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Preparation and Properties of Flavored Fermented Beverage Based on Partial or Complete Replacement of Milk with Quinoa Seeds Water Extract (QSWE)

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ABSTRACT

The use of water extract of Quinoa Seeds Water Extract (QSWE) in the manufacturing of milk-based fermented beverage was investigated. The prepared QSWE was used to replace 0, 25, 50, 75 and 100% of Buffalo Skim Milk (BSM) and these mixtures were used for manufacture of fermented beverages using 2% of yogurt starter. The obtained fermented beverages were stored at 5±1°C for ten days. The changes in the chemical composition, sensory and microbiological quality of the fermented beverages were followed during the storage period. Minerals and amino acids values of fermented beverages were evaluated when fresh. The data showed that, the total solids and carbohydrates contents decreased with increasing the ratio of added QSWE but there were no significant differences in the results of the protein, fat and ash contents between the control and the other treatments during storage. Results showed that the acidity increased in control and all treatments but T_3 and T_4 treatments had relatively lower acidity than the control during storage. Minerals contents in fermented quinoa beverages were decreased with increasing the added ratio of Quinoa Seeds Water Extract (QSWE). While, the values of iron in all treatments were found to increase with increasing the added ratio of QSWE. In addition, data showed that all amino acids decreased with increasing the added ratio of QSWE except phenylalanine, methionine, histidine and leucine. The results indicated that the total bacterial counts were higher in all fermented beverages after 3 days and slightly decreased at 7 days then decreased to the end of storage period. In addition, data showed that yeast and mould were not detected at fresh and after 3 days then detected after seven days and decreased at ten days in control and all treatments during storage. No growth of coliform was detected in all fermented beverages under study at both fresh and stored treatments. The sensory evaluation of the fermented product indicated that the control T_1 and T_2 gained the highest score at zero time for flavor, body, texture, color and appearance among all treatments. After 10 days data showed that the highest score was for T_4 followed by T_3. Therefore, it is possible to produce fermented beverages by adding 75 or 100% quinoa seeds water extract to BSM as alternative to the fermented milk beverages successfully.

Key words: Quinoa seeds water extract, fermented milk, nutrition value, fermented beverage

INTRODUCTION

Fermented milk products are considered to be the most popular foods fermented that provide consumers with viable lactic acid bacteria which play beneficial roles in human health.

Quinoa seeds were reported to have high quality protein, calcium, phosphorus, iron, fiber and B-vitamins than barley, oats, rice, corn, or wheat (Dini *et al*., 2005). Koziol (1992) stated that the quality of quinoa protein is equal to the quality of protein of whole dried milk. Furthermore, In comparison with the FAO/WHO reference pattern suggested for preschool children, quinoa presents the best amino acid profile, since there is no deficiency of any essential amino acid. Quinoa presents high levels of histidine, isoleucine and aromatic amino acids (phenylalanine and tyrosine) and has similarly in leucine and tryptophan contents. When compared to the requirements in school children and adults, quinoa protein can supply more than 150% the requirements of school children and more than 200% of adults (Valcarcel-Yamani and da Silva Lannes, 2012).

Quinoa can be found in the form of flakes, grains and flours as well as in products such as noodles and energy bars and its grains can be cooked in hot water prior to consumption (FAO, 2003). There are several developments with quinoa flour at a smaller scale such as bread, muffins, pasta, snacks, drinks, flakes, baby foods, beer and extradites (James, 2009). Quinoa is now commonly used for altitude sickness. Because of its high calcium content, it is considered beneficial in treating bone problems. Because quinoa is high in protein and complex carbohydrates, low in fat and rich in vitamins and minerals than other grains, the Indian people consider it an endurance food and include as a daily staple as well as it used to heal broken bones. In addition, as gluten free-foods, quinoa can be recommended for people with celiac disease (Berti *et al*., 2004).

