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The Role of Probiotic Bacteria on Microbiology and Acceptability of Sudanese White Soft Cheese

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Abstract

The objectives of this investigation is to study the effect of three types of probiotic bacteria (*Lactobacilus rhamnosus*, *Lactobacillus casei*, *Bifidobacterium bifidum*) on the microbiological and acceptability of Sudanese white soft cheese during storage period 0, 15, 30, 45 and 60 days. Microbiological analysis revealed that, the highest count of probiotic bacteria ($87x10^8$cfu/g) was obtained by sample containing *L.rhamnosus* and the lowest ($39x10^6$ cfu/g) by sample containing *B.bifidum*, while the sample containing *L.casei* ranked in intermediate position. Storage period affected the total probiotic bacteria count, the highest count at 2 weeks for *L.casei* and *B.bfidum* and after 4 weeks for *L.rhamnosus*, while the lowest at the end. The microbial analysis did not detect any pathogenic bacteria (*coliform bacteria*, *salmonella* and *staphylococcus aureus*) or yeast and molds.

The sensory evaluation quality revealed that the cheese containing *L.rhamnosus* gave the best appearance, texture, flavour and overall acceptability, followed by *L.casei* and *B.bifidum* compared with the control samples. The storage period significantly ($p \leq 0.05$) affected the acceptability of the cheese, where the highest score was obtained at day 30 and the lowest at the beginning of the storage. The study recommends further studies and tests to improve the quality of the Sudanese white soft cheese treated by probiotic bacteria.

Keywords: Probiotic bacteria, cheese, storage period

1. Introduction

Probiotic as a term is a relatively new word meaning for life and it is currently used to describe a group of bacteria when administered insufficient quantity, confer beneficial effects for humans and animal (Kopp-Hoolihan, 2001). Probiotic bacteria are applied to balance disturbed intestinal microflora and important in the treatment of a wide range of human disorders including lactose intolerance, diarrhea, food allergies, intestinal infection, constipation gastroenteritis, hepatic, flatulence, colitis, gastric acidity, osteoporosis, high blood cholesterol and cancer (Pitino *et al.,* 2012).

The most organisms used as probiotic belong to *bifidobacteria*, *Lactobacillus* and some *Enterococcus* ssp. (Fooks *et al.,* 1999). Lactic acid bacteria (LAB) and bifidobacteria are amongst the most important groups of microorganisms used in the food industry, used in the production of fermented products, such as yoghurts, cheese and pickled vegetables (Venema *et al*., 2015).

Bifidobacteria spp. beneficially affects human health by improving the balance of intestinal microflora and improving mucosal defenses against pathogens. Additional health benefits include enhanced immune response, reduction of serum cholesterol, vitamin synthesis, anti-carcinogenic activity, and anti-bacterial activity (Robinson *et al*., 1992; Blanchette *et al*., 1996). *Lacticobacillus casei* improvement of balance of intestinal microbiota and volatile fatty acid, antitumor action, stimulation of the immune system, and antimicrobial activity (Fujimoto *et al*., 2008).

Lactobacillus rhamnosus benefits are reducing the activity of fecal enzymes such as β-glucuronidase and azoreductase which contribute to the risk of colon, mammary, and prostate cancer (Tanock *et al*., 2000). *Lactobacillus rhamnosus* increases the number and the activity of natural killer cells and exerts immunostimulating effects, including on fetuses (Ibrahim *et al*., 2010).

Cheese is known as a complete nutritious food product and excellent source of many key nutrients, suitable for many ages. It is rich in protein and minerals such as calcium. There are different types of cheese: soft cheese, semi hard and hard cheese, the difference in these types is mainly due to water content or water activity and the methods and technology for cheese making (Pantaleao *et al*., 1990).

The major traditional cheese types produced in Sudan include Gibna Bayda, Gibna Mudaffra and Mozarella and Romi cheese (Abdel Razig, 2000). Cheese making in Sudan is the major preservation method for surplus milk in rural areas especially during rainy season when plenty of milk is available (El Owni and Hamid, 2007). The Sudanese Gibna Bayda (white cheese) has a unique, very originated and traditional technology, and can be categorized as white-brined soft cheese (Robinson, 1983). White pickled cheese of the Sudan is a product traditionally made from raw milk to which salt (6-20%) has been added. White cheese is usually made from raw milk and without the use of starter culture (Abdel Razig, 1996).

