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(Original Article)

Improving the Functional Properties of Bio-yogurt by Adding Whey Protein Concentrate and Arabic Gum

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Abstract

The purpose of this study was to improve the functional properties of bio-yogurt, which is one of the most popular fermented dairy products widely, consumed worldwide, and to evaluate the effect of whey protein concentrate (WPC) and Arabic Gum (AG) on promoting growth and survival of Bifidobacterium longum. Bio- yogurt was manufactured by using 2% *Bifi. longum* and enriched with 1% WPC or 2% AG, after milk inoculation by bacterial culture it was incubated at 42±1°C until complete coagulation and then stored at 5±1°C. Chemical, bacteriological analysis and sensory evaluation had been carried out in fresh and after 7 & 14 days of storage. The obtained results indicated that, acid development in control samples without probiotic bacteria or WPC & AG was less compared with Bio-yogurt containing *Bifi. longum*, WPC and AG, which scored highest acidity and lowest pH values during storage. Moreover, during storage there were an increase in total solids, soluble nitrogen, total nitrogen and acidity and slight decrease in pH values of cheese made with 1% WPC or 2% AG in all treatments. Concerning the bacteriological determinations, there were a slight increase in total bacterial, *Streptococci, Lactobacilli* and *Bifi. longum* counts during first 7 days of storage, and then decrease gradually during the second week of storage. In addition, WPC and AG increased the total bacteria, *Lactobacilli*, *Streptococci* and *Bifi. longum* counts comparing with control samples. Generally, the addition of WPC increased organoleptic properties of the product, while the addition of AG did not.

Keywords: *Bio-yogurt, Bifidobacterium longum, Whey protein concentrate, Arabic Gum*

Introduction

Healthy diet has become a mainstream of the modern lifestyle and, thus, there is an increasing market demand for functional foods with beneficial effects on human health. Functional foods containing viable probiotic bacteria have become of particular interest, due to their health promoting benefits; they maintain the normal intestinal microflora, protect against gastrointestinal pathogens, and reduce the serum cholesterol level and blood pressure. Probiotics suggested levels in the

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dairy products ranged from 10^6-10^9 colony-forming units per milliliter (cfu/ml) taking into account a daily consumption of 100 g or 100 ml (Farag *et al*., 2020).

Fermented dairy products are healthy and nutritious foods consumed by the people around the world as a part of diet. Consumption of fermented dairy products has been remarkably increased compared to the consumption of liquid milk over the past few decades (Hamdy *et al*., 2020). The main probiotic species added to fermented products belong to Lactobacillus and Bifidobacterium genera, although the potential and use of many other probiotic strains are being evaluated and explored by the food industry (Yerlikaya *et al*., 2020). Yogurt is one of the most widely consumed fermented dairy products in the world, and it is often regarded as a nutritious food (Bouhadi *et al*., 2021). With the growing popularity of yogurt, manufacturers and scientists continue to search for value-added ingredients such as probiotics, prebiotics, and various types of plant extracts to create functional yogurts with more beneficial features than regular yogurt (Fazilah *et al*., 2018). Standard yogurt is usually made by traditional initiator culture strains, *Lact. delbrueckii* ssp *bulagricus* and Str. thermophilus (Arena *et al*., 2015). Meanwhile, Bio-yogurt or probiotic yogurt is supplemented with probiotic strains such as Bifi. and *Lact. acidophilus* that are claimed to have numerous health benefits and should remain live at adequate counts (Chen *et al*., 2017). Bifidobacterium is a widely known genus of probiotic bacteria. Usually appears in V or Y-shaped pairs with methylene blue. Anaerobic, non-pathogenic, Gram-positive, non-spore-forming, cells that have a polymorphous rod shape and are often found in groups, either in chains or in clumps (Zacarías *et al*., 2020). Prebiotics are a group of non-digestible food additives or nutritional supplements that selectively encourage the growth of natural probiotic bacteria in the human gut to give a health benefit on the host (Younis *et al*., 2015). For example, it has been found that Arabic Gum (AG), oat, whey protein concentrate (WPC), yeast extract, peptone, fructose, inulin, fructooligosaccharides, glactooligosaccharides and amyl maize starch selectively stimulates the growth of Bifidobacteria (El-Batawy *et al*., 2019). The ability of WPC to enhance probiotic aggregate is well known (Ahmed *et al*., 2020, Shenana, 2021). Whey proteins may stimulate the growth of Bifidobacteria. In addition, it may improve its culture ability due to its protein and phosphate contents promoting buffering of dairy products (Antunes *et al*., 2005). AG is a natural gum uses as antioxidant, antimicrobial, anticoagulant and anti-inflammatory as well as it uses to improve the shelf life of food products (Patel and Goyal, 2015). Symbiotic are simply described as health-enhancing meals or nutritional supplements that combine probiotics and prebiotics in a synergistic manner (Daou and Zhang, 2012). Synergistic symbiotic containing prebiotics that can stimulate specifically the growth of probiotic provide more additive benefits in gastrointestinal function (Krumbeck *et al*., 2016). Therefore, the aim of the present study was to investigate the effect of adding 1% WPC and 2% AG on the chemical, bacteriological and organoleptic properties of probiotic yogurt manufactured by using Str. thermophilus, *Lact. delbrueckii* ssp *bulgaricus* and *Bifi. longum*.