Farinazzi-Machado *et al*. (2012) reported that the use of quinoa in the composition of a cereal bar may help reduce risk factors related to cardiovascular diseases that are among the major causes of death in today's globalized world although further studies are needed to prove the benefits observed. Quinoa flakes can be used in cereal bars or can be added in food products such as cookies, breakfast cereals and diet supplements. The objective of this study was to investigate the possibilities of making good healthy fermented beverages from quinoa seeds water extract mixed with different levels of buffaloes skim milk.

MATERIALS AND METHODS

Buffaloe's skim milk was obtained from Dairy Science Department, Faculty of Agriculture, Cairo University, Cairo, Egypt. Pure cultures of *Lactobacillus delbruckii* ssp. *bulgaricus* and *Streptococcus salvarius* ssp. *thermophiles* were obtained from Hansen Laboratories (Denmark). Quinoa (*Chenopodium quinoa,* variety Titicaca) seeds were obtained from Crop Intensification Research Section Field Crops Research Institute, Agriculture Research center 2% fat (coconut oil), 4% sugar (sucrose), 0.4% stabilizer Carboxy Methyl Cellulose (CMC) and 0.1% vanellia were used and they were purchased from the local market, Cairo, Egypt.

The chemical composition of Buffaloe's skim milk and Quinoa seeds water extract used in the manufacture of fermented beverages is shown in Table 1.

Preparation of quinoa seeds water extract: Quinoa Seeds Water Extract (QSWE) was prepared in soy processing unit. Food Technology Research Institute, Agriculture Research Center, Giza, Egypt. Three kilograms of quinoa seeds were washed several times by tap water, soaked in water for 20 h at room temperature and new washed again three times using two fold volume of

Table 1: Chemical composition (%) of buffalo skim milk and QSWE

Item	Fat	Total solids	Protein	Carbohydrate	Ash	Acidity	pH
Buffalo skim milk	0.3	9.40	3.40	4.90	0.80	0.18	6.62
QSWE	0.4	6.35	3.27	1.97	0.71	0.26	3.51

water each. Boiling water (15 L) was used to the soaked quinoa seeds in the grinding steps. It was accomplished by passing the quinoa slurry through a roller soymilk extractor and vibrating screen separator, then heated at 90°C for 10 min.

Preparation of fermented beverage from QSWE: Five treatments were carried out as follow: control (100% Buffaloes Skim Milk (BSM)), T_1(75% BSM+25% QSWE v/v), T_2(50% BSM+50% QSWE v/v), T_3 (25% BSM+75% QSWE v/v) and T_4(100% QSWE v/v). About 2% coconut oil, 4% sucrose, 0.4% Carboxy Methyl Cellulose (CMC) and 0.1% vanellia were added. All treatments homogenization by passing through a two stage homogenizer (3500/500 pis) to reduce size of coconut oil and remaining insoluble materials into very fine and uniform particles (Nelson, 1992) and heated to 85°C for 15 min, cooled to 40±1°C then inoculated with 2% mixed starter culture (*Lactobacillus delbruckii* ssp. *bulgaricus* and *Streptococcus salavarius* ssp. *thermophilus* (1:1)) packed in sterilized cups (100 mL) then incubated at 42±1°C for 3-4 h. The whole experiment was repeated three times and samples were stored at 5±1°C for 10 days and evaluated chemically, sensory and microbiologically at different storage periods (fresh 3, 7 and 10 days) (Hassanein and Somaya, 2008).

Analytical methods: The moisture, ash, fat and total protein contents of the prepared fermented beverage were determined according to the AOAC methods and the total carbohydrates were calculated by difference (AOAC, 2007).

The titratable acidity was determined according to (Richardson, 1986) and pH values were measured using a digital pH meter (hanna Germany) equipped with a combined electrode. The mineral contents were determined after dry ashing according to the method described by the AOAC (2007) using atomic absorption spectrometer (Perkin-Elmer, Model 3300, USA), phosphorus content were measured according to Tiessen and Moir (1993) method. The amino acids contents were determined by high performance amino acids analyzer (9 Biochrom 30) according to the method described by AOAC (2012).

Sensory evaluation: Sensory attributes were evaluated directly after preparation according to the method of Bodyfelt *et al.* (1988) by ten panelists from the staff members of the Food Technology Research Institute.