2. Objective

The objectives of this study were to study the effect of three types of probiotic bacteria (*Lactobacillus rhamnosus*, *Lactobacillus casei* and *Bifidobacterium bifidum*) on the quality of Sudanese white soft cheese during storage period 0, 15, 30, 45 and 60 days

3. Materials and Methods

Fresh cow's milk was obtained from Alarabia Company, Khartoum North, Sudan. Rennet tablets, Freeze-dried of commercial strains cultures (*Bifidobacterium bifidum, Lactobacillus casei, and Lactobacillus rhamnosus*) were obtained from (Chr.Hansens Lab., Copenhagen, Denmark). Sodium chloride, polyethylene packs were obtained from the local market, Khartoum North, Sudan.

3.1 Cheese manufacture

Cow's milk was pasteurized to72°C for 1 minute, and cooled to 40°C. Milk was divided into four separate tanks (A, B, C, D) each one contained 10 liters, (A) left as a control, 2g of probiotics bacteria (*Bifidobacterium bifidum,* *Lactobacillus casei and Lactobacillus rhamnosus*) were added to each tank (B, C, D) at 40°C respectively. Followed by the addition of $CaCl_2$ (0.02%) and rennet (0.2g). Milk stirred for 5 minutes and then left to develop a curd. After the coagulated was completed, the curd was cut into cups. The curd was kept for about 20-30 minutes for whey drainage. The whey of each tank was collected. The curd was transferred to clean wooden molds lined with cheese cloth and pressed with about 1 Kg over night. Next day the curd was removed from the molds, weighed and cut. 6% w/v NaCl was added to the collected whey, then pasteurizing at 72°C for 1 minute, and added to cheese curd into sterile plastic buckets. Cheese was stored at room temperature (38±2°C) for 60 days. Microbiological analysis was carried out at 0,15,30,45 and 60 days intervals (Abdel Razig, 1996).

3.2 Microbiological Analysis

L.rhamnosus and *L.casei* were enumerated on MRS agar (Bergamini *et al.,* 2005). *B.bifidum* was enumerated on BFM medium according to Nebra and Blanch (1999). All samples examined, Salmonella, *Staphylococcus aureus*, Mould and yeast according to Harrigan (1998), Coliforms counts according to Marshall (1992).

3.3 Sensory evaluation

The sensory evaluation of white soft cheese was evaluated by scoring procedure (headonic, scale) as described by Ihekoronye and Ngoddy (1985), where 5: excellent, 4: very good, 3: good, 2: acceptable and 1: poor

4. Results and Discussion

4.1 Total count of probiotic bacteria

Table 1 shows the total count of probiotic bacteria of Sudanese white soft cheese during storage period. The highest ($87x10^8$ cfu/g) was obtained by the cheese samples containing *Lactobacillus rhamnosus*. The lowest ($39x10^6$cfu/g) by the *Bifidobacterium bifidum* samples, while the sample containing *L.casei* ranked in an intermediate position ($p \leq 0.05$). In our study the number of probiotic bacteria *L.rhamnosus* increased from the beginning today 30 ($87x10^8$cfu/g) then decreased to ($47x10^7$cfu/g) at the end of storage period. *L.casei*, *B.bifidium* numbers increased until day 15 ($67x10^8$ and $52x10^8$cfu/g) then decreased to ($4x10^7$ and $39x10^6$ cfu/g) respectively at the end of storage period. The viability of probiotic bacteria decreased during storage period. Due to the decrease in the pH of the medium and accumulation of organic acids as a result of growth and fermentation (Randazzo *et al*., 2013).

Kebary *et al*., (2011) observed that *L. rhamnousus* counts in all Ras cheese increased during the first month of ripening period then decreased up to the end of storage period. Ozer *et al*., (2009) conducted that probiotic Beyaz cheese with *B. bifidum* decreased during ripening periods for 90 days at significant level. Fritzen-Freire (2010) reported that counts of *B. Bifidum* in minas frescal cheese did not decrease during ripening periods for 28 days.

Bergamini *et al*., (2010) stated that the viability of different probiotic cultures was assessed during Pategra´s cheese ripening. All the probiotics tested maintained counts above 107 cfu/g during the shelf-life settled for the product.

