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AN ATTEMPT TO PRODUCE SYNBIOTIC BUTTERMILK BEVERAGES SUPPLEMENTED WITH BARLEY AND OAT FLOUR

Mohamed E. Abd El-Hameed[1*], E. Abd El-Sattar[2], S.A. Khalifa[1] and A.A. El-Neshawy[1]

1. Food Sci. Dept., Fac. Agric., Zagazig Univ., Egypt

2. Food and Dairy Technol. Dept., Fac. Technol. and Dev., Zagazig Univ., Egypt

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ABSTRACT: Buttermilk has a potential to become a daily diet drink at global level due to its high nutritive value and ease of production process. In present study, novel buttermilk beverages were developed using barley and oat flour supplementations. Acidity, pH, viscosity, whey separation and sensory properties were studied. Supplementation with barley and oat flours (2 and 4% for both) showed changes in buttermilk acidity and pH. Whey separation was lower and viscosity was higher in buttermilk sample containing 4%barley and oat flours. Buttermilk samples were also evaluated for their sensory characteristics including colour and appearance, body and mouth feel, flavour and overall acceptability. Samples with 4% oat flours level obtained the highest scores in the sensory evaluation. The viscosity of the buttermilk samples increased proportionally with the levels of barley and oat flour supplementations. Oat flour supplementation at 4% level in buttermilk improved nutritive, physicochemical and desirable sensory characteristics more than barley flour.

Key words: Buttermilk, barley and oat flour, symbiotic beverages.

INTRODUCTION

Because of consumer's awareness towards the relationship between food and health. functional foods, which exert the beneficial effects on specific body functions, in addition to the traditional nutritional effects. Synbiotic foods are those which contain bio-active compounds, such as phytochemicals, oligo-saccharides, dietary fiber (prebiotics) and friendly bacteria (probiotics) **(Fuller, 1989).**

According to a recent report **IDF (2014)** the world output of butter and other milk fats (butter oil, ghee) is estimated at around 10 million tons. The by-product of this industry, known as buttermilk, is low cost product which can be described as a milky liquid product containing casein and water soluble components of cream including lactose, minerals and whey proteins. Using buttermilk as an ingredient in food preparation many have three potential effects reducing production costs of final product, reducing environmental pollution due to dispose of buttermilk as waste and improving the nutritional value of food product in which buttermilk is added (**Abou El-Nour *et al.*, 2014).**

Cereals such as barley and oat are an important source of protein, carbohydrates, vitamins, minerals and fiber for people all over the world, and can be used as sources of non-digestible carbohydrates that besides promoting several beneficial physiological effects can also selectively stimulate the growth of *Lactobacilli* and *Bifidobacteria* present in the colon, thereby acting as prebiotics. Cereals contain water-soluble fiber, oligosaccharides and resistant starch, and thus have been suggested to fulfill the prebiotic concept (**Charalampopoulos *et al.*, 2002).**

The aim of this study was to produce of novel synbiotic buttermilk beverages supplemented with barley and oat flour to improve nutritive, value, physicochemical and desirable sensory characteristics of the final product.

Corresponding author: Tel. : +20105655865
E-mail address: mohamedlab1988@gmail.com

MATERIALS AND METHODS

Materials

Barley and oat flour were purchased from King M for industrial foods company, Badr city, Egypt. Buttermilk (0.65% fat, 2.80% proteins, 4.21% lactose) were obtained from the manufacturing of sweet cream butter. ABT-5 culture containing *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium bifidum* were obtained from Christian Hansen Laboratory Copenhagen, Denmark. All used chemicals were obtained from El-Gomhouria Company, Egypt.