Microbiological examination: The total bacterial count, coliform bacteria, yeast and mould were enumerated according to the methods of APHA (1992).

Statistical analysis: The data was statistically analyses using for SPSS (Ver.11) software program ANOVA with two factors or significant level of 0.05 (Steel *et al.*, 1997). Multiple comparisons were carried out applying the least significant difference LSD.

RESULTS AND DISCUSSION

Chemical composition of fermented beverages made from QSWE: The chemical composition from all treatments of fermented beverages are shown in Table 2. The data showed that, the total solids and carbohydrates contents decreased with increasing the ratio of added QSWE and during storage. These results are in agreement with those reported by Gomaa *et al.* (2000) for fermented

Table 2: Chemical composition of fermented beverages made from buffaloes skim milk and QSWE during storage period

Storage period and treatments	Fat (%)*	T.S (%)	Ash (%)	T.P (%)	Carbohydrate (%)
One day					
Control	2.25±0.070	16.01±0.0420^{a}	0.875±0.008^{a}	3.415±0.007^{a}	9.47±0.113^{a}
T_1	2.20±0.141	15.43±0.1130^{b}	0.850±0.014^{b}	3.380±0.014^{b}	9.00±0.028^{b}
T_2	2.15±0.070	14.45±0.0431^{c}	0.810±0.028^{bc}	3.335±0.021^{c}	8.42±0.318^{c}
T_3	2.15±0.070	13.785±0.134^{d}	0.780±0.014^{cd}	3.305±0.007^{cd}	7.56±0.084^{d}
T_4	2.15±0.070	13.07±0.0900^{e}	0.740±0.014^{d}	3.275±0.006^{d}	6.90±0.176^{e}
LSD	-	0.549	0.0437	0.0325	0.4502
3 days					
Control	2.25±0.070	16.02±0.0700^{a}	0.90±0.0140^{a}	3.40±0.0060^{a}	9.46±0.148^{a}
T_1	2.20±0.141	15.29±0.0630^{b}	0.865±0.021^{ab}	3.38±0.0210^{a}	8.83±0.078^{b}
T_2	2.15±0.070	14.46±0.0190^{c}	0.820±0.028^{bc}	3.33±0.0140^{b}	8.16±0.091^{c}
T_3	2.15±0.070	13.67±0.0990^{d}	0.780±0.014^{cd}	3.29±0.0080^{c}	7.44±0.035^{d}
T_4	2.15±0.070	12.99±0.0490^{e}	0.755±0.097^{d}	3.28±0.0080^{c}	6.80±0.021^{e}
LSD	-	0.1694	0.0474	0.0326	0.2249
7 days					
Control	2.25±0.070	15.975±0.003^{a}	0.915±0.002^{a}	3.405±0.006^{a}	9.41±0.130^{a}
T_1	2.20±0.141	15.34±0.0050^{b}	0.87±0.0100^{ab}	3.375±0.070^{b}	8.89±0.069^{b}
T_2	2.15±0.070	14.94±0.0070^{c}	0.83±0.0280^{bc}	3.325±0.070^{c}	8.64±0.049^{b}
T_3	2.15±0.070	13.68±0.0070^{d}	0.795±0.020^{c}	3.295±0.070^{d}	7.44±0.160^{c}
T_4	2.15±0.070	12.98±0.0060^{e}	0.785±0.007^{c}	3.27±0.0100^{e}	6.77±0.014^{d}
LSD	-	0.157	0.057	0.023	0.26
10 days					
Control	2.15±0.070	15.98±0.634^{a}	0.92±0.014^{a}	3.41±0.014^{a}	9.50±0.060^{a}
T_1	2.15±0.141	15.31±0.015^{b}	0.88±0.014^{ab}	3.37±0.070^{b}	8.92±0.070^{b}
T_2	2.15±0.070	14.82±0.280^{c}	0.85±0.020^{bc}	3.31±0.010^{c}	8.52±0.210^{c}
T_3	2.15±0.070	13.67±0.050^{d}	0.81±0.020^{cd}	3.29±0.010^{cd}	7.43±0.130^{d}
T_4	2.05±0.070	12.93±0.110^{e}	0.79±0.070^{d}	3.28±0.060^{d}	6.86±0.070^{e}
LSD	-	0.359	0.042	0.032	0.296