Kebary *et al*., (2015) observed that the count of *L. rhamnousus* in Domiati cheese increased in the first 4 weeks reached 10^{11}cfu/g, then decreased gradually during storage period to reached 10^{8}cfu/g. The probiotic dairy product, contain at least 10^{6}-10^{7}cfu/g of viable probiotic bacteria at the time of consumption (FAO/WHO, 2002).

Shah *et al*., (1995) mentioned that initial count of *B.bifidum* was 10^{6}-10^{7} cfu/ml at the time of consumption. The final viable counts of probiotic bacteria were >10^{7} cfu/g, such as *L.casei* in Fresco cheese stored 10 days (Fernandez *et al*. 2005). Vinderola *et al*., (2000) evaluated the suitability of Argentinian Fresco cheese as a food carrier of probiotic cultures. Used cultures of *Bifidobacterium bifidum*, *Lactobacillus casei* in different combinations, counts decreased <1 log order for *bifidobacteria* but no decrease was detected for *L. casei*. Blanchette *et al*., (1996) developed a Cottage cheese containing *Bifidobacterium infantis*. Cheeses presented populations as high as 1x10^{6} cfu/g during storage. Sua´rez-Solı´s *et al*., (2002) pointed that in manufactured fresh cheese supplemented with *B. bifidum and L. casei* the viable counts of *B.bfidum* and *L.casei* reached 1x10^{7}cfu/g during storage. Yilmaztekin *et al*., (2004) observed survival of *Bifidobacterium bifidum* in white brined

Table 1 Total count of probiotic bacteria (cfu/g) of white soft cheese during storage period.

Storage period (Days)	Types of probiotic bacteria		
	Bifidobacterium bifidum	***Lactobacillus rhamnosus***	***Lactobacillus casei***
0	$37x10^8$	$63x10^8$	$59x10^8$
15	$52x10^8$	$75x10^8$	$67x10^8$
30	$29x10^7$	$87x10^8$	$25x10^8$
45	$43x10^6$	$90x10^7$	$71x10^7$
60	$39x10^6$	$47x10^7$	$4x10^7$

cheese, *B.bifidum* inoculated at levels of 2.5% and 5.0% were $7.0x10^8$cfu/g and $1.2x10^9$ cfu/g respectively, these figures dropped to $4.0x10^6$ cfu/g and $1.1x10^7$ cfu/ g after 90 days. Mahmoud *et al*., (2013) noticed that viability of *B. bifidum* and *L.rhamnosus* in Karish Cheese effected of probiotic *Bifidobacterium bifidum* and *Lactobacillus rhamnosus* decreased markedly from $38x10^7$ to $60x10^2$ and from $40x10^7$ to $51x10^2$ cfu/g respectively at the end of storage period. The growth of *B. bifidum* and *L. rhamnosus* during storage of Kareish cheese increased with a peak at 7 days of storage then decreased.

Dave and Shah (1997) conducted that, the viability of bacteria from commercial starter culture during storage of dairy product, contained *bifidobacteria* observed on the level 10^6-10^9cfu/ml depending on the kind of starter culture and the medium used for enumeration. Decreased of number of these bacteria was observed but it was above the recommended limit 10^6 through the storage period. Zomorodi *et al*., (2011) stated that in Iranian white cheese supplemented with free and microencapsulation probiotics (*L.casei*, *B.bifidum*) the number of *B.bifidum* colonies did not decrease remarkably in the free and capsulated form.

Yangilar and Ozdemir (2013) enumerated that in Turkish Beyaz cheese samples produced with different probiotic cultures *B. bifidum* decreased at 1 log levels from the beginning to the end of ripening times. Aljewicz *et al*., (2014) stated that in Edam Cheese supplemented with Probiotic *Lactobacillus rhamnosus* viability of probiotics (approx. 1 log cfu/g) reduction of probiotic bacteria population was observed in the analyzed experimental cheese samples between the 2nd and the 4th week of ripening. The viability of probiotic bacteria remained stable in all experimental cheese samples from the 4th week.

Gobbetti *et al*.,(1998) said that addition of *bifidobacteria* to the Crescenza cheese affected when added individually, *B. bifidum* was present at the same concentration in the milk (log10 6.0 cfu/ml) but reached final cell numbers of log10. *Bifidobacterium bifidum* adapted well to the cheese environment cell numbers decreased throughout ripening. Abadía-García *et al.*, (2013) observed that incorporated *L.casei*, *L. rhamnosus* and a commercial mix of probiotics in cottage cheese. *L. casei* count was 10^8 cfu g−1, while the other probiotic populations remained at levels of about 10^6 cfu g−1 during 28 days of storage at 8 °C.