Materials and Methods

Materials

Whole fresh buffalo's milk was obtained, from the Herd of the Animal Production Department, Faculty of Agriculture, Al-Azhar University (Branch of Assiut).

Arabic Gum (AG) was procured from Agricultural Research Center, Giza, Egypt.

Whey protein concentrate (WPC) its composition as follow's (80% protein, 5.0% moisture, 2.0% ash & 4% fat) obtained from local market.

Starters

Bifidobacterium longum (ATCC 15707) and yogurt starter consisted *of Lactococcus delbrueckii* ssp *bulgaricus* (EMCC 11102) *& Streptococcus. thermophilus* (EMCC 11044) was obtained from Cairo Microbiological Resource Center (MIRCEN), Faculty of Agriculture, Ain Shams University.

Methods

Experimental procedure

Twelve kg fresh buffalo's milk (6.5% fat) were used for manufacture of bio-yogurt as described by Hassaan *et al*., (2019) (fig. 1). Milk was divided into 4 equal portions each of which 3 kg:

The first and second portions were heated directly to 90±1°C for 15 min and cooled to 42±1°C, and then inoculation, while third and fourth portions supplemented with 1% WPC and 2% AG; respectively and heated directly to 90±1°C for 15 min and cooled to 42±1°C, and then inoculation as follows:-

The first portion (YC) was inoculated by yogurt starter (*Str. thermophilus* and *Lact. bulgaricus* with ratio 1:1%; respectively). The second portion (YB) was inoculated by *Str. thermophilus*, *Lact. bulgaricus* and *Bifi. longum* with ratio 1:1:2%; respectively. The third portion (YW) manufactured by adding 1% WPC before heat treatment and inoculated by *Str. thermophiles*, *Lact. bulgaricus* & *Bifi. longum* (1:1:2%); respectively. The fourth portion (YG) manufactured by adding 2% AG before heat treatment and inoculated by *Str. thermophiles*, *Lact. bulgaricus* & *Bifi. longum* (1:1:2%); respectively.

Chemical analysis

Titratable acidity, Total solids (TS), Total nitrogen (TN), water soluble nitrogen (SN) were determined according to AOAC (2020). The pH values were measured for different milk products samples using a pH meter (model 68 ESD 19713), USA.