Preparation of Synbiotic Buttermilk Beverages

Five different formulations of fermented buttermilk beverages were prepared: C control, buttermilk without any additives T1 buttermilk contains 2.0% barley flour, T2 buttermilk contains 4.0% of barley flour T3 buttermilk contains 2.0% of oat flour and T4 buttermilk contoins 4.0% oat flour. The obtained beverages or buttermilk for the control sample were heated 85 ±2ºC, cooled down to fermentation temperature (42±2ºC), fermented with added starter (0.025%) up to pH 4.5–4.6, stirred, distributed into plastic bottles (500 ml), and stored at 4 ±2 ºC.

Chemical Analyses

Total solids, fat, total protein (TN) contents, titratable acidity and dietary fiber of samples were determined according to **AOAC (2007)**. The changes in pH in the yoghurt samples during storage were measured using a laboratory pH meter with glass electrode (HANNA, Instrument, Portugal)• Total volatile fatty acids (TVFA) was estimated according to **Kosikowski (1984).**

Flavour Compounds

Acetaldehyde and diacetyl in a synbiotic buttermilk beverage treatments were determined by **Less and Jago (1969).** Acetaldehyde reacts with semi-carbazide to form semi-carbazone which has absorption value at wave length of 224 nm meanwhile diacetyl has an absorption value at wave length of 270 nm.

Rheological Measurements

Viscosity

Viscosity of a synbiotic buttermilk beverage samples were determined by the method described by **Aryana (2003)** using Rotational Viscometer Type Lab. Line Model 5437. Results expressed as (mPa)

Synaeretic properties

Synaeretic properties were determined by centrifugation. The amount of serum discharged after centrifugation (2000 rpm min^{-1}, 20 min, 20 g of sample) was measured and expressed in % according to **Liutkevičius *et al.* (2016).**

Microbiological analyses

Microbiological analyses preformed when fresh and after, 5, 10 and 15 days of storage. The enumeration of *S. thermophilus* was accomplished after incubation at 37°C for 48 hr., under anaerobic conditions using M17agar (Oxide Ltd). *L. acidophilus* counts were determined by using MRS-sorbitol agar (Oxide Ltd), and the plates were incubated in anaerobic conditions at 37°C for 72 hr., **(Dave and Shah, 1996)**.

B. bifidum counts were enumerated according to **Dinakar and Mistry (1994)** by using a modified MRS agar media (a mixture of antibiotics, including 2 g of neomycin sulphate, 0.3 g of nalidixic acid, 4 g of paromomycin sulphate, and 60 g of lithium chloride (NPNL, Sigma Chemical Co.) prepared in 1000 ml of distilled water, filter-sterilized, and stored at 4°C until use. The mixture of antibiotics (5 ml) was added to 100 ml of MRS agar media. Cysteine-HCl was added at the rate of 0.05% to decrease the redox potential of the medium, and the plates were incubated in anaerobic conditions at 37ºC for 72 hr. All the results were recorded as log number of colony forming units per g (cfu/g).

Sensory evaluation

Sensory evaluation of control buttermilk and supplemented buttermilk treatments was carried out using 9-point Hedonic scale. Ten panelists were selected on the basis of their previous experience and knowledge on sensory evaluation of dairy and dairy-associated products. Colour and appearance, body and texture, flavour and overall acceptability were evaluated by panel according to **Mudgil and Barak (2016**).

Statistical Analysis

The obtained results were evaluated statistically using analysis of variance as reported by **McClave and Benson (1991)**. In addition the other reported values were expressed as mean ±SD, two-tailed Student's t test was used to compare between different groups. . P value less than 0.05 was considered statistically significant. SPSS (Chicago, IL, USA) software window Version 16 was used.

RESULTS AND DISCUSSION

Chemical Composition of Barley and Oat Flours

Chemical composition of raw materials, barley flour (BF) and oat flour (OF) is presented in Table 1. The results showed that barley flour had the highest value of protein (12.32%) then, oat flour (11.0%). Oat flour had the highest fat content (8.0%) followed by barley flour (1.74%). Oat flour had higher value of ash content (4.62%), than barley flour. The highest value of crude fiber was noticed in oat flour (9.0%) followed by barley (1.94%), the lowest value of total carbohydrates was found in barley (68.28%). These results are in agreement with **(Abou-Raya *et al*., 2014**).