Bezerra *et al*., (2016) observed the lactic acid bacteria counts in the cheeses were higher than 6.5 log cfu/g cheese and 7 log cfu/g cheese at the 1st and 28th days of storage, respectively. The addition of selected bacterial in simple and cheeses can improve bacterial viability during storage (Buriti *et al*., 2005[a,b]). Probiotic bacteria maintained their viability throughout the storage period with a negligible loss or less than 1 log cycle loss, or even with increase in the viable counts (Karimi *et al*., 2011).

4.2 Coliforms, S.aureus, Salmonella, yeast and molds count

The Coliform, S.aureus, Salmonella, yeast and molds were not detected in all Sudanese soft white cheese samples in control samples or samples containing probiotic bacteria (*L.rhamnosus, L.casei* and *B.bifidum*) during ripening period. This may be due to high hygienic condition during making cheese and pickling period and the development of acidity in cheese during the ripening period (Kebary *et al*., 2015). Intestinal lactobacilli and bifidobacteria produce antimicrobial substances that are active against pathogenic bacteria (Servin *et al*., 2004).

El-Kholy *et al.,* (2003) mentioned that milk supplemented with *L. rhamnosus* used for manufacturing soft cheese resulted in reduction in counts of pathogens, as well as molds and yeasts. Probiotic *L.rhamnosus* inhibited the growth of pathogenic *Salmonella enterica* by producing lactic acid and other secreted antimicrobial molecules (Marianelli *et al*., 2010). El-Shafei *et* *al*., (2008) found that *L. rhamnosus* in Kareish cheese were able to totally inhibit the growth of tested yeasts during storage for 30 days. The yeast counts increased sharply in control samples and spoiled after 15 days of storage. Kebary *et al*., (2015) conducted that in probiotic Domiati cheese made by *L.rhamnosus* the coliform, aerobic spore forming bacteria, yeast and mold did not detected in all cheese treatments either when fresh or during pickling period.

Bacteriocins are also present in species of genus Lactobacillus, the *L.casei* produce casein80 (Klaenhammer, 1993). Yuguchi and Okonogi (1992) and Fayed *et al*., (2011) demonstrated that the administration of bifidobacteria to rats increased their number in the intestine, and on the other hand, the numbers of staphylococci and coliform bacteria were significantly reduced in groups received cultured milks as compared to the control.

4.3 Sensory evaluation

4.3.1 Appearance

Table2. Shows the effect of type of probiotic bacteria on appearance score of the Sudanese white soft cheese during storage period. The highest (4.6) was obtained by samples containing *Lactobacillus rhamnosus*. The lowest (3.9) by the control samples, while the other samples ranked in an intermediate position ($p \leq 0.05$). The appearance scores increased with the addition of the probiotic bacteria.

Storage period significantly ($p \leq 0.05$) affected the appearance score of white soft cheese. The lowest values obtained at the beginning of the storage period while the highest at day 30 then decreased towards the end of storage period ($p \leq 0.05$).

Probiotic bacteria in cheese especially lactobacilli possess several peptidases, which can hydrolyze peptides to oligopeptides and amino acid and induce change in appearance of the cheese (Shihata and Shah, 2000; Santillo and Albanzia, 2008 and Soufa and Saad, 2009). Kebary *et al*., (2011) observed increased of appearance score in all Ras cheese treatments with probiotic *L.rhamnosus* as ripening period progressed. Ryhanen *et al*., (2001) obtained good results in Festivo cheese relation to appearance score that contain *bifidobacterium*. Kebary *et al*., (2015) stated that appearance increased in all Domiati cheese supplemented with different levels of *L.rhamnosus* more than the control as ripening period progressed.

Yerlikaya and Ozer (2014) mentioned highest averages in appearance score recorded in cheeses made with *Lactobacillus casei*. Gabir (2016) conducted that the addition of *B.bifidum* gives a good appearance of dairy product. Abdalla (2005) observed that organoleptic evaluate of white soft cheese (Gibna beyda) made using different rates of starter culture had a good colour. Brearty *et al.,* (2001) stated that cheeses made with the adjunct cultures received significantly higher scores for appearance than the control cheese. Sidig *et al*., (2016) noticed ahigher appearance score in white soft cheese (jibna-beida) prepared by using starter culture (LAB).

