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Research Article

Effect of Different Levels of Whey and Storage Period on Physiochemical Properties of Whey-Yoghurt

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Abstract

Objective: This study was carried out to evaluate the chemical composition of Yoghurt fortified with various levels of Whey upon storage.

Methods: Yogurt samples were manufactured (day one) from five different levels of whey (A, B, C, D, and E), transported to the laboratory in an ice box, and stored at 7°C for 14 days. Samples were analyzed for total solids, moisture, ash, curd protein, fat, pH and acidity at 1, 7 and 14 days.

Results: The results showed that fat, protein, total solids, ash, and pH were high in A and low in E, except for acidity which was increased in E low in C. During storage fat, protein, ash contents, and pH decreased to a minimum at day 14, except for total solids and acidity increased to a maximum at day 14. Towards the end of storage, the fat content slightly decreased in E and increased in A. The protein content reduced somewhat towards the end in E and increased in A. The total solids and ash contents somewhat reduced in all treatments at the end of storage, while acidity increased towards the end of storage in all treatments.

***Keywords**: Yoghurt; Whey Levels; Chemical Composition; Storage Period*

Introduction

Dairy products are generally known to be a good source of proteins, calcium, potassium, phosphorus, magnesium, zinc, and some B vitamins such as riboflavin, niacin, and vitamins B6 and B12 [1]. Dairy products refer to all products produced from milk Yogurt is a type of dairy product. The word yogurt comes from Turkey and refers to tart, thick milk [2]. Yogurts are made by the addition of certain bacteria cultures called starter cultures. Yogurt represents a very significant dairy product around the world. It is a semisolid fermented product made from a heat treated standardized milk mix by the activity of a symbiotic blend of *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. Bulgaricus* [3].

The lactose content of the yogurt mix is generally approximately 6% before fermentation. It is argued that proteins from yogurt are generally more digestible than proteins from milk, and this is due to the conditional predigesting of milk proteins in yogurt. This argument is supported by the evidence of a higher free amino acid content, especially proline, and glycine, in yogurt than in milk. Whey proteins and caseins in yogurt are rich sources of essential amino acids. Proteins in yogurt are of excellent biological quality as milk proteins due to the nutritional value of milk proteins being well preserved during fermentation processes [1].

Yogurts are shown to have a higher concentration of conjugated linoleic acid (CLA), a naturally occurring trans fatty acid obtained from omega-six essential fatty acid, than the milk from which it was processed [4]. The increase in CLA content and its isomers is due the presence of starter cultures (bacteria). According to Paszczyk [5] the content of CLA in cow milk yogurts was higher at 7th day of storage compared to 1 day. They reported that changes in CLA and its isomers in yogurts were produced when it was stored at temperature 5°C for 14 days.

Yogurt is an acidic food substance, and as a result of its acidic pH, it ionizes calcium, facilitating intestinal calcium uptake. Other compositional elements of yogurt include B vitamins and minerals. There is a much greater risk of losing vitamins than minerals during yogurt processing due to the greater sensitivity of vitamins to environmental factors than minerals [1].

Milk whey is a highly nutritious by-product obtained from the dairy industry producing cheese, constituting almost 45 - 50% of total milk solids, 70% of milk lactose, 20% of milk proteins, 70 - 90% of milk minerals, and almost all the water-soluble vitamins initially present in milk [6]. Worldwide whey production is estimated at around 180 to 190×106 ton/year; of this amount only 50% is processed [7]. Approximately 50% of worldwide cheese-whey (CW) production is treated and transformed into various foods and feed products. About half of this amount is used directly in liquid form, 30% as powdered cheese-whey, 15% as lactose and its byproducts and the rest as cheese whey-protein concentrates [8]. This study was carried out to evaluate the chemical composition of Yoghurt fortified with various levels of Whey uponstorage.

Materials and Methods

This study was conducted in the department of Dairy Production, Faculty of Animal Production, University of Gezira, from November to December 2020.

Collection of samples: Samples of yoghurt were processed from five different levels of whey A (0%), B (25% whey), C (50% whey), D (75% whey), and E (100% whey), transported to the laboratory in an ice box and kept in the refrigerator (7°C) for 14 days The samples were analyzed for total solids, moisture, ash, curd protein, fat, pH and titratable acidity at 1, 7 and 14 days intervals.