Chemical Composition of Synbiotic Buttermilk Beverages Supplemented with Barley and Oat Flours

Chemical composition of resultant beverages was assessed by determining total solids, total protein, fat, acidity and pH.

Table 2 show that buttermilk containing 4% oat and barley flour had the highest total solids (TS) and it was significantly (p ±= 0.05) differently from other buttermilk treatments, while the control buttermilk exhibited the lowest (TS) content. The TS content of buttermilk beverages supplemented with oat flour slightly increased gradually by increasing the level of addition. However, the TS content of buttermilk beverage from all treatments slightly increased during the storage period.

The same Table 2 shows that addition of oat and barley flours to buttermilk slightly increased the total protein compared to control buttermilk (C). The total protein of buttermilk supplemented with oat and barley flour slightly increased by increasing the percentage added. On the other hand, the total protein of all treatments was not significantly changed throughout the storage periods (**Gebreselassie *et al*., 2016)**.

On the other hand, supplementation of buttermilk with oat and barley flour did not affect the fat content of the resultant buttermilk. The fat content of all treatments was not significantly changed as storage period proceeded. Supplementation of buttermilk with 4% oat flour slightly increased the fat content of the resultant buttermilk. Slight differences were observed in acidity of buttermilk from different treatments. Supplementation of buttermilk with oat and barley flour with different concentration increased acidity of buttermilk, moreover acidity slightly increased up to the storage period (Table 3).

Also results in Table 3 show the changes in pH value of buttermilk from different treatments as affected by supplementation of oat and barley flour or storage period followed almost opposite trend to acidity. These results are in agreement with those reported by **Mudgil and Barak (2016).**

Flavour Compounds of Synbiotic Buttermilk Beverage Supplemented with Barley and Oat Flours

Some flavour compounds of fermented buttermilk beverages were assessed by the determination of some volatile compounds *e.g.* acetaldehyde, diacetyl and total volatile fatty acids (TVFA) which have been reported as flavour compounds in yoghurt **(Tamine and Deeth, 1980**). It is evident from Table 4, that supplementation of buttermilk with barley and oat flour especially at higher concentration showed significantl effect on these compounds. On the other hand, it was found that in acetaldehyde values decreased during the storage period, also diacetyl values increased up to 5^{th} days for storage and then decreased until the end of storage. This may be due to the ability of lactic organisms to hydrolysis acetaldehyde and diacetyl to acetone. These results agree with those reported by **Gebreselassie *et al*. (2016)**.

The same Table illustrates that, total volatile fatty acids (TVFA) increased in all treatments of

Table 1. Chemical composition of barley and oat flour

Component	Barley flour	Oat flour
Moisture (%)	5.13	4.05
Total protein (%)	12.32	11.00
Crude Fat (%)	1.74	8.00
Ash (%)	2.92	4.62
Crude Fiber (%)	1.94	9.00
Carbohydrate (%)	68.28	72.73

Table 2. Total solids, fat and total protein of synbiotic buttermilk beverages supplemented with barley and oat flour