4.3.2 Texture score

Table 3. Shows the effect of types of probiotic bacteria on texture score of Sudanese white soft cheese during storage period. The highest score (4.4) was obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (3.8) by the control sample, while the other samples ranked in an intermediate position ($p \leq 0.05$). The texture score increased with the addition of the probiotic bacteria.

Storage period significantly ($p \leq 0.05$) affected the texture score of white soft cheese. The lowest values obtained at the beginning of the storage period while the highest at day 30 then decreased towards the end of storage period ($p \leq 0.05$).

The rate and level of acidification have a major impact on cheese texture due to demineralization of the casein micelles (Buriti *et al*., 2005[a]). Kebary *et al*., (2011) observed that the use of *L.rhamnosus* in Ras cheese increased texture in all cheese treatments during ripening period. Yerlikaya and Ozer (2014) mentioned highest averages in texture were recorded in cheeses made with *Lactobacillus casei*. Ryhanen *et al*., (2001) obtained good results in Festivo cheese relation to texture score that contain *bifidobacterium*.

Katsiari *et al*., (2002) pointed that the addition of *L. casei* ssp. *rhamnosus* produced positive sensory changes in relation to texture in Kefalograviera type cheese after 90 and 180 days of ripening, when compared with the control cheese without addition of cultures. El-Shafei *et al.*, (2008) enumerated that Karish cheese manufactured with a protective culture consisting of *L. rhamnosus* had a higher values of textural parameters. The use of this protective culture enhanced texture of the treated Kareish cheese compared with the control.

Gabir (2016) conducted that the dairy products have a good texture with addition of *B.bifidum*. Probiotic bacteria in cheese especially lactobacilli possess several peptidases, which can hydrolyze peptides to oligopeptides and amino acid and induce change in texture of the cheese (Shihata and Shah, 2000; Santillo and Albanzia, 2008 and Soufa and Saad, 2009). Maruyama *et al*., (2006) noticed that the textures of the probiotic petit-suisse cheese reported higher rates during ripening. LAB play an important role in the development of the texture attributes of cheese, through the enzymatic potential of the strains used in cheese manufacturing (Karimi *et al.*, 2012). Giraffa *et al*., (2010) reported LAB leads to improvement in texture.

Kebary *et al*., (2015) stated that texture increased in all Domiati cheese supplemented with different levels of *L.rhamnosus* more than the control during storage period. Hussein and Shalaby (2014) observed the Kareish cheeses made with different starters had got the highest scores in texture. Sidig *et al*., (2016) noticed that white soft cheese (jibna-beida) prepared by using starter culture (LAB) had agood texture. El Owni and Hamid (2008) studied the effect of storage period on texture characteristics of Sudanese white soft cheese (Gibna Beida), they found improved in texture during storage.

4.3.3 Flavour score

Table3. Shows the effect of types of probiotic bacteria on flavour score of Sudanese white soft cheese during storage period. The highest score (4.5) was obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (3.9) by the control sample, while the other samples ranked in an intermediate position ($p \leq 0.05$). The falavour increased with the addition of the probiotic bacteria.

Storage period significantly ($p \leq 0.05$) affected the flavour score of white soft cheese. The lowest values obtained at the beginning of the storage period while the highest at day 30 then decreased towards the end of storage period ($p \leq 0.05$).

LAB play an important role in the development of the flavour attributes of cheese through the enzymatic potential of the strains used in cheese manufacturing (Karimi *et al.*, 2012). Kebary *et al*., (2011) observed that addition of *L.rhamnosus* in Ras cheese influence flavour in all Ras cheese treatments as ripening period progressed**.** Ryhanen *et al*., (2001) obtained good results in Festivo cheese relation to flavour score that contain *bifidobacterium*. Abdalla (2005) observed that organoleptic evaluation of white soft cheese (Gibna beyda) made using different rates of starter culture had a good flavour. Hong-Xin *et al*., (2015) said that *Lactobacillus casei* has a great influence on the cheese's flavour during the cheddar cheese ripening progress. Miočinović *et al*., (2014) found that cheese made with commercial probiotic culture received a higher flavour scores than the control.

