a smooth and pasty form with a semisolid mass and high acceptable properties more than the control Labneh cheese.

Table 6: Sensory properties of control Labneh cheese and Labneh cheese made by wheat germ extract during storage period at 5±2°C.

Sample	Storage period (days)	Taste	Odor	Body & texture	Appearance	Overall acceptability
Control	1	6.6^{B}±0.22	6.70^{B}±0.21	6.35^{A}±0.21	7.0^{B} ±0.21	6.65^{BC}±0.24
	7	6.70^{B}±0.21	6.60^{B}±0.27	6.3^{A}±0.26	6.80^{B} ±0.25	6.3^{DC}±0.21
	15	5.80^{C}±0.20	5.50^{C}±0.17	5.3^{B}±0.21	6.70^{B}±0.21	5.7^{D}±0.15
Treatment	1	7.45^{A}±0.35	7.6^{A}±0.37	7.5^{A}±0.22	7.55^{A}±0.16	7.4^{A}±0.34
	7	7.80^{A}±0.13	7.70^{A}±0.15	7.5^{A}±0.16	7.80^{A}±0.13	7.6^{A}±0.16
	5	6.70^{B}±0.21	7.70^{A}±0.15	7.4^{A}±0.16	7.6^{A}±0.16	7.2^{BA}±0.25

Means with the same letter are not significantly different ($P \leq 0.05$).

CONCLUSION

In general, using wheat germ extract heated at 121°C/15 min in the manufacture of Labneh cheese improved growth of starter culture and stimulate the growth of *B. bifidum* more than *L. acidophilus*. Also, it enhanced the hardness and the sensory properties compared with control cheese. With respect to the positive impact of wheat germ extract of food and a technological standpoint, it is proposed more studies for using wheat germ extract in the Egyptian cheese industry.

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