Treatment	Total solids (%)				Fat (%)				Total protein (%)			
	Storage period (day)											
	Fresh	5	10	15	Fresh	5	10	15	Fresh	5	10	15
C	9.70±0.20	9.74±0.18	9.80±0.20	9.86±0.21	0.65±0.15	0.71±0.21	0.77±0.12	0.84±0.12	3.40±0.02	3.46±0.02	3.75±0.05	3.82±0.07
T1	9.78±0.15	9.83±0.11	9.92±0.18	9.98±0.14	0.67±0.18	0.73±0.20	0.78±0.14	0.86±0.15	3.46±0.03	3.50±0.02	3.80±0.05	3.85±0.08
T2	9.86±0.12	9.90±0.14	9.96±0.12	10.04±0.16	0.70±0.18	0.75±0.15	0.80±0.15	0.92±0.10	3.52±0.02	3.58±0.03	3.86±0.07	3.94±0.05
T3	9.82±0.14	9.88±0.08	9.95±0.14	10.02±0.08	0.72±0.20	0.78±.15	0.84±0.10	0.98±0.12	3.42±0.02	3.46±0.03	3.65±0.08	3.72±0.07
T4	9.94±0.09	9.98±0.12	10.05±0.14	10.12±0.12	0.76±0.21	0.85±0.18	0.92±0.11	1.06±0.18	3.44±0.02	3.52±0.02	3.70±0.04	3.84±0.08
LSD	0.16	0.63	0.12	0.19	0.19	0.22	0.22	0.23	0.04	0.04	0.07	0.12

Each value represents mean ± SD. Means in the same column with different letters are significantly different at $p < 0.05$.)

C: control buttermilk beverage; T1: buttermilk beverage supplemented with 2% barley flour; T2: buttermilk beverage supplemented with 4% barley flour; T3: buttermilk beverage supplemented with 2% oat flour; T4: buttermilk beverage supplemented with 4% oat flour.

Table 3. Acidity and pH of synbiotic buttermilk beverages supplemented with barley and oat flours

Treatment	Acidity (lactic acid %)				pH			
	Storage period (day)							
	Fresh	5	10	15	Fresh	5	10	15
C	0.62±0.03	0.77±0.03	0.90±0.02	1.06±0.04	4.84±0.04	4.78±0.06	4.70±0.05	4.64±0.06
T1	0.62±0.02	0.82±0.04	1.00±0.03	1.20±0.03	4.84±0.03	4.74±0.04	4.66±0.02	4.60±0.04
T2	0.63±0.02	0.90±0.04	1.10±0.03	1.30±0.03	4.82±0.05	4.70±0.05	4.60±0.04	4.56±0.05
T3	0.63±0.03	0.86±0.03	1.04±0.04	1.28±0.05	4.83±0.04	4.72±0.02	4.62±0.03	4.58±0.02
T4	0.63±0.03	0.94±0.05	1.08±0.06	1.36±0.05	4.84±0.02	4.68±0.03	4.56±0.02	4.50±0.03
LSD	0.06	0.04	0.04	0.05	0.08	0.21	0.04	0.03

Each value represents mean ± SD. Means in the same column with different letters are significantly different at $p < 0.05$.
C: control buttermilk beverage; T1: buttermilk beverage supplemented with 2% barley flour; T2: buttermilk beverage supplemented with 4% barley flour; T3: buttermilk beverage supplemented with 2% oat flour; T4: buttermilk beverage supplemented with 4% oat flour.

Table 4. Some flavour compounds of synbiotic buttermilk beverages supplemented with barley and oat flour

Treatment	Acetaldehyde µg/g				Diacetyl µg/g				TVFA(0.1 N-NaOH/100 g)			
	Storage period (day)											
	Fresh	5	10	15	Fresh	5	10	15	Fresh	5	10	15
C	22.0±2.00	20.0±2.12	17.0±1.57	14.0±2.00	36.0±2.00	40.0±3.00	38.0±2.00	37.0±2.57	2.80±0.14	4.20±0,18	5.70±0.20	6.40±0,22
T1	25.0±2.52	23.0±2.00	19.0±2.00	15.0±2.00	38.0±2.52	43.0±2.60	41.0±2.14	40.0±2.00	3.20±0.22	6.10±0,22	7.68±0,14	8.42±0,18
T2	28.0±2.00	26.0±2.52	23.0±2.14	18.0±2.54	41.0±2.20	46.0±2.58	44.0±2.57	43.0±2.00	4.36±0.12	6.94±0,15	8.20±0.18	8.86±0,12
T3	28.0±2.12	25.0±2.14	21.0±2.00	16.0±2.14	40.0±2.48	45.0±2.20	42.0±2.12	41.0±2.12	3.40±0.18	6.80±0,18	7.92±0,12	8.60±0,14
T4	32.0±1.53	29.0±2.00	25.0±2.14	22.0±2.12	44.0±2.00	50.0±2.54	46.0±2.00	44.0±2.42	4.80±0.20	7.14±0,12	8.86±0,20	9.24±0,20
LSD	3.33	3.93	3.41	3.29	3.21	3.72	3.54	3.30	0.21	0.18	0.16	0.22