Control: Fermented beverage made from Buffaloes Skim Milk (BSM), T_1: Made from 75% BSM+25% QSWE, T_3: Made from 25% BSM+75% QSWE, T_2: Made from 50% BSM+50% QSWE, T_4: Made from QSWE, *LSD: Least significant difference *No significant differences between means. Different letters in the same row or column (a, b, c, ...) means that many comparisons are different from each other, letter a is highest mean followed by b, c ..... etc. Results are significant at 0.05 level

soymilk. On the other hand, no significant differences ($p>0.05$) were found in the fat, total protein and ash contents between the control and all treatments through storage period. Also, the storage period had no significant effect on the fat content.

Based on the results presented in Fig. 1, it is evident that acidity values of fermented beverages increased in control and all treatments during storage. The changes in total acidity have been an important factor, that affect the shelf life and the acceptability of fermented beverages considered (Salem *et al.*, 2013). The results showed that fermented beverages, T_3 and T_4 treatments had relatively lower acidity than the control during storage. In addition, Dallagnol *et al.* (2012) reported that lactic acid production during slurry fermentations by *Lactobacillus plantarum* CRL778 was greater in quinoa than in wheat. The trend of the changes in pH values of fermented beverages from all treatments was opposite to that of acidity a result of microorganism metabolism (Abd-Allah *et al.*, 1993).

Minerals content: Table 3 shows mineral content (ppm) of five treatments (control, T_1, T_2, T_3 and T_4). Minerals contents in fermented quinoa beverages were decreased with increasing the

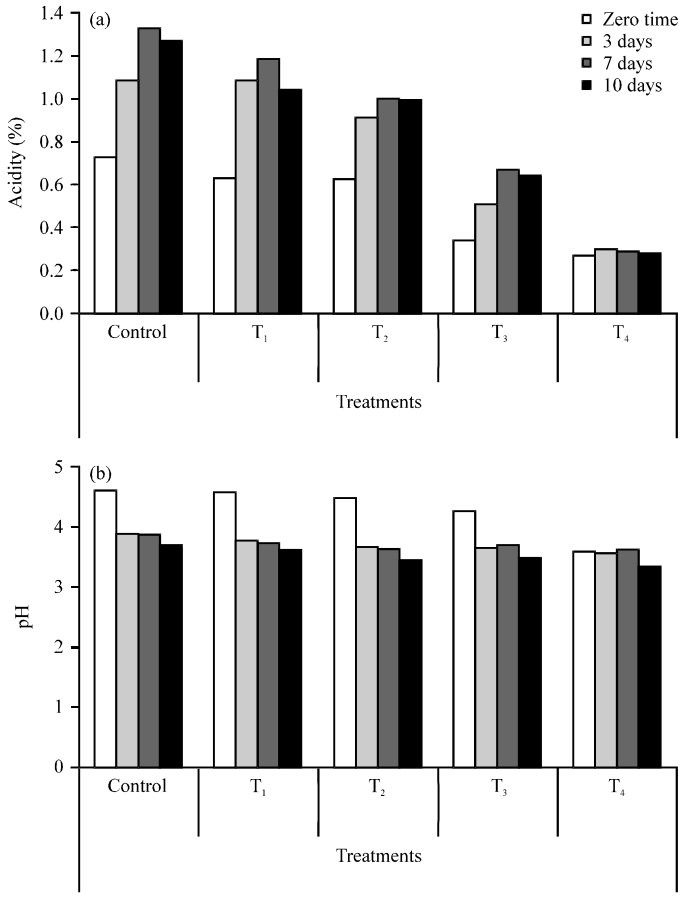

Fig. 1(a-b): (a) Acidity (%) and (b) pH values of fermented beverages made from buffaloes skim milk and QSWE during storage period