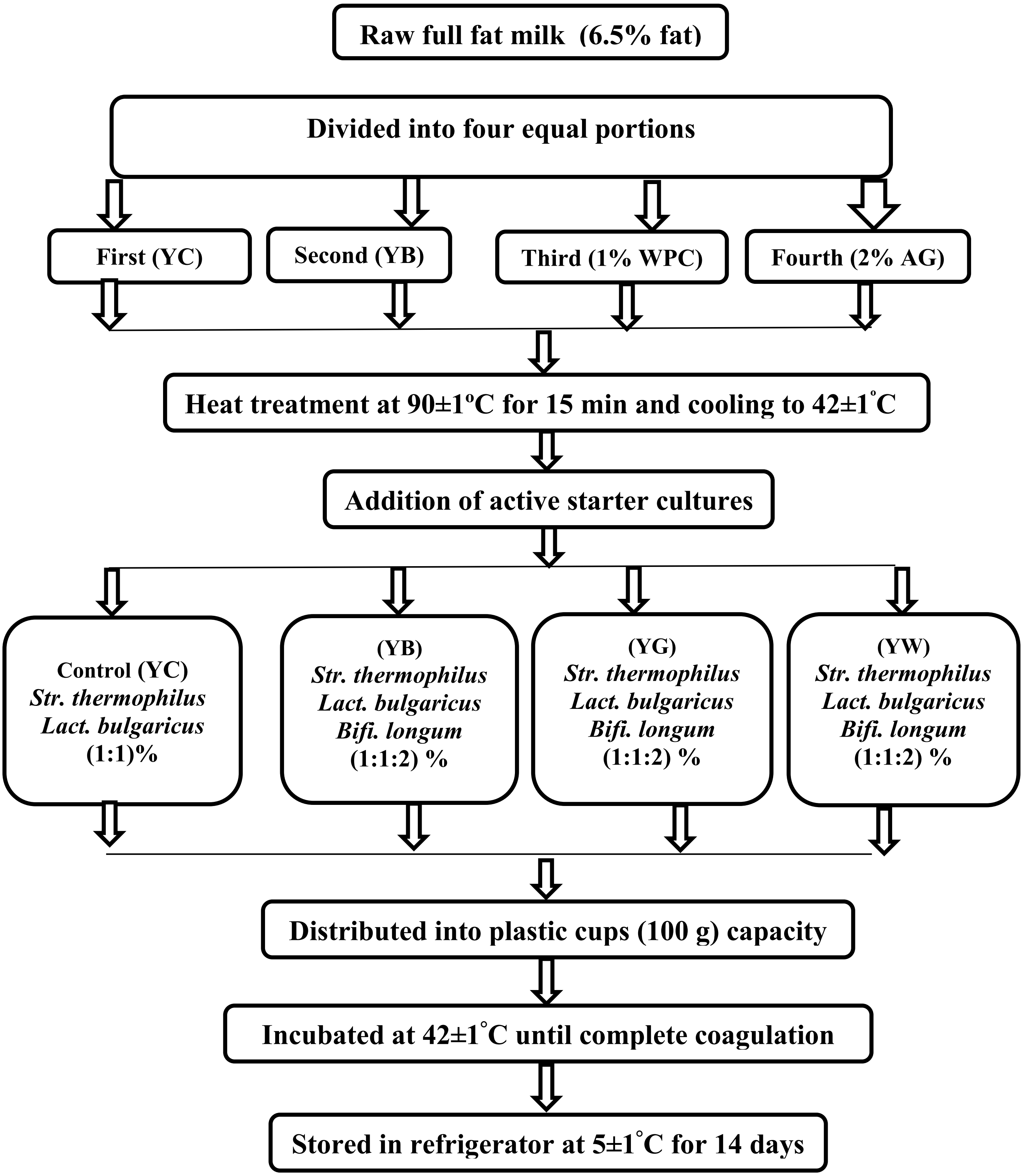

Fig 1. Flow diagram for making bio-yogurt with WPC and AG.

Bacteriological analyses

Total colony forming unit (cfu) was determined according to Marshall (2004).

Lactobacilli count was estimated on the selective medium for lactobacilli (MRS) as suggested by IDF Standard (1997). The plates were incubated at 37°C for 48 h.

Streptococci count was determined by using M17 agar medium. The plates were incubation at 30°C and observed after 24-48 h (IDF Standard, 1997).

Bifidobacteria count was enumerated according to Dave and Shah (1996), using modified MRS agar medium (m-MRS), supplemented with 0.05% L-Cysteine HCL and 0.3% lithium chloride. The plates were incubated at 40°C for 48 h under anaerobic condition.

Coliform count: Violet Red Bile Agar (VRBA) medium was used for enumeration the coliform group and incubating for 24-48 h at 3 °C (IDF Standard, 1985).