Each value represents mean ± SD. Means in the same column with different letters are significantly different at $p < 0.05$.
C: control buttermilk beverage; T1: buttermilk beverage supplemented with 2% barley flour; T2: buttermilk beverage supplemented with 4% barley flour; T3: buttermilk beverage supplemented with 2% oat flour; T4: buttermilk beverage supplemented with 4% oat flour.

fermented buttermilk beverages and during storage periods. It could be attributed to proteolytic and lipolytic action of starter cultures during making and storage. However, oat flour showed higher effect than barley flour in this respect. These results are in agreement with those reported by **Gebreselassie *et al*. (2016)**.

Some Rheological Properties of Synbiotic Buttermilk Beverages Supplemented with Barley and Oat Flour

Supplementation of fermented buttermilk beverages with barley and oat flour significantly reduced whey syneresis compared with buttermilk beverages without additives (C). This reduction was proportional to the supplementation ratio as shown in Table 5. These results might be due to increasing the water holding capacity by dietary fiber in the resultant curd. These results are in agreement with those reported by **Liutkevicius *et al*. (2016).**

Control buttermilk beverages were significantly less viscosity than symbiotic buttermilk beverages supplemented with barley and oat flour. Synbiotic buttermilk beverages with oat flour showed significantly higher ($P < 0.05$) viscosity for the resultant buttermilk beverages. The increase was slightly proportional to the rate of additives. This increase could be attributed to the water hydration of oat and barley flour. Similar results were reported by **Mudgil and Barak (2016) and Liutkevicius *et al*. (2016)**.

Microbiological Evaluation of Synbiotic Buttermilk Beverages Supplemented with Barley and Oat Flour

Table 6 indicate that *Streptococcus thermophiles* and *Lactobacillus acidophilus* counts increased gradually in all treatments up to 10 days of storage and then decreased at the end of storage period. Buttermilk beverage treatments supplemented with oat flour had the highest *Streptococcus thermophiles* and *Lactobacillus acidophilus* counts. *Bifidobacterium bifidum* counts increased gradually in all treatments up to the end of storage period. Buttermilk beverage treatments supplemented with oat flour had the highest *Bifidobacterium bifidum* counts**.** The addition of oat and barley flour improved the viability of *Streptococcus thermophiles, Lactobacillus acidophilus* and *Bifidobacterium bifidum*. Similar results were reported by other researchers concerning the viability and survival of *L. acidophilus* and other lactobacilli in oat mash (**Akalin *et al*., 2012)**. In addition, similar results were obtained by **Elsanhoty and Ramadan (2018)** who found that supplementation of probiotic low fat yoghurt with barley β-glucan enhanced the probiotic viability during storage.

Sensory Evaluation Synbiotic Buttermilk Beverages Supplemented with Barley and Oat Flours

Table 7 shows the sensory evaluation of control and barley and oat flour supplemented buttermilk. The sensory characteristics of buttermilk supplemented with barley and oat flour markedly improved as compared to control sample. Colour and appearance and flavour of control and barley and oat flour supplemented buttermilk sample showed insignificant change whereas there was observed a significant changes in body, mouthfeel and overall acceptability. Sensory evaluation as well as overall acceptability results of the buttermilk samples showed that T4 buttermilk sample (4% oat flour level) was the most acceptable sample by judging panel members. T4 sample scored highest among all samples with respect to colour and appearance, body and mouthfeel and overall acceptability, similar results were reported by **Mudgil and Barak (2016)** and **Liutkevicius *et al*. (2016)**.

