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Utilization of sweet whey and Ultra Filtration-milk permeate in manufacture of yoghurt drink

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ABSTRACT

Sweet whey and UF-milk permeate, the nutritional and valuable dairy by-products were successfully used in yoghurt drink manufacture. Sweet whey, UF-milk permeate or water were added to fresh cow's milk in a ratio of (1:1). Yoghurt drink cultures: ABT probiotic yoghurt culture (*Lactobacillus acidophilus, Bifidobacterium bifidum, & Streptococcus thermophilus*) and YC- X11 thermophilic yoghurt culture (*Streptococcus thermophilus & Lactobacillus delbrueckii subsp. bulgaricus*) were also used. The higher total solid (TS) content were shown in sweet whey yoghurt drink samples meanwhile, water samples were the lowest. ABT yoghurt drink samples exhibited pH values slightly lower than that of YC-X11 when compared at the same order. *Lb. acidophilus* was recorded a developing count in water yoghurt drink treatment along 14 days meanwhile; sweet whey yoghurt drink treatment recorded the highest developing count up to 21 days of storage at (4 ± 1°C). The lower TS content the lower developing count of *Lb. acidophilus*. The joint growth of *S. thermophilus* and (*B. bifidum* & *Lb. acidophilus*) was better more than that with *Lb. bulgaricus* even at the low levels of the TS. No yeast and mold counts were detected in all treatments when fresh and during storage up to the day 21. For the sensory character assessed sweet whey yoghurt drink treatments were the most preferred and UF-milk permeate yoghurt drink was slightly less acceptable. Three replicates were carried out for each treatment and the data obtained were statistically analyzed at $p \leq 0.05$.

***Keywords*:** Yoghurt drink, Sweet whey, UF-milk permeate, Water, ABT yoghurt culture, YC- X11 thermophilic yoghurt culture. *Lb. acidophilus, B. bifidum, S. thermophilus* and *Lb. bulgaricus*.

Introduction

Fermented dairy products are the most popular fermented products widely consumed all over the world. Fermented beverages are of great importance due to they provide and sustain large quantities of nutrients in a wide diversity of flavor, texture and enrichment of health benefits, Kumar *et al.*, (2017). Most of yoghurt drinks is usually manufactured by dilution of yogurt by water. Flavors, stabilizers and other ingredients can also be added. These products require sensory, physical and chemical characterization for product development. There are new procedures could be applied to help deliver higher functionality and nutritional value of yoghurt drink products to be better useable. Therefore, some natural milk derivatives or by-products as milk permeate and sweet whey can be used for yoghurt drink characterization enhancement. Milk permeate is a good source for the essential electrolytes such as calcium, potassium, sodium, magnesium and phosphorus. So, it have been studied as ingredient in a variety of applications ranging from the use as a fermentation media to a beverage ingredient, Hattem *et al.*, (2011). Sweet whey has a higher nutritional and functional properties used in preparation of milk beverage for introduce desirable, soft, smooth and proteinaceous products, (Kumar *et al.*, 2017). Sweet whey can strengthen the gel structure being as a result of milk proteins, to enhance the value of yoghurt drink. Visual appeal depending on whey ingredients, can add opacity to the finished products. Phospholipids and gangliosides are highly bioactive compounds that enhance the main biological activities of whey, are suggested to include cancer prevention, increase of glutathione levels, antimicrobial function, and increase of satiety response (Valli and Trail, 2005 & Madureira *et al.*, 2007). Manufacture of yoghurt drink through lactic fermentation can provide

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desirable sensory profiles and has already been considered an option to whey add value (Salminen *et al*., 1991; Skudra *et al*., 1998 and Pescuma *et al*., 2008). Yoghurt drinks are being sold on market as bio-yoghurt due to its high digestibility and bioavailability. Although, there is an importance by lactic acid produced from different microorganisms such as *S. thermophilus* and *Lb. bulgaricus* due to particular attributes of rapid acid production from lactose and development of suitable quantities of the volatile compounds, Robinson (2002). Now even the efforts are going on to incorporate the mixed cultures of health promoting bacterial species such as *Lactobacillus acidophilus* and *Bifidobacterium ssp.*, into fermented milk products, Junaid *et al.,* (2013). Yoghurt drinks is considered as a probiotic carrier that can deliver significant amount of probiotic bacteria into body, can claim specific health benefits, Weerathilake *et al.,* (2014). Probiotic bacteria are defined as live microorganisms when administrated in adequate amounts can provide a health benefit on the host. Probiotic bacteria has been shown to have effects on enhancement of the immune system, prevention of gut, vaginal, urogenital infections, diarrhea, and gastritis, by inhibiting enteric and foodborne microbial pathogens, Walsh *et al.,* (2010).