El-Shafei *et al.,* (2008) reported that cheese manufactured with a protective culture consisting of *L.rhamnosus* enhanced the flavour of Kareish cheese compared with the control. El Owni and Hamid (2008) found that the flavour improved in white soft cheese during storage. Gabir (2016) conducted that the dairy products have a good flavour with the addition of *B.bifidum*. Crow *et al*., (2001) noticed that the strains of *L.rhamnosus* significantly improved the flavour of cheeses. Probiotic bacteria in cheese especially lactobacilli possess several peptidases, which can hydrolyze peptides to oligopeptides and amino acid and induce change in flavour of the cheese (Soufa and Saad, 2009). The effect of probiotic bacteria on flavour is mainly dependent on the species and strains added and also on the metabolic activity of the strains during cheese production and storage (Karimi *et al*., 2012). Sidig *et al*., (2016) noticed that white soft cheese (jibna-beida) prepared by using starter culture (LAB) had a higher flavour.

Brearty *et al.,* (2001) stated that the cheese made with the adjunct cultures received higher scores for flavour intensity than the control cheese after 90 and 180 days of ripening. Some researchers have announced that addition of probiotic strains in cheeses can improve flavor (De Souza *et al* 2008. Salama and Shahein (2002) reported that the various starters play an important role in flavour development and improved the organoleptic properties in cheese. The acidity affects the cheese flavour this reported by McSweeney and Fox (2004). Abdel Razig (1996) noticed that Sudanese white soft cheese have a good flavor during storage period.

4.3.4 Over all acceptability

Table 5. Shows the effect of types of probiotic bacteria on over all acceptability of the Sudanese white soft cheese during storage period. The highest (4.4) was obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (3.8) by the control samples, while the other samples ranked in an intermediate position ($p \leq 0.05$).The overall acceptability increased with the addition of the probiotic bacteria.

Storage period significantly ($p \leq 0.05$) affected the overall acceptability of white soft cheese. The lowest values obtained at the beginning of the storage period while the highest at day 30 then decreased towards the end of storage period ($p \leq 0.05$).

Hussein and Shalaby (2014) stated that Kareish cheeses made with probiotic starter *bifidobacterium* had more accepted. Gabir (2016) conducted that the dairy product had a higher acceptability with the addition of *B.bifidum* compared with the control. Ramzan *et al*., (2010) found that *L.rhamnosus* on cheddar cheese enhanced the quality of Cheddar cheese. Abdalla (2005) observed that organoleptic evaluated of white soft cheese (Gibna beyda) made using different rates of starter culture had a high quality standard more than the control. The sensory parameters for probiotic Beyaz cheese samples during their storage period, cheese batch containing *B.bifidum* received the highest sensory scores (Yangilar and Ozdemir, 2014).

Oliveira *et al*., (2012) noted that Coalho cheese with the added probiotic lactic acid strains alone and in co-culture were had better accepted in the sensory evaluation than cheeses without the probiotic strains. Escobar *et al*. (2012) reported that probiotic supplementation of Panela Cheese containing *L.rhamnosus* showed greater consumer acceptance. Kebary *et al*., (2015) noticed that acceptability increased in all Domiati cheese supplemented with different levels of *L.rhamnosus* during the early stage of storage and by extending of the pickling period. Mahmoudi *et al*., (2012) mentioned that white Iranian probiotic cheese with starter had the highest of sensory acceptability. Sidig *et al*., (2016) noticed that white soft cheese (jibna-beida) prepared by using starter culture (LAB) had a higher acceptability. Probiotic bacteria in cheese especially lactobacilli possess several peptidases, which can hydrolyze peptides to oligopeptides and amino acid and induce change in flavour, body and texture and, consequently, in sensory properties of the cheese (Shihata and Shah, 2000; Santillo and Albanzia, 2008; Soufa and Saad, 2009).

Table 2 Effect of types of probiotic bacteria on appearance score of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	*Lactobacillus rhamnosus*	*Lactobacillus casei*
0	$4.1^{i}\pm0.08$	$4.2^{h}\pm0.07$	$4.5^{e}\pm0.05$	$4.3^{g}\pm0.04$
15	$3.3^{g}\pm0.06$	$4.4^{f}\pm0.04$	$4.7^{c}\pm0.03$	$4.4^{f}\pm0.05$
30	$4.5^{e}\pm0.04$	$4.6^{d}\pm0.03$	$4.9^{a}\pm0.01$	$4.7^{c}\pm0.02$