Conclusion

Results proved that buttermilk was a suitable matrix to maintain the viability of probiotic strains and to formulate synbiotic beverages with appropriate sensorial attributes. From the obtained results of this research it could be concluded that oat flour supplementation at 4% level can be used in buttermilk beverages manufacture to improved nutritive, physicochemical and desirable sensory characteristics more than barley flour supplementation.

Table 5. Syneresis and viscosity of synbiotic buttermilk beverages supplemented with barley and oat flour

Treatment	Syneresis (%)				Viscosity(mPa)			
	Storage period (day)							
	Fresh	5	10	15	Fresh	5	10	15
C	52.7±3.52	53.2±3.70	54.6±3.72	54.8±3.80	220.4±25.17	250.2±30.0	280.6±20.28	290.4±26.46
T1	50.8±3.00	51.4±32.06	52.7±3.12	53.2±3.20	230.6±30.55	270.5±20.0	290.8±20.0	310.4±30. 0
T2	47.6±2.52	48.5±2.60	49.2±2.72	50.3±2.80	242.8±35.00	282.4±25.1	302.5±20.0	324.8±20. 0
T3	49.4±3.04	50.2±3.12	51.6±2.20	52.8±2.22	236.5±20.0	278.6±32.0	295.4±25.1	318.2±20.82
T4	46.8±2.70	47.4±2.82	48.7±2.85	49.6±2.90	248.2±30.0	290.5±30.0	306.8±30.0	335.4±23.0
LSD	3.41	3.29	3.33	3.93	3.2	3.83	3.75	4.67

Each value represents mean ± SD. Means in the same column with different letters are significantly different at $p < 0.05$.
C: control buttermilk beverage; T1: buttermilk beverage supplemented with 2% barley flour; T2: buttermilk beverage supplemented with 4% barley flour; T3: buttermilk beverage supplemented with 2% oat flour; T4: buttermilk beverage supplemented with 4% oat flour.

Table 6. Microbiological examination of synbiotic buttermilk beverages supplemented with barley and oat flour (Log cfu/g).

Microorganism	Treatment	Storage period (day)			
		Fresh	5	10	15
Streptococcus thermophiles	C	7.15	8.40	8.53	8.30
	T1	8.34	8.53	8.63	8.45
	T2	8.65	8.72	8.81	8.73
	T3	8.56	8.62	8.72	8.60
	T4	8.81	8.87	8.89	8.83
Lactobacillus acidophilus	C	7.60	7.95	8.30	8.04
	T1	8.08	8.30	8.50	8.34
	T2	8.39	8.51	8.64	8.48
	T3	8.26	8.38	8.57	8.41
	T4	8.51	8.60	8.82	8.68
Bifidobacterium bifidum	C	8.72	8.78	8.80	8.86
	T1	8.75	8.81	8.85	8.88
	T2	8.87	8.93	8.94	8.95
	T3	8.88	8.94	8.97	8.98
	T4	8.93	8.95	8.97	8.98

C: control buttermilk beverage; T1: buttermilk beverage supplemented with 2% barley flour; T2: buttermilk beverage supplemented with 4% barley flour; T3: buttermilk beverage supplemented with 2% oat flour; T4: buttermilk beverage supplemented with 4% oat flour -ND= Not detected.