Therefore; this study has achieved to increase the interest in sweet whey and UF-milk permeate based yoghurt drinks with a good properties and acceptable quality using mixed cultures of bacterial species with specific health characteristics.

Materials and Methods

Materials:

Fresh cow's milk was procured from Dina for Agriculture Investments S.A.E., (Dina Farms), Egypt. Sweet whey was obtained from Faculty of Agriculture, Cairo University, Egypt. UF-milk permeate was obtained from Animal Production Research Institute, Agriculture Research Center, Dokki, Egypt.

Yoghurt drink cultures:

ABT probiotic yoghurt culture containing *Lactobacillus acidophilus, Bifidobacterium bifidum, Streptococcus thermophiles,* and YC-X11 thermophilic yoghurt culture containing *Streptococcus thermophilus, Lactobacillus delbrueckii subsp. bulgaricus* were obtained from Chr. Hansen's, Denmark.

Method of yoghurt drink manufacture:

Fresh cow's milk was divided into three portions for dilution by: water, sweet whey or UF-milk permeate in ratio of (1:1). Three portions were pasteurized at (75 ± 1°C) for 30 Sec. and then cooled to 40°C. Every portion was divided into two sections to inoculate by 2.5% ABT yoghurt culture or YC-X11 thermophilic yoghurt culture. Inoculated yoghurt drink mixtures were incubated for 4 h at 40°C, the incubation time was prolonged for 5 h at 40°C for water yoghurt drinks mixtures. After incubation all treatments were packaged in 100 ml plastic cubs, cold and stored under refrigerated conditions (4 ± 1°C) for 21 days.

Methods of analysis:

Chemical Analysis:

Fresh yoghurt samples were chemically analyzed for total solids (TS), fat and ash content according to AOAC (2012). Total protein (TP) content was determined using semi micro-Kjeldal method as mentioned by Ling (1963).

Physico-Chemical Properties:

pH values:

pH values were measured using a digital laboratory Jenway 3510 pH meter, UK. Bibby Scientific LTD. Stone, Stafford shire, ST 15 OSA.

Apparent viscosity:

Yoghurt drink samples were gently stirred in clockwise direction prior to viscosity measurements. Apparent viscosity was measured at 20°C using a coaxial rotational viscometer, Brookfield Engineering labs DV- III ultra rheometer, USA. The measuring device spindle (HA-21) was used with a sample volume of 30g per run. The sample was subjected to shear rates at different ranges and the apparent viscosity was recorded at all shear rates for upward curve. Viscosity measurements were expressed as centipoise (cP).

Microbiological strains enumeration:

Viable microbial strains counts as log Colony Forming Units/mL (log CFU mL^{-1}) were enumerated by plate count method as follows:

***Lactobacillus acidophilus* counts:**

Lactobacillus acidophilus counts were enumerated according to Gilliland and Walker (1990), using MRS agar for pouring the plates and incubated anaerobically at 37°C for 48 h.

***Bifidobacterium bifidum* counts:**

Bifidobacterium bifidum counts were detected as the method described by Vinderola and Reinheimer (1999) using MRS agar supplemented with 0.05% L-cysteine HCL and 3 % lithium chloride. The plates incubated at 37°C for 72 h under anaerobic conditions.

***Streptococcus thermophiles* counts:**

According to Terzaghi and Sandine (1975) *S. thermophilus* counts were enumerated at 37°C for 48h using M17 agar under aerobic conditions.

***Lactobacillus delbrueckii* subsp. *bulgaricus* counts:**

Lactbacillus bulgaricus counts were enumerated using De Man-Rogosa- Sharpe (MRS) agar according to De Man *et al.* (1960). The plates were incubated at 37°C for 48 h under anaerobic conditions.

Yeast and mould counts:

Yeast and mould counts were detected using potato dextrose agar (pH 3.5) according to the method of APHA (1994). The plates were incubated aerobically at 25°C for 3 - 5 days.