Table 3: Minerals contents of fermented beverages of different treatments as affected by replacing different levels of QSWE

	Treatments				
Minerals (ppm)	Control	T_1	T_2	T_3	T_4
Mg	3.47	3.23	2.98	2.78	1.51
Na	1.36	1.44	1.68	1.82	0.56
K	2.92	2.55	2.14	2.23	1.20
Fe	9.40	21.06	22.55	24.48	27.39
Ca	978.00	1006.00	856.00	762.00	791.00
Zn	7.60	6.32	5.80	3.56	2.44
P	273.00	226.00	164.00	89.00	27.00

Control: Fermented beverage made from Buffaloes Skim Milk (BSM), T_1: Made from 75% BSM+25% QSWE, T_3: Made from 25% BSM+75% QSWE, T_2: Made from 50% BSM+50% QSWE T_4: Made from QSWE

added ratio of Quinoa Seeds Water Extract (QSWE). Data revealed that the high levels were calcium and phosphorus, then followed by zinc, magnesium, potassium and sodium in control and other treatments, respectively. While, the values of iron in all treatments were found to increase by increasing the added ratio of QSWE.

Abou-Arab (1991) detected trace levels of metals in skim milk, while Enb *et al.* (2009) reported that the reduction of metals may be due to the manufacture process and the fermentation by starter used. Quinoa is a good source of minerals. It contains more calcium, magnesium, iron and zinc than common cereals and the iron content is particularly high. Polishing and washing quinoa seeds reduce the mineral content to some extent, 12-15% in the concentration of iron, zinc and potassium and cause 27% loss of copper and 3% loss of magnesium (Valencia-Chamorro, 2003). FAO/WHO (1973) observed that quinoa seeds have higher levels of calcium, phosphorus, iron, fibre and B-vitamins than barley, oats, rice, corn, or wheat (Dini *et al.*, 2005).

Amino acids contents: Amino acids contents in fermented beverages made from buffaloes skim milk and QSWE are present in Table 4. Results showed that the highest values were for glutamic acid and leucine followed by lysine and proline. In addition, data showed that all amino acids decreased with increasing the added ratio of QSWE except phenylalanine, methionine, histidine and leucine. The reduction of amino acids of QSWE may be due to washing quinoa seeds and during manufacture process. According to values indicated by FAO/WHO/UNU (1985) and James (2009) quinoa protein can supply around 180% of histidine, 274% of isoleucine, 338% of lysine, 212% of methionine + cysteine, 320% of phenylalanine+tyrosine, 331% of threonine, 228% of the tryptophan and 323% of valine recommended in protein sources for adult nutrition. In addition, the sulfur-containing amino acids cystine and methionine are found in concentrations that are unusually high compared to other plants (Schlick and Bubenheim, 1996). Also, Koziol (1992) reported that amino acids phenylalanine, methionine, histidine are found higher in quinoa protein than milk protein.

Microbiological examination: The results in Table 5 showed that the changes in total count of different treatments of fermented beverages under study during storage period at refrigerator

Table 4: Amino acids contents of fermented beverages as affected by replacing different levels of QSWE

	Treatments				
Amino acid (g/100 mL)	Control	T_1	T_2	T_3	T_4
Argenine	0.105	0.098	0.099	0.095	0.096
Aspartic acid	0.220	0.216	0.212	0.207	0.208
Alanine	0.120	0.112	0.151	0.125	0.118
Isoleucine	0.180	0.175	0.173	0.169	0.164
Proline	0.289	0.280	0.282	0.279	0.274
Therionine	0.125	0.119	0.116	0.113	0.116
Glutamic acid	0.673	0.661	0.662	0.665	0.660
Glycine	0.069	0.065	0.061	0.058	0.055
Serine	0.141	0.135	0.130	0.132	0.138
Cysetine	0.043	0.040	0.040	0.035	0.032
Valine	0.205	0.198	0.194	0.190	0.181
Phenylalanine	0.201	0.210	0.218	0.223	0.235
Lysine	0.304	0.295	0.290	0.287	0.281
Leucine	0.320	0.318	0.319	0.315	0.318
Methionine	0.085	0.089	0.095	0.108	0.113
Histidine	0.111	0.115	0.124	0.131	0.142
Tyrosine	0.151	0.149	0.142	0.138	0.131