Chemical analysis: Fat content was determined by the Gerber method, while protein content was determined by the Kjeldahl method [9]. The total solids content was determined according to the modified method of AOAC [10] as follows; three grams of Yoghurt were placed in a clean, dried flat-bottomed aluminum dish and heated in a steam bath for 10 minutes. The dishes were dried in an air oven at 100°C for three h, then transferred to a desiccator to cool, and then weighed. Heating, cooling, and weighing were repeated several times until the difference between two successive weightings was less than 0.5 mg. The total solids content was calculated as follows:

$$TS\% = \frac{W_1 \text{ X } 100}{W_2}$$

Where:

W1 = Weight of sample before drying

W2 = Weight of sample after drying

Moisture was determined using the gravimetric method [10].

The ash content was determined according to AOAC [11].

Physical analysis: The titratable acidity was determined using the titrimetric method of AOAC [12]. pH was measured using a thermo scientific digital pH meter.

Statistical analysis: The data were statistically analyzed using Statistical Package for Social Sciences (SPSS, ver. 23) completely randomized design was used for statistical analysis, and means were separated by Duncan Multiple Range Test at $p < 0.05$.

Results and Discussion

Table 1 shows the chemical composition of yoghurt total solids, moisture, crude protein, fat, and ash were significantly affected by the whey levels. The highest fat content was in A (2.68 ± 0.025), while the lowest was in E (1.73 ± 0.025). The protein content was high in A (3.75 ± 0.024) and low in E (2.28 ± 0.024). The total solids content was high in A (15.50 ± 0.091) and low in E (10.68 ± 0.091). This characteristic could be responsible for the difference in TS content [17]. The ash content was high in A (1.25 ± 0.018), while lowest value was obtained from E (0.65 ± 0.018).

Table 1 and figure 1 and 2 show the chemical composition of yoghurt during a storage period of 14 days. The fat content regularly decreased from day one (3.19 ± 0.019) to a minimum at day 14 (1.23 ± 0.019), beyond which the content decreased ($p < 0.001$).

The protein content steadily decreased to a minimum at day 14 (1.93 ± 0.018) when the value at start of storage (was 4.04 ± 0.018) ($p < 0.001$). The total solids content followed a different trend as protein content increasing to a maximum at day 14 (14.34 ± 0.070) and then decreased to (11.89 ± 0.070) at the start ($p < 0.01$). The ash content decreased from (1.13 ± 0.014) on day one to (0.81 ± 0.014) at the end ($p < 0.001$). Compared with the control yogurt, the Yoghurt with 50% WP showed denser and well-organized protein clusters with a high connectivity network structure. The white arrow indicates the area. When the milk system was inoculated with starter cultures, the WP might interact with casein micelle to form bridges during acidification [13], which improved the water-holding capacity of the Yoghurt with WP [14].

Factor A (Whey levels)	Total solids	Moisture	Crud protein	Fat	Ash
0%	15.50^a	84.50^e	3.75^a	2.68^a	1.25^a
25%	14.16^b	85.79^d	3.30^b	2.50^b	1.10^b
50%	13.48^c	86.52^c	3.02^c	2.22^c	0.97^c
75%	12.78^d	87.27^b	2.58^d	1.98^d	0.82^d
100%	10.68^e	89.28^a	2.28^e	1.73^e	0.65^e
± S.E	0.091	0.099	0.024	0.025	0.018
Sig	**	**	**	**	***
Factor B (Storage Period)					
0ne day	11.89^c	88.11^a	4.04^a	3.19^a	1.13^a
Seven days	13.73^b	86.30^b	2.99^b	2.25^b	0.93^b
Fourteen days	14.34^a	85.61^c	1.93^c	1.23^c	0.81^c

± S.E	0.070	0.076	0.018	0.019	0.014
Sig	**	**	**	**	**
Factor A and Factor B					
± S.E	0.157	0.171	0.041	0.043	0.031
Sig	**	**	**	**	**

Table 1: *Effect of whey levels and storage period on chemical composition of yoghurt.*

a-e: Mean within column with different superscript letter are significantly different at p < 0.01.

S.E: Standard Error.

Sig: Significant Level.