Organoleptic properties

The organoleptic evaluation of resultant bio-yogurt was assessed by a panel of 10 persons of staff members of the Dairy Department, Faculty of Agriculture, Al-Azhar University, as fresh and after 7 and 14 days of storage period at 5±1°C according to the scheme described by Badawi *et al*., (2008). An overall score out of (100 points) was given for flavor (45 points), Body & texture (30), appearance (15 points) and acidity (10 points).

Results and Discussion

Chemical composition

To improve the chemical, microbiological and sensory properties of bio-yogurt, 1% (WPC) and 2% (AG) were added to the buffalo's milk. Different yogurt samples were stored at 5±1°C for 14 days and analyzed when fresh and after 7 and 14 days.

Titratable acidity (TA)

Results in Table 1 showed that, in fresh samples the TA values were 0.82, 0.87, 0.93 and 0.84 % in YC, YB, YW, and YG; respectively. The lowest value was in YC and the highest was in YW, which can be explained by the effect of WPC in increasing the rate of lactic acid production from milk lactose during incubation time. These results are in agreement with those obtained by Khairi *et al*., (2020). During 14 days of storage, there was a gradual increase in TA, reaching to 0.90, 0.93, 0.99 and 0.96 % in YC, YB, YW and YG; respectively. These results indicate that, addition of WPC and AG to milk before inoculate by the bacterial starter had increase the bacterial ability to form lactic acid from lactose. In the time, the effect of WPC was more than AG. The increase in available nutrients from whey proteins may partially influence the growth of probiotic bacteria, and possibly affected the changes in TS%, acidity, pH values and protein content (Khairi *et al*., 2020).

Table 1. Chemical composition of bio-yogurt fortified by WPC and AG during storage at 5±1°C up to 14 days

Storage period (Days)	YC	YB	YW	YG
		TA (%)		
Fresh	0.82	0.87	0.93	0.84
7	0.85	0.90	0.97	0.94
14	0.90	0.93	0.99	0.96
		pH		
Fresh	4.40	4.80	4.29	4.31
7	3.95	3.93	3.25	3.27
14	3.86	3.82	3.16	3.22
		TS (%)		
Fresh	14.684	14.719	17.072	16.159
7	15.107	15.800	17.135	16.730
14	15.393	15.826	17.162	16.953
		TN (%)		
Fresh	0.532	0.558	0.697	0.618
7	0.638	0.671	0.787	0.739
14	0.667	0.715	0.885	0.829
		SN (%)		
Fresh	0.032	0.032	0.044	0.037
7	0.034	0.036	0.053	0.044
14	0.037	0.040	0.056	0.050

YC: Control yoghurt, Yogurt manufactured by using Str. thermophilus and Lact. bulgaricus (1:1) %
YB: Yogurt manufactured by using Str. thermophilus, Lact. bulgaricus and Bifi. longum (1, 1, 2) %
YW: Yogurt manufactured by adding 1% WPC and Str. thermophilus, Lact. bulgaricus & Bifi. longum (1, 1
YG: Yogurt manufactured by adding 2% AG and Str. thermophilus, Lact. bulgaricus &Bifi. longum (1, 1, 2) %

pH values

Results in the same Table show the changes in pH values, in fresh samples and during 14 days of storage. In fresh samples, it is clear that the addition of WPC and AG decreased the pH comparing with YC and YB samples. In the same time, the obtained results indicated that as TA was increased; there was a decrease in pH values. These results are consistent with those of Shenana, (2021), who reported that addition of WPC and AG could increase lactic acid, thereby lowering the pH level. The increase in buffering capacity slowly lowered the pH and enhanced the level of acidification by the initiating bacteria (El-Alfy, 2021). During storage there were a gradual decrease in pH values reached 3.86, 3.82, 3.16 and 3.22 in YC, YB, YW and YG after 14 days of storage; respectively. The pH values in YW and YG were lower than in YC and YB, which prove the effect of WPC and AG in increasing the rate of decrease in pH values. These results are comparable with those obtained by Habibi Najafi *et al*., (2019). Moreover, the addition of WPC and AG to milk prior to inoculate by starter can increase the starter activity in lactic acid formation. The reason for this decrease in the pH value may be due to the continuous fermentation of lactose and its conversion to lactic acid, as a result of the slow fermentation activity of the starter cultures during cold storage (Shenana, 2021).