Control: Fermented beverage made from Buffaloes Skim Milk (BSM), T_1: Made from 75% BSM+25% QSWE, T_3: Made from 25% BSM+75% QSWE, T_2: Made from 50% BSM+50% QSWE, T_4: Made from QSWE

Table 5: Microbiological analysis (log CFU mL^{-1}) of fermented beverages with different levels of QSWE added to BSM during storage period

Storage period and treatments	Total count	Mould and yeast
One day		
Control	5.740	ND*
T_1	5.455	ND
T_2	5.898	ND
T_3	6.063	ND
T_4	6.140	ND
3 days		
Control	6.643	ND
T_1	6.627	ND
T_2	6.507	ND
T_3	6.679	ND
T_4	6.732	ND
7 days		
Control	6.456	4.362
T_1	6.509	4.312
T_2	6.425	4.491
T_3	6.585	4.439
T_4	6.635	4.683
10 days		
Control	4.525	3.130
T_1	4.544	3.061
T_2	4653	3.225
T_3	4.579	3.161
T_4	4.398	2.709

Control: Fermented beverage made from Buffaloes Skim Milk (BSM), T_1: Made from 75% BSM+25% QSWE, T_3: Made from 25% BSM+75% QSWE, T_2: Made from 50% BSM+50% QSWE, T_4: Made from QSWE, *ND: Not detected

temperature 5±1°C. The results indicated that the total bacterial counts were higher in all fermented beverages after 3 days then slightly decreased at 7 days then decreased to the end of storage period. This may be due to the activity of lactic acid bacteria in fermented beverages increased the acidity and consequently decrease the total bacterial count in agreement with Nayra *et al.* (2002).

Counts of yeast and mould recorded in fermented beverage were presented in the same table. It could be seen that the yeast and mould were not detected at fresh and after 3 days for control and all treatments. Moreover, yeast and mould were detected and counted in control and all treatments after 7 days of storage. This increase may be due to the acidity development and accumulation of lactic acid. These results are in agreement with the results reported by Nayra *et al.* (2002). They found that the yeast and mould began to appear after 7 days of storage. In addition, data showed that yeast and mould counts decreased after 10 days of storage in control and all treatments. This decrease may be due to antifungal activity of the remains of saponins in quinoa seeds after washing and processing (Woldemichael and Wink, 2001).

No growth of coliform was detected in all fermented beverages under study in both fresh and stored. This may be due to the efficient heat treatment and high sanitation conditions during manufacture. This is due to low pH according to Salji and Saadi (1986) who found that the lowest count of coliform bacteria was enumerated in the lowest pH yogurt. Steinkraus (2002) and Erbas *et al.* (2006) noticed that fermented foods are safe due to low pH and high organic acids such

as lactic acid. The production of acids and other antimicrobial components during fermentation may promote or improve the microbiological safety and stability of the product (Holzapfel, 1997).

Sensory evaluation: Table 6 shows the changes in the organolyptic properties of fermented beverages under study at zero time and during cold storage at 5±1°C for 10 days. It's known that the flavor, body, texture, colour and appearance in five treatments (control, T_1, T_2, T_3 and T_4) at zero time, 3, 7 and 10 days, respectively. Results indicated that the control, T_1 and T_2 possessed the highest score at zero time for flavor, body, texture, colour and appearance among all treatments. After three days the highest score was for control and T_1 (25% QSWE) followed by T_2. On the other hand, no differences found among all treatments after 7 days. After 10 days data showed that the highest score was T_4 (100% QSWE) followed by T_3. It could be conclude that the fermented beverages (T_3 and T_4) gave the highest score after 7 and 10 days of storage. James (2009) reported

Table 6: Sensory evaluation of fermented beverages with different levels of QSWE added to BSM during storage period