Table 7. Sensory evaluation of synbiotic buttermilk beverages supplemented barley and oat flour

Treatment	Colour appearance				Body mouth feel				Flavour				Overall acceptability			
	Storage period (day)				Storage period (day)				Storage period (day)				Storage period (day)			
	Fresh	5	10	15	Fresh	5	10	15	Fresh	5	10	15	Fresh	5	10	15
C	8.0	7.8	7.5	7.4	7.5	7.3	7.2	7.0	8.5	8.3	8.2	8.0	7.0±0.18	7.0±0.18	6.8±0.15	6.8±0.17
T1	8.1	8.0	7.8	7.6	7.8	7.5	7.4	7.2	8.5	8.4	8.4	8.3	7.4±0.20	7.3±0.21	7.3±0.20	7.1±0.18
T2	8.2	8.2	8.0	7.9	8.0	7.9	7.7	7.6	8.6	8.6	8.5	8.5	8.0±0.25	8.0±0.25	7.8±0.22	7.8±0.22
T3	8.2	8.1	7.9	7.8	8.2	8.0	7.8	7.8	8.6	8.5	8.4	8.4	7.9±0.22	7.9±0.23	7.7±0.22	7.6±0.22
T4	8.4	4.3	8.2	8.0	8.5	8.4	8.2	8.0	8.7	8.7	8.6	8.6	8.5±0.25	8.4±0.25	8.3±0.24	8.0±0.22
LSD													0.22	0.28	0.18	0.34

Each value represents mean ± SD. Means in the same column with different letters are significantly different at $p < 0.05$.

C: control buttermilk beverage; T1: buttermilk beverage supplemented with 2% barley flour; T2: buttermilk beverage supplemented with 4% barley flour; T3: buttermilk beverage supplemented with 2% oat flour; T4: buttermilk beverage supplemented with 4% oat flour.

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محـــاولة لإنتاج مشروبات اللبن الخـض الســينبيوتك المــدعمة بدقــيق الشــعير والشـــوفان

محمد السيد عبدالحميد[١] - السيد عبدالستار[٢] - صلاح احمد خليفة[١]- أحمد علاء الدين النشوي[١]

١- قسم علوم الأغذية - كليه الزراعة - جامعة الزقازيق – مصر

٢- قسم تكنولوجيا الأغذية والألبان - كليه التكنولوجيا والتنمية - جامعة الزقازيق – مصر

يعتبر اللبن الخض شرابًا غذائياً هاماً على المستوى العالمي بسبب قيمته الغذائية العالية وسهولة عملية إنتاجه، في الدراسة الحالية تم إنتاج مشروب اللبن الخض الجديد المدعم بدقيق الشعير والشوفان، وتم تقدير الحموضة، الرقم الأيدروجيني، اللزوجة، انفصال الشرش والخصائص الحسية، وأظهر التدعيم بدقيق الشعير ودقيق الشوفان (٢ و ٤% لكلاهما) وجود تغيرات في حموضة المنتج والرقم الايدروجينن كما قل معدل انفصال الشرش وزيادة قيم اللزوجة في عينة اللبن الخض المتخمر المحتوية على ٤% من دقيق الشعير ودقيق الشوفان، كما تم تقييم الخواص الحسية لعينات اللبن الخض المتخمر بما في ذلك اللون والمظهر والتركيب والنكهة والقبول العام، وحصلت العينات المدعمة بـ ٤% من دقيق الشعير ودقيق الشوفان على أعلى الدرجات في التقييم الحسي، وزادت لزوجة عينات اللبن الخض المتخمر بالتناسب مع مستويات إضافة دقيق الشعير والشوفان، التدعيم بدقيق الشوفان بمعدل ٤% للبن الخض أدى الى تحسن القيمة الغذائية والخواص الفيزوكيميائية وأعطى خواص حسية مرغوبة مقارنة بدقيق الشعير.

المحكمـــون:

١- د. محمــد ماهــر أحمد نصـــر أستاذ الألبان المتفرغ - مركز البحوث الزراعية

٢- أ.د. محمد مجدى ذكى العباسى أستاذ الألبان المتفرغ - قسم علوم الأغذية - كلية الزراعة- جامعة الزقازيق.