Total solid percentages (TS)

Results present in the same Table show TS% of in fresh and stored samples. In fresh samples, TS% were 14.684, 14.719, 17.072 and 16.159% in YC, YB, YW and YG; respectively. The addition of WPC and AG to milk prior to inoculate had increase the TS% in the product, and the effect of WPC was much higher than that AG in all treatments. These results are in agreement with those obtained by Alakali *et al*., (2008), who found that the addition of WPC and AG increase TS% comparing with YC. During 14 days of storage, there were a gradual increase in TS% in all samples, and reached to 15.393, 18.826, 17.162 and 16.953 % in YC, YB, YW and YG; respectively. The increase in TS% can be due to slight decrease in moisture content as a result of evaporation and the effect of the increase in TA and its effect of synereses of whey from the product. In the same time, the higher content of TS was found in YW samples comparing with YC, YB and YG.

Total & soluble nitrogen percentages (TN & SN %)

Results obtained for TN & SN% in fresh and stored sample are presented in Table 1. YW and YG had higher percentage of TN (0.697 & 0.618%), which can be explained higher TN% in WPC and AG. After 14 days of storage, there was a gradual increase in TN%, it was reached to 0.667, 0.715, 0.885 and 0.829% in YC, YB, YW and YG; respectively. Which can be explained by slight evaporation and decrease in moistures content as a result of the increase in acidity of the product. Similar results were obtained by Salih *et al*., (2020). Regarding SN%, it is obvious that the addition of WPC and AG increased SN%. In fresh samples, it was 0.032, 0.032, 0.044 and 0.037 % in YC, YB, YW and YG; respectively. After 14 days of storage, there were a gradual increase in SN in all treatments. Moreover, the rate of increase was faster in YW and YG comparing with YC and YB in all treatments. The SN% in YW and YC, increased from 0.044 to 0.056% (0.012%), and from 0.037 to 0.050% (0.013%); respectively. While, the correspond increase in YC and YB was 0.005 and 0.008%; respectively. These results can be explained by the higher percentage of TN in WPC and AG, which is similar to those results obtained by Kermiche *et al*., (2018).

Bacteriological analysis

Data presented in Table 2 illustrate the bacteriological analysis of bio-yogurt, enriched with 1% WPC and 2% AG during storage periods at refrigerator temperature for 14 days.

Total bacterial count (TBC)

Results in Table 2 present TBC (log cfu/ml) in all treatments, when fresh and after 14 days of storage at 5±1°C. It is clear that, in fresh samples there was no big differences in TBC. The minimum was 7.30 cfu/ml in YC, while the maximum was 7.74 cfu /ml in YW, which can be attributed to the chemical composition of WPC and its content of nitrogenous compounds, these compounds enhance the bacterial growth. After the first 7 days of storage, there was gradual increase in TBC in all treatments, in the same time the higher increase was in YW samples and the lower was in YC 7.62 log cfu/ml. At the end of storage, there was a gradual decrease in TBC in all treatments. The highest count was in YW being 7.068 log cfu/ml. These results are in agreement with those obtained by Hammad, (2019), who found that adding WPC and AG to yogurt had increased TBC comparing with control samples. In the same time, the decrease in TBC after 14 days of storage can be explained by the increase in TA, and the effects of increase in acidity on viability and activity of bacteria, which is in accordance with the results of Ismail *et al*., (2017).

Table 2. Bacteriological analysis (log cfu/ml) of bio-yogurt fortified by WPC and AG during storage at 5±1°C for 14 days

Storage period (Days)	YC	YB	YW	YG
Total bacterial count (TBC)				
Fresh	7.30	7.32	7.74	7.68
7	7.62	8.41	8.60	8.53
14	7.55	7.55	7.68	7.27
***Lactobacilli* count**				
Fresh	7.30	7.74	7.97	7.77
7	7.77	8.39	853	850
14	7.11	7.62	7.92	7.84
***Streptococci* count**				
Fresh	6.04	6.14	6.39	6.30
7	6.57	6.82	7.74	7.32
14	6.17	6.57	6.90	6.63
***Bifi. longum* count**				
Fresh	-	7.23	7.88	7.79
7	-	8.63	9.30	9.00
14	-	7.34	7.60	7.41
Coliform count				
ND*				