Storage period and treatments	Sensory evaluation				
	Flavor (50)	Body and texture (30)	Colour (10)	Appearance (10)	Total score (100)
One day					
Control	44.6±0.55^{a}	23.4±0.30^{bc}	8.6±0.55^{ab}	8.6±0.55^{a}	85.2±1.640^{ab}
T_1	45.2±0.11^{a}	26.2±0.59^{ab}	8.8±0.84^{a}	8.8±0.83^{a}	88.6±4.820^{a}
T_2	44.2±0.08^{a}	27.2±0.64^{a}	8.6±0.89^{ab}	8.8±0.83^{a}	88.2±5.450^{a}
T_3	41.6±0.16^{a}	22.8±0.92^{cd}	7.6±0.89^{b}	7.2±0.44^{b}	79.2±4.440^{b}
T_4	36.0±0.47^{b}	20.0±0.91^{c}	6.4±0.14^{c}	6.4±0.89^{b}	68.8±9.730^{c}
LSD	5.08	3.06	1.17	0.97	7.69
3 days					
Control	45.2±0.49^{a}	24.5±0.04	9.2±0.75	8.3±1.37	88.4±6.660^{a}
T_1	43.2±0.03^{a}	27.2±0.54	9.2±0.75	8.5±1.38	87.0±7.510^{a}
T_2	41.6±0.03^{ab}	26.7±0.06	9.0±1.09	8.0±1.41	82.8±5.220^{ab}
T_3	37.8±0.12^{b}	22.7±0.50	8.3±0.82	7.0±1.41	76.4±8.080^{b}
T_4	36.6±0.88^{b}	22.2±0.02	7.8±0.98	6.5±2.17	76.4±5.410^{b}
LSD	5.12	-	-	-	8.80
7 days					
Control	43.0±4.00	24.0±5.33	8.5±1.05	8.2±1.47	86.2±9.010
T_1	43.3±3.90	25.0±4.47	8.3±1.03	8.5±1.40	86.6±6.340
T_2	43.0±2.37	25.7±3.27	8.3±1.03	8.5±1.40	87.4±5.460
T_3	41.0±4.64	23.0±5.18	8.2±0.75	8.3±0.81	83.2±9.620
T_4	37.5±5.78	21.8±4.88	8.0±0.63	8.0±0.89	77.2±11.12
LSD	-	-	-	-	-
10 days					
Control	41.0±3.80^{b}	25.6±0.89	8.6±0.55	8.4±0.55	83.6±3.360^{b}
T_1	40.0±3.46^{b}	26.8±1.30	8.2±084	8.6±0.55	83.6±4.720^{b}
T_2	41.4±3.78^{b}	27.2±0.84	8.4±0.89	8.6±0.55	85.6±3.440^{b}
T_3	43.0±2.12^{ab}	26.6±1.14	8.6±0.55	8.4±0.89	89.6±2.070^{ab}
T_4	46.4±1.14^{a}	26.4±1.14	8.8±0.55	8.8±0.45	93.4±1.810^{a}
*LSD	4.02	-	-	-	4.30

Control: Fermented beverage made from Buffaloes Skim Milk (BSM), *LSD: Least significant difference, T_1: Made from 75% BSM+25% QSWE, T_3: Made from 25% BSM+75% QSWE, T_2: Made from 50% BSM+50% QSWE, T_4: Made from QSWE. *No significant differences between means. Different letters in the same row or column (a, b, c, ...) means that many comparisons are different from each other, letter a is highest mean followed by b, c ..... etc. Results are significant at 0.05 level

that the solubility values of quinoa flour in the acid pH region (6-10) imply that the protein may be useful in the formulation of beverages, dehydrated soups and low-acid foods and can be used as a good source of nutrition for infants and children.

CONCLUSION

Now a days, QSWE which may have potential for consumption directly as milk or in dairy products, may in the near future is a significant consumption for its nutritional benefits all over the world.

This study demonstrated that quinoa has a relatively high content of good-quality protein, minerals and other bioactive compounds. It has a long history of safe use in South America especially in low-income areas. Therefore, it may present a new viable crop option for low-income areas and also provide a new ingredient for specific foods for particular target.

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