Sensory properties evaluation:

Yoghurt drink samples were sensory evaluated according to Ladokun and Oni (2014). The ratings were scored from a Hedonic scale ranging from 1.0 - 5.0, for Appearance, Odor, Mouth, feel and Overall acceptability. Keys: 5.0 = Very Good, 4.9 - 4.0 = Good, 3.9 - 3.0 = Fair, 2.9 - 2.0 = Poor, 1.9 - 1.0 = Bad. The evaluation was carried out by regular members scoring panel of Food Science Department, Faculty of Agriculture, Ain Shams University; Dairy Department, National Research Centre; and Dairy Research & Tech. Department, Agricultural Research Center.

Statistical analysis:

The one-way and two-way analysis of variance ANOVA was carried out using Co-State 6.311 (2005), to determine the statistical significance among means of three replicates of samples at $p \leq 0.05$.

Results and Discussion

Chemical composition:

The chemical compositions as (%) of yoghurt drink samples using water, sweet whey and UF-milk permeate are shown in Table (1).

Total Solids (TS):

From the table, it can be seen that TS content in yoghurt drink water samples being the lowest 5.87 &5.92, and increased in permeate or sweet whey yoghurt drink samples. The higher content were shown in sweet whey yoghurt drink samples that exhibited 9.12 or 9.27 for ABT and YC-X11 yoghurt culture.

Fat:

Fat content in yoghurt drink ABT yoghurt culture samples were displayed slight differences from that of YC-X11 yoghurt culture samples. Yoghurt drink sweet whey samples were having the higher fat content and that with water were have the lower. These slight differences could be due to the fat content of sweet whey when used.

Total Protein (TP):

Total protein content of ABT yoghurt culture samples were 1.83, 2.53 and 2.05 for water, sweet whey and permeate, respectively. Meanwhile, it was 1.82, 2.62 and 2.01 for YC-X11 yoghurt culture samples. These differences could be due to the differences of protein content among added sweet whey or permeate.

Ash:

Samples of yoghurt drink have ash content ranged from 0.340 to 0.875 for ABT yoghurt culture comparing by that ranged from 0.343 and 0.895 for YC-X11 thermophilic yoghurt culture samples. The higher ash contents could be correlated to the mineral content of sweet whey and permeate as a natural component.

Table 1: Chemical composition (%) of yoghurt drink ABT yoghurt culture (A) or YC-X11 thermophilic yoghurt culture (Y) treatments using water, sweet whey and UF-milk permeate.

Treatments*	TS	Fat	TP	Ash
HA	5.87^{b}	1.54^{a}	1.83^{b}	0.340^{b}
WA	9.12^{a}	1.65^{a}	2.53^{a}	0.843^{a}
PA	8.56^{a}	1.57^{a}	2.05^{b}	0.875^{a}
HY	5.92^{b}	1.51^{a}	1.82^{b}	0.343^{b}
WY	9.27^{a}	1.67^{a}	2.62^{a}	0.895^{a}
PY	8.46^{a}	1.56^{a}	2.01^{b}	0.801^{a}

* H : Yoghurt drink using water W : Yoghurt drink using sweet whey
P : Yoghurt drink using UF-milk permeate
a, b, c: Means with different letters are significantly different ($p \leq 0.05$).

pH values:

Variations of yoghurt drink pH values using ABT or YC-X11 yoghurt culture samples are reported in Table (2). ABT yoghurt drink fresh samples exhibited pH values slightly lower than that of YC-X11 when compared at the same order.

Table 2: pH values of yoghurt drink ABT yoghurt culture (A) or YC-X11 thermophilic yoghurt culture (Y) treatments using water, sweet whey and UF-milk permeate when fresh and during storage.

Treatments*	Storage period / days			
	0	7	14	21
HA	4.36^{ab}	4.26^{abc}	4.15^{abcd}	4.04^{cde}
WA	4.40^{a}	4.30^{abc}	4.18^{abcd}	3.93^{de}
PA	4.37^{ab}	4.28^{abc}	4.19^{abcd}	4.07^{cde}
HY	4.38^{a}	4.29^{abc}	4.20^{abcd}	4.05^{cde}
WY	4.41^{a}	4.3^{abc}	4.18^{abcd}	3.95^{de}
PY	4.39^{a}	4.30^{abc}	4.22^{abcd}	4.09^{bcde}

* The same as Table (1)
a, b, c: Means with different letters are significantly different ($p \leq 0.05$).