YC: Control yoghurt, Yogurt manufactured by using *Str. thermophilus* and *Lact. bulgaricus* (1:1) %
YB: Yogurt manufactured by using *Str. thermophilus*, *Lact. bulgaricus* and *Bifi. longum* (1, 1, 2) %
YW: Yogurt manufactured by adding 1% WPC and *Str. thermophilus*, *Lact. bulgaricus* & *Bifi. longum* (1, 1, 2) %
YG: Yogurt manufactured by adding 2% AG and *Str. thermophilus*, *Lact. bulgaricus* & *Bifi. longum* (1, 1, 2) %

Lactobacilli count

Results in the same Table show that, counts of lactobacilli were slightly different between treatments in fresh samples, and the minimum was in control samples 7.30 log cfu/ml, and the maximum was in samples fortified with WPC and AG which was 7.97 and 7.77 log cfu/ml; respectively. These results are similar to those obtained by Kebary *et al*., (2015), who found that the addition of WPC and AG increased Lactobacilli count in bio-yogurt as an effect of the composition of WPC and AG, and its content from sugar, proteins and small peptides. After 7 days of storage, there was increase in Lactobacilli count in all treatments, it obvious that the increase in YW and YG samples was higher comparing with YC and YB samples. At the end of storage, there was slight decrease in Lactobacilli count in all treatments. In the same time, the higher was in YW samples being 7.92 log cfu/ml compared with 7.11, 7.62 and 7.84 log cfu/ml in YC, YB and YG; respectively. The decrease in Lactobacilli count at the end of the storage was explained as a result of increase in TA (Mangia *et al*., 2014).

Streptococci count

From the results presented in the same Table, it can be seen that Streptococci colony counts was slightly different between fresh samples in all treatment. The minimum was 6.04 log cfu/ml in YC, and the maximum was 6.39 and 6.30 log cfu/ml in YW and YG; respectively. This can be explained the effect of WPC and AG as a growth promoting for Streptococci as they contain small peptides and sugar which stimulate Streptococci growth. Similar results were obtained by Ismail *et al*., (2020). After 7 days of storage, although there were an increase in Streptococci counts in all treatment, the higher counts were in YW and YG, being 7.74 and 7.32 log cfu/ml respectively. After 14 days of storage as a result for the increase in acidity, there was slight decrease in Streptococci count, the counts were 6.90 and 6.63 log cfu/ml in YW and YG; respectively, and the minimum was 6.17 log cfu/ml in control samples. These results are similar to the results found by Hamad *et al*., (2016), who obtained that WPC and AG clearly encouraged the growth of *Str. thermophilus* in probiotic yogurt.

***Bifidobacterium longum* count**

Results in the same Table, clearly show that in fresh samples total cfu of *Bifi. longum* were 7.23, 7.88 and 7.79 log cfu/ml in YB, YW and YG; respectively. In the same time, the lowest count was in YB samples, which reflect the effect of WPC and AG as a growth promoting for Bifi. longum due to their richness in carbohydrates and small peptides. These results are similar to those obtained by Abou-Dobara *et al*., (2017). Moreover, Khairi *et al*., (2020) mentioned that, the available nutrients in WPC might influence the growth of Bifi. longum and possibly affect the acidity and pH in probiotic yogurt. After 7 days of cold storage, there were an increase in Bifi. longum counts in all treatments, the highest count was 9.30 log cfu/ml in YW and the lowest was 8.63 log cfu/ml in YB. These counts were decrease after 14 days of cold storage and still highest in YW samples. These results meet the requirements for a product to be called probiotic functional food; as it have at least 10^6cfu /ml of Bifi. longum at the end of the storage period as mentioned by El-Alfy, (2021).

Coliform count

It was not detected in all treatments, which indicates that we prepared yogurt was under aseptic and hygienic conditions, so we did not detect any contamination by coliform bacteria in all samples and up to the end of the storage periods.

Sensory evaluation

Results of sensory evaluation of bio-yogurt manufactured by using *Str. thermophilus*, *Lact. bulgaricus* and *Bifi. longum* and 1%WBC and 2% AG are presented in Fig 2.