45	$4.2^{h}\pm0.07$	$4.3^{g}\pm0.06$	$4.8^{b}\pm0.02$	$4.5^{e}\pm0.03$
60	$3.9^{K}\pm0.11$	$4.0^{J}\pm0.09$	$4.6^{d}\pm0.04$	$4.2^{h}\pm0.06$

- Mean ± SD. Having different superscript letters on columns and rows are significantly different ($P\leq0.05$)

Table 3 Effect of types of probiotic bacteria on texture score of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	*Lactobacillus rhamnosus*	*Lactobacillus casei*
0	$4.0^{h}\pm0.11$	$4.1^{g}\pm0.09$	$4.3^{e}\pm0.06$	$4.2^{f}\pm0.07$
15	$4.1^{g}\pm0.08$	$4.3^{b}\pm0.04$	$4.5^{c}\pm0.03$	$4.4^{d}\pm0.05$
30	$4.2^{f}\pm0.05$	$4.4^{d}\pm0.06$	$4.7^{a}\pm0.01$	$4.6^{b}\pm0.02$
45	$4.1^{g}\pm0.06$	$4.3^{e}\pm0.07$	$4.6^{b}\pm0.04$	$4.5^{c}\pm0.03$
60	$3.8^{i}\pm0.12$	$4.2^{f}\pm0.08$	$4.4^{d}\pm0.05$	$4.3^{e}\pm0.06$

- Mean ± SD. Having different superscript letters on columns and rows are significantly different ($P\leq0.05$)

Table 4 Effect of types of probiotic bacteria on flavour score of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	*Lactobacillus rhamnosus*	*Lactobacillus casei*
0	$4.0^{i}\pm0.09$	$4.2^{g}\pm0.07$	$4.6^{c}\pm0.04$	$4.3^{f}\pm0.06$

15	$4.1^{h}\pm0.08$	$4.4^{e}\pm0.01$	$4.7^{b}\pm0.02$	$4.4^{e}\pm0.05$
30	$4.3^{f}\pm0.06$	$4.5^{d}\pm0.03$	$4.8^{a}\pm0.01$	$4.6^{c}\pm0.04$
45	$4.2^{g}\pm0.03$	$4.4^{e}\pm0.05$	$4.6^{c}\pm0.03$	$4.5^{d}\pm0.02$
60	$3.9^{J}\pm0.11$	$4.2^{g}\pm0.06$	$4.5^{d}\pm0.04$	$4.3^{f}\pm0.07$

- Mean ± SD. Having different superscript letters on columns and rows are significantly different ($P\leq0.05$)

Table 5 Effect of types of probiotic bacteria on overall acceptability score of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	*Lactobacillus rhamnosus*	*Lactobacillus casei*
0	$4.0^{i}\pm0.09$	$4.1^{h}\pm0.07$	$4.5^{d}\pm0.03$	$4.2^{g}\pm0.08$
15	$4.1^{h}\pm0.08$	$4.2^{g}\pm0.06$	$4.6^{c}\pm0.04$	$4.4^{e}\pm0.05$
30	$4.2^{g}\pm0.07$	$4.4^{e}\pm0.03$	$4.8^{a}\pm0.01$	$4.5^{d}\pm0.03$
45	$4.0^{i}\pm0.12$	$4.2^{g}\pm0.06$	$4.7^{b}\pm0.02$	$4.3^{f}\pm0.07$
60	$3.8^{J}\pm0.11$	$4.1^{h}\pm0.09$	$4.4^{e}\pm0.05$	$4.2^{g}\pm0.08$

- Mean ± SD. Having different superscript letters on columns and rows are significantly different ($P\leq0.05$)

5. Conclusion

The effect of probiotic bacteria on the quality, the growth and survival of probiotics strains (*L.rhamnosus*, *L.casei* and *B.bifidium*) in Sudanese white soft cheese made from cow's milk was investigated. Microbial analysis and sensory evaluation were carried out at 0,15,30,45 and 60 days interval.

- probiotic culture counts reached approx. above 10^6 CFU/g .The consumption of 80–100 g of the obtained cheese per day could deliver health benefits.
- White soft cheese with probiotic bacteria decreased the TBC.
- Sensory evaluation (appearance, texture, flavour and overall acceptability) increased in all probiotic cheese samples till day 30.
- *L.rhamnosus* obtained good results in all samples in contrast with *L.casei* and *B.bifidum*.

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