These could be correlated to the differences in activity of the starter bacteria producing acids. In spite of the pH value of the sweet whey was tending to the acid phase, sweet whey yoghurt drink pH samples were the higher and followed by permeate samples. This could be due to the buffering capacity of whey proteins, Kailasapathy and Rybka (1997). Due to the fact of, the more SNF content the more buffering capacity (Shafiee *et al.,* 2010). Yoghurt drink samples of water were having the lowest pH ever that with ABT or YC-X11 yoghurt culture due to lower TS content. pH values have varied by variations of added diluent due to variations in TS content, (Shafiee *et al.,* 2010), which in turn means a higher decrease in pH for the same amount of acid produced, (Kristo *et al.,* 2003).These could be correlated to the activity differences of the starter bacteria producing acids.

Moreover, all treatments when stored showed a decrease in pH values up to the end of storage. The decrease were more noticeable in whey samples especially that of ABT yoghurt culture.

Viscosity:

Yoghurt drink treatments viscosity values (cP) at different shear rates (S^{-1}) were illustrated in Fig (1). Yoghurt drink with that added sweet whey using ABT or YC-X11 yoghurt culture were having the highest viscosity values. This could be due to the TS content especially proteins, with an increase in the TS there were an increase in apparent viscosity, Fetahagić *et al.,* (2004) and Barretto Penna *et al.,* (2006). In spite of, sweet whey and permeate YC-X11 yoghurt culture treatments were having higher viscosity when compared by that of ABT yoghurt culture in the same order, water treatment of ABT yoghurt culture being higher than that of YC-X11 yoghurt culture. In the other meaning, water treatment of YC-X11 yoghurt culture being the lowest comparing by all treatments.

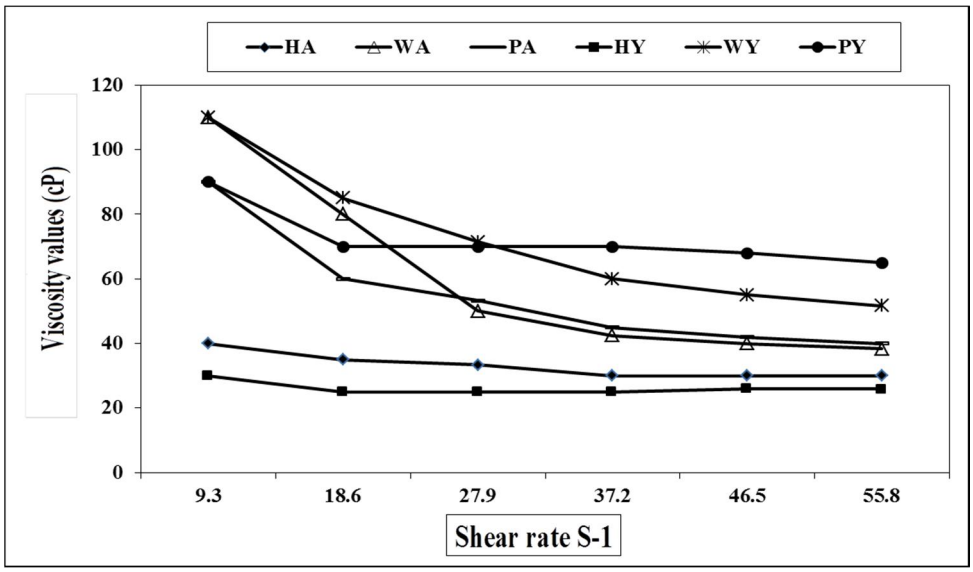

Fig. 1: Viscosity values (cP) of yoghurt drink ABT yoghurt culture (A) or YC-X11 thermophilic yoghurt culture (Y) treatments using water (H), sweet whey (W) or UF-milk permeate (P) when fresh.

Yoghurt drink ABT yoghurt culture counts:

The bacterial counts of yoghurt drink ABT yoghurt culture treatments, *Lb. acidophilus, B. bifidum and S. thermophilus* are shown in Table (3) when fresh and during storage.

***Lactobacillus acidophilus counts*:**

Table (3) showed the count of *Lb. acidophilus* in yoghurt drink ABT yoghurt culture samples when fresh and during storage. UF-milk permeate yoghurt drink treatment recorded 8.08 log CFU mL^{-1}, meanwhile water and whey yoghurt drink treatments recorded 8.07 log CFU mL^{-1} when fresh. Counts were increased in water yoghurt drink treatment along 14 days to record 8.10 log CFU mL^{-1}, it has the minimum time for the maximum count reproduction comparing by other treatments, Shori and Baba (2012). The lower TS content the lower reproduction of *Lb. acidophilus* count, Almeida *et al.,* (2009). At the day 21, sweet whey yoghurt drink treatment recorded the maximum developing count