Flavor

All samples were evaluated when fresh and after 7 and 14 days of storage at 5±1°C. The obtained results indicated that, bio-yogurt samples manufacture by adding 1% WPC gained higher flavor scores when fresh and throughout the storage period that may be due the chemical composition of WPC, which can hydrolyze during storage periods. Moreover, samples manufacture by using 2% AG gained the minimum flavor scores compared with other treatments. These results are in agreement with Soliman and Zaki (2016), who demonstrated that using probiotic cultures in manufacturing of dairy products give better flavor than that without it.

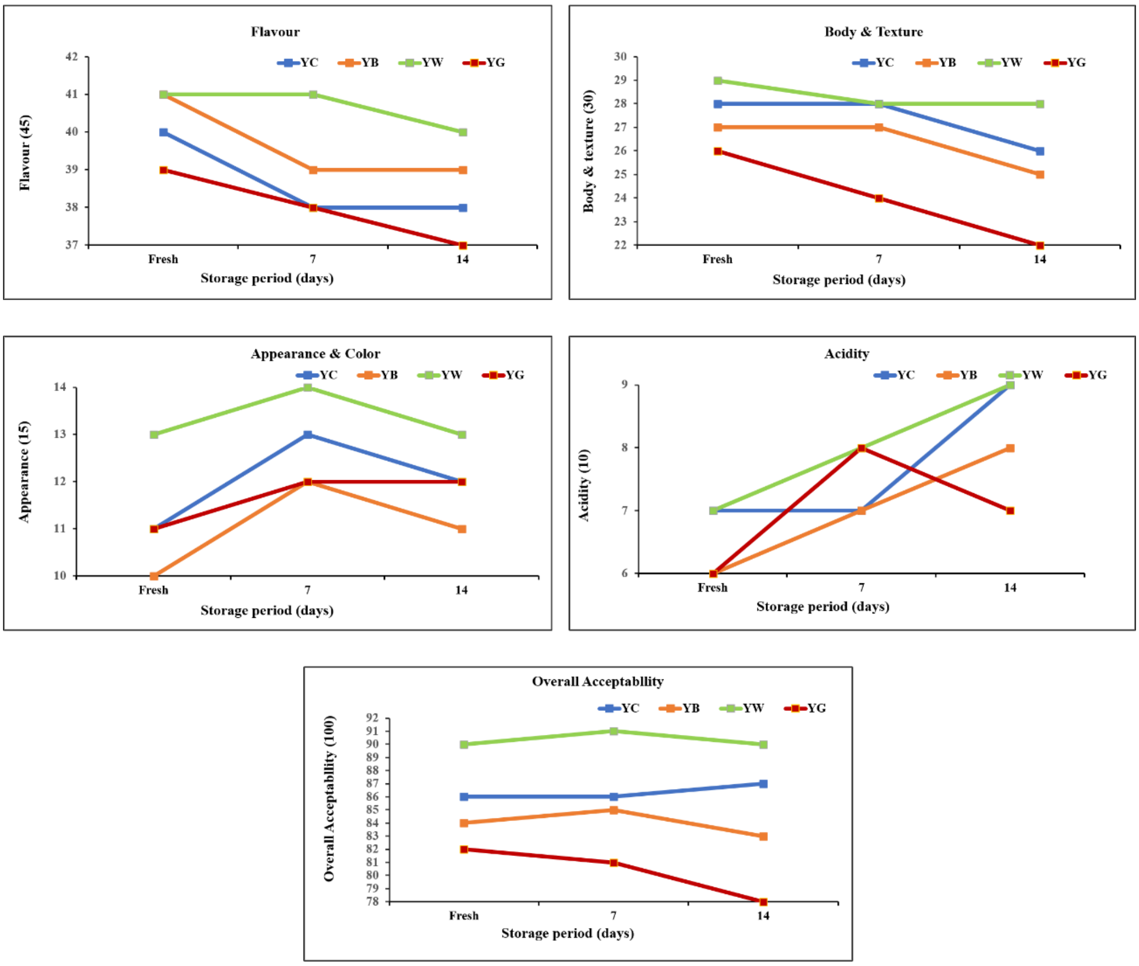

Fig 2. Sensory evaluation of bio-yogurt fortified by WPC and AG during storage at 5±1°C

Body and texture

Concerning body and texture, samples manufacture by adding 1% WPC gained higher scores, while samples manufactured by adding 2% AG gained the minimum scores comparing with other treatments. These results can be explained according to El-Tahra, (2014), that addition of WPC gave rise to increase in TS content and improve body and texture of the product.