among all treatments. Sweet whey treatment recorded 8.14 log CFU mL^{-1}, followed by permeate treatment 8.12 log CFU mL^{-1}. These differences could be due to the more nutrient content in whey such as mineral, vitamins and whey proteins, can increase bacterial growth, *Lb. acidophilus* count has a better develop in the presence of proteins and peptides, Ayar and Burucu (2013). *Lb. acidophilus* able to resist acid accumulation produced by *S. thermophilus* and possess several mechanisms to counteract acid stress, Azcarate-Peril *et al.,* (2004). At the end of storage, the decreased count was recorded for the water treatment 8.05 log CFU mL^{-1}. Decrease could be due to changes in pH mentioned parts, at lower pH values starter bacteria enter the death phase of bacterial growth, Shafiee *et al.,* (2010). Contributing factors for loss of cell viability are the pH decrease during storage Eissa *et al*., (2010), and accumulation of organic acids as a result of growth and fermentation, Dave and Shah, (1997).

Table 3: ABT yoghurt culture (A) counts (log CFU mL^{-1}) of yoghurt drink treatments using water, sweet whey and UF-milk permeate when fresh and during storage.

Treatments*	Storage period / days			
	0	7	14	21
		Lb. acidophilus		
HA	8.07^{g}	8.08^{f}	8.10^{e}	8.05^{h}
WA	8.07^{fg}	8.10^{e}	8.13^{b}	8.14^{a}
PA	8.08^{f}	8.10^{e}	8.11^{d}	8.12^{c}
		B. bifidum		
HA	8.04^{e}	8.08^{c}	8.09^{c}	8.00^{g}
WA	8.06^{d}	8.11^{b}	8.13^{a}	8.11^{b}
PA	8.02^{f}	8.08^{c}	8.10^{b}	8.08^{c}
		S. thermophilus		
HA	8.01^{g}	8.04^{f}	8.06^{e}	7.97^{h}
WA	8.05^{ef}	8.09^{d}	8.13^{a}	8.10^{cd}
PA	8.09^{d}	8.11^{bc}	8.12^{ab}	8.10^{cd}

* The same as Table (1)

a, b, c: Means with different letters are significantly different ($p \leq 0.05$).

***Bifidobacterium bifidum counts*:**

All treatments when fresh were having *B. bifidum* numeration of 8.04, 8.06 and 8.02 log CFU mL^{-1} for water, sweet whey and permeate yoghurt drink respectively. The higher numeration was recorded for whey yoghurt drink treatment and the lower was recorded for permeate treatment. After 7 days of storage the numeration were increased in all treatments, this increase was recorded up to 14 days of refrigerated storage. Whey treatment has the higher numeration among all treatments. This could be with respect to the point of the initial number of *B. bifidum* cells inoculated. Since *Bifidobacteria* strains have a lack proteolytic activity, they could be grown by adding casein hydrolysates, Hattingh and Viljoen (2001). Whey glycomicropeptide (GMP), lactoferrin and mineral also consider a bioactive components can support the growth of *Bifidobacteria,* Ayar and Burucu (2013). Extending the storage up to 21 days caused deterioration for *B. bifidum* numeration in different trends. Nevertheless, water yoghurt drink treatment numeration was higher than that of permeate at fresh time, the permeate yoghurt drink treatment was higher at the end of storage when compared. This could be due to lower buffering capacity in water treatment as a mean of pH drop rate causes pH drop shock to probiotic cells, Shafiee *et al.,* (2010). Decrease in numeration by storage for the different treatments could be reverse to the decrease in pH values. *Bifidobacterium bifidum* is significantly less tolerant to the lower pH values moreover, their growth and activity is restricted at pH < 5.0, Shafiee *et al.,* (2010). In addition, whey treatment was containing the higher count among all treatments even after 21 days of storage. Higher buffering capacity in treatments with higher SNF content increase the viability of probiotic bacteria due to processing appropriate protective effect of the solid matrixes on probiotic bacteria against detrimental factors such as molecular oxygen, hydrogen ions, H_2O_2 and organic acids, Talwalkar and Kailasapathy (2004). Since *B. bifidum* is a dependent on other lactic acid bacteria to ensure its growth, (Klaver *et al*., 1993), oxygen toxicity is consider as an important and critical factor. The oxidative damage is associated to the presence of some enzymes and changes in morphology & components on the cell surface, Ruiz *et al*., (2011).

Even more, molecular oxygen induces cell death or poor viability of probiotics. Therefore, the viability of probiotic organisms were improved when the dissolved oxygen concentration was low in the product. So, the presence of *S. thermophilus* acts as an oxygen scavenger in bio-yogurt with a beneficial to the growth of *Bifidobacterium* spp., Ishibashi and Shimamura (1993).

Streptococcus thermophilus* counts*:

Streptococcus thermophilus counts of ABT yoghurt culture for yoghurt drink treatments when fresh expressed as 8.01, 8.05 and 8.09 log CFU mL^{-1} for water, sweet whey and permeate respectively. The differences among treatments could be due to the differences of initial counts when added and the starter behavior during incubation, Shafiee *et al.,* (2010). Such nutrient as lactose and mineral in whey and permeate can help count increase in whey and permeate yoghurt drink treatments more than that of water. The more extending the storage, the more increase *S. thermophilus* counts in all treatments up to 14 days at (4 ± 1^{O}C). Storage more than 14 days caused gradual count decrease in different trends. Nevertheless, the decrease in count by storage, whey and permeate yoghurt drink treatments recorded the higher count. The lower count was recorded for the water yoghurt drink treatment in a significant difference from the other treatments due to differences in TS content. These results are in agreement of Almeida *et al.,* (2009).

Yoghurt drink YC-X11 thermophilic yoghurt culture counts:

Counts of yoghurt drink YC-X11 thermophilic yoghurt culture treatments *S. thermophilus* and *Lb. bulgaricus* are shown in Table (4) when fresh and during storage.

Table 4: YC-X11 Thermophilic yoghurt culture (Y) counts (log CFU mL^{-1}) of yoghurt drink treatments using water, sweet whey and UF-milk permeate when fresh and during storage.

Treatments*	Storage period / days			
	0	7	14	21
		Lb. bulgaricus		
HY	8.08^{f}	8.10^{cde}	8.11^{bcd}	8.00^{g}
WY	8.10^{def}	8.12^{bcd}	8.14^{a}	8.13^{ab}
PY	8.09^{ef}	8.10^{cde}	8.12^{abc}	8.08^{ef}
		S. thermophilus		
HY	7.99^{f}	8.03^{e}	8.05^{e}	7.90^{g}
WY	8.04^{e}	8.10^{bcd}	8.13^{a}	8.09^{cd}
PY	8.08^{d}	8.11^{bc}	8.12^{ab}	8.08^{d}

* The same as Table (1)

a, b, c: Means with different letters are significantly different ($p \leq 0.05$). .

***Lactobacillus bulgaricus counts*:**

Viable counts of *Lb. bulgaricus* in all treatments when fresh recorded 8.08, 8.10 and 8.09 log CFU mL^{-1} for water, sweet whey and permeate yoghurt drink in order. Count in whey treatment was the higher nevertheless, it was the lower in water treatment. Almeida *et al.,* (2009) recorded that *Lb. bulgaricus* counts were increased by the increase of TS level. After 7 days the count increased in all treatments, for water and whey treatments it increased by 0.02 log cycles. Meanwhile, it increased by 0.01 log cycles in permeate treatment. When the storage increased for 14 days at (4 ± 1 ^{O}C) the count increased to the maximum levels in all treatments. For water and permeate yoghurt drink treatments, the count increased by 0.03 log cycles comparing by that when fresh. For whey treatment *Lb. bulgaricus* count increased by 0.04 log cycles. It has the higher growth rate, these results in agreement of Cruz *et al.,* (2012). Whey as a source of protein can stimulate the growth of *Lb. bulgaricus*, Ayar and Burucu (2013).

Lactobacillus bulgaricus counts after storage for 21 days decreased in different rates, it decreased by 0.11, 0.01 and 0.04 log cycles in water, sweet whey and permeate yoghurt drink treatments respectively, that when compared with the maximum growth levels. It is clear that, whey yoghurt drink treatment has the lower impair rate when stored for 21 days. Whey yoghurt drink composition contains more TS, can act as a protective components for the starter cells, from

metabolites and acids, Shafiee *et al.,* (2010). Impair rate was more rapid in water and permeate yoghurt drink treatments. It could be due to the decrease in such nutrients and growth factors, important for *Lb. bulgaricus* growth during storage.

***Streptococcus thermophiles* counts:**

Streptococcus thermophilus counts of yoghurt drink YC-X11 thermophilic yoghurt culture treatments when fresh recorded count of 7.99, 8.04, and 8.08 log CFU mL^{-1} for water, sweet whey and permeate yoghurt drink treatments in order. When samples stored, the counts were increased until the day 14, it could be observed that whey yoghurt drink treatment has the higher count followed by that of permeate. Counts in all treatments decreased gradually when the storage increased up to the day 21, Zacarchenco and Massaguer-Roig (2006) & Shori and Baba (2012). The lowest counts were recorded for the water yoghurt drink treatments and the highest were recorded for that of sweet whey.

***Streptococcus thermophilus* in ABT or YC-X11 yoghurt culture:**

Streptococcus thermophilus counts of ABT yoghurt culture when compared by that of YC-X11 thermophilic yoghurt culture in yoghurt drink treatments, it can be observed that, *S. thermophilus* counts of ABT yoghurt drink treatments recorded slightly higher count than that of YC-X11 yoghurt culture for all treatments in the same order. In the other meaning, the joint growth of *S. thermophilus* with *B. Bifidum* and *Lb. acidophilus* was better more than that with *Lb. bulgaricus* even at the low levels of the TS. These results agree with Almeida *et al.,* (2009). Low pH was not a critical factor dictating their counts. High level of H_2O_2 may hamper the viability of *S. thermophilus* Elizabeth *et al.,* (2011). *Lb. bulgaricus* produces a large amount of acid (sharp acidification) and H_2O_2. Sarvari *et al.,* (2014) reported that single growth of *Lb. bulgaricus* yielded seven to nine fold higher amounts of H_2O_2, than those produced by *S. thermophilus* as a single cell or that produced by the both species when inoculated together. The presence of *S. thermophilus* helps H_2O_2 to decompose via NADH peroxidase into water to regenerate NAD +, Smart and Thomas (1987). Without sufficient scavenging mechanism of *S. thermophilus* the intracellular accumulation of H_2O_2 and other toxic oxygenic metabolites such as superoxide anions and hydroxyl radical can eventually lead to microbial cell death Talwalkar and Kailasapathy (2003).

Yeast and mould:

Yeast and mould counts of different yoghurt drink treatments were detected when fresh and during storage. There were no enumerated counts of yeast and mould in all treatments using ABT or YC-X11 yoghurt culture when fresh and during storage up to the day 21. These could be due to lactic acid produced by the starter bacteria causing quite unfavorable pH for the growth of those microorganisms, Igwegbe *et al*., (2015) and Falade *et al.,* (2015).

Sensory evaluation:

Sensory evaluation of yoghurt drink treatments using water, sweet whey and permeate when fresh and during storage are shown in Table (5). Fresh samples even with ABT or YC-X11 yoghurt culture displayed that, permeate yoghurt drink were have the mostly white colour meanwhile, whey samples were slightly lower white colour due to the yellowish–green colour of whey, Legarová and Kourimska, (2010). Samples of water were have the lower preferred colour because the added water diluted the own colour of milk due to the dilution of contents especially proteins. For appearance, the most preferred samples have the best appearance were that of whey and permeate yoghurt drink. Water samples have a slightly lower preferred appearance. Yoghurt drinks with added water recorded 4.8 for both starters. On the other hand, no separations were observed in any sample for both starters. Odor attribute recorded the highest score for whey yoghurt drink samples, its being the best and have pleasant clean odor as a reverse of the presence of aroma compounds due to the fermentation, Mauriello *et al.*, (2001). Permeate yoghurt drink with ABT yoghurt culture has a slight sour acetone odor. Lower scores recorded for water yoghurt drink samples due to the light odor. When yoghurt drink mouthfeel evaluated for the different samples, whey samples were the most preferred among the all. Whey yoghurt drink samples have a good clean slight sour mouthfeel, followed by that of permeate and that of water with YC-X11 yoghurt culture. Despite of, the acidity of whey samples, it's mouthfeel were having a little sour effect. This could be due to, the produced flavor compounds

contributing to the fermentation, Mauriello *et al.*, (2001). Also, due to that starter bacteria *Lb. bulgaricus* and *S. thermophilus* have a better effect on the mouthfeel, Wood, (1997). Mouthfeel of permeate yoghurt drink sample with ABT yoghurt culture were more sour than that of YC-X11or water samples. Water samples have a weak mouthfeel unless, that with ABT yoghurt culture was having a more sour mouthfeel with a lower aroma compounds. Overall acceptability was the highest for whey yoghurt drink samples due to good homogeneity and the preferred characters. Sweet whey–milk mixture was the best for the improvement of all sensory character assessed, Legarová and Kourimska, (2010). Permeate and water yoghurt drink with ABT yoghurt culture were less acceptable more than that of YC-X11 yoghurt culture due to presence of some accumulations caused non homogeneity. After 14 days of refrigerated storage (4± 1 °C), All characters assessed for the sensory evaluation deteriorate in all samples in different trends, Zacarchenco and Massaguer-Roig (2006). Significant depreciation were observed in the sensory characters especially mouthfeel and overall acceptability by extending the storage period. Water & permeate samples with ABT yoghurt culture were having an intensive sour mouthfeel. Moreover, whey samples were having the highest acceptability and good homogeneity in contrary to the other samples, and that with ABT yoghurt culture was the most preferred up to the end of storage.

Table 5: Sensory evaluation of yoghurt drink ABT yoghurt culture (A) or YC-X11 thermophilic yoghurt culture (Y) treatments using water, sweet whey and UF-milk permeate when fresh and during storage.

Character Assessed	Treatments*					
	HA	WA	PA	HY	WY	PY
			0 days			
C (5)	4.8^{b}	4.9^{ab}	5.0^{a}	4.8^{b}	4.9^{ab}	5.0^{a}
A (5)	4.8^{c}	4.9^{b}	4.9^{b}	4.8^{c}	4.9^{b}	5.0^{a}
O (5)	4.75^{e}	5.0^{a}	4.85^{c}	4.75^{e}	5.0^{a}	4.85^{c}
M (5)	4.65^{d}	4.9^{a}	4.7^{c}	4.7^{c}	4.9^{a}	4.8^{b}
OA (5)	4.7^{d}	4.9^{a}	4.6^{e}	4.8^{c}	4.9^{a}	4.8^{c}
			7 days			
C (5)	4.8^{b}	4.9^{ab}	5.0^{a}	4.8^{b}	4.9^{ab}	5.0^{a}
A (5)	4.7^{d}	4.9^{b}	4.8^{c}	4.7^{d}	4.9^{b}	4.8^{c}
O (5)	4.7^{f}	4.9^{b}	4.75^{e}	4.75^{e}	4.9^{b}	4.7^{f}
M (5)	4.4^{g}	4.9^{a}	4.5^{f}	4.5^{f}	4.9^{a}	4.6^{e}
OA (5)	4.5^{f}	4.9^{a}	4.5^{f}	4.6^{e}	4.85^{b}	4.7^{d}
			14 days			
C (5)	4.3^{d}	4.8^{b}	4.5^{c}	4.3^{d}	4.8^{b}	4.5^{c}
A (5)	4.6^{e}	4.8^{c}	4.7^{d}	4.6^{e}	4.8^{c}	4.7^{d}
O (5)	4.2^{h}	4.8^{d}	4.3^{g}	4.0^{i}	4.7^{f}	4.2^{h}
M (5)	3.7^{l}	4.7^{c}	4.0^{j}	3.5^{m}	4.6^{e}	3.8^{k}
OA (5)	3.5^{k}	4.7^{d}	4.0^{i}	3.6^{j}	4.6^{e}	4.2^{h}
			21 days			
C (5)	4.0^{ef}	4.5^{c}	3.7^{g}	4.1^{e}	4.5^{c}	3.9^{f}
A (5)	3.9^{j}	4.3^{f}	4.0^{i}	3.8^{k}	4.2^{g}	4.1^{h}
O (5)	3.2^{l}	4.3^{g}	3.3^{k}	3.1^{m}	4.0^{i}	3.6^{j}
M (5)	3.2^{n}	4.3^{h}	3.0^{p}	3.0^{p}	4.1^{i}	3.1^{o}
OA (5)	3.0^{n}	4.4^{g}	3.2^{l}	3.1^{m}	4.0^{i}	3.5^{k}

* The same as Table (1)

C : Color O : Odor OA : Overall Acceptability

A : Appearance M : Mouth feel

a, b, c: Means with different letters are significantly different ($p \leq 0.05$).

Conclusion

Milk–sweet whey mixture in ratio of (1:1) for yoghurt drink manufacture using ABT or YC-X11 yoghurt culture were successful. Sweet whey samples were having the highest starter viable counts with a good homogeneity and that of ABT yoghurt culture was having the better preference for the sensory evaluation. Milk–sweet whey mixture was the best for the improvement of all yoghurt drink characters assessed.

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