Appearance and color

Concerning appearance and color, samples manufactured by adding 1% WPC gained the higher scores, which can be explained by the effect of WPC, which make the product whiter than the other treatments. These results are similar to those found by Rafiq *et al*., (2020).

Acidity

Concerning acidity, samples manufactured by adding 1% WPC gained the higher scores, while samples manufactured without WPC or AG gained the minimum scores comparing with other treatments.

Generally, samples manufactured by adding 1% WPC gained higher flavor, body & texture, appearance and color when fresh and at the end of storage period comparing with other treatments.

Overall score

The obtained results proved that the addition of WPC in the manufacture of bio- yogurt improved overall score of the product, which can be explained according to Rafiq *et al*., (2020), that addition of WPC as a growth promoting agent for probiotic dairy products improves; flavor, body & texture , appearance and color of the product.

Conclusion

Our results showed that, the addition of WPC and AG in the manufacture of bio- yogurt improved the chemical composition and bacteriological quality of the product, which agreed with the world requirements and regulations. Its mean that, the product contain at least 10^6 cfu/ml or 6 log cfu/ml at the end of date of validity. Moreover, the addition of WPC increased organoleptic properties of the product, while the addition of AG did not.

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تحسين الخصائص الوظيفية للزبادي الداعم للحيويه باضافة مركز بروتينات الشرش والصمغ العربي

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الملخص

الغرض من هذه الدراسة هو تحسين الخصائص الوظيفية للزبادي الداعم للحيوية والذي يعتبر أحد منتجات الالبان المتخمرة الاكثر شيوعا والتي يتم استهلاكها على نطاق واسع في جميع انحاء العالم. وقد تم تقييم مدي تأثير مركز بروتينات الشرش والصمغ العربي علي تعزيز نمو وحيوية سلالة الـ *Bifidobacterium longum* حيث تم تصنيع الزبادي المدعم للحيوية باستخدام *Bifidobacterium longum* و% 1 مركز بروتينات الشرش و2% من الصمغ العربي، وبعد تلقيح اللبن تم تحضينه عند 42±1 درجة مئوية حتي اكتمال التجبن ثم تم تخزينه عند درجة 5±1 درجة مئوية في الثلاجة، وتم اجراء التحليلات الكيميائية والبكتريولوجيه والتحكيم الحسي للعينات الطازجة وبعد 7 و 14 يوم من التخزين، وقد اشارت النتائج الي انخفاض الحموضة في عينة المقارنة مقارنة بالزبادي المحتوي علي *Bifidobacterium longum*ومركز بروتينات الشرش والصمغ العربي والذي سجل اعلي درجة حموضه وادني قيمه للاس الهيدروجيني اثناء التخزين، كما اظهرت النتائج أنه أثناء التخزين كان هناك زيادة في المواد الصلبة الكلية ، النيتروجين القابل للذوبان ، النيتروجين الكلي والحموضة وانخفاض طفيف في قيم الأس الهيدروجيني للجبن المصنوع من 1% مركز بروتينات الشرش أو 2% من الصمغ العربي في جميع المعاملات، وفيما يتعلق بالتقديرات البكتريولوجية ، كانت هناك زيادة طفيفة في كلا من العدد الكلي للبكتريا ، *Streptococci* ، *Lactobacilli*،*Bifi. Longum* خلال الأيام السبعة الأولى من التخزين ، ثم انخفض تدريجيًا خلال الأسبوع الثاني من التخزين، وقد أدت إضافة مركز بروتينات الشرش أو الصمغ العربي إلى زيادة هذه الاعداد مقارنة بعينات المقارنة. اوضحت النتائج ان اضافة مركز بروتينات الشرش أدى إلى وزيادة الخصائص الحسية للمنتج ، في حين أن إضافة الصمغ العربي عكس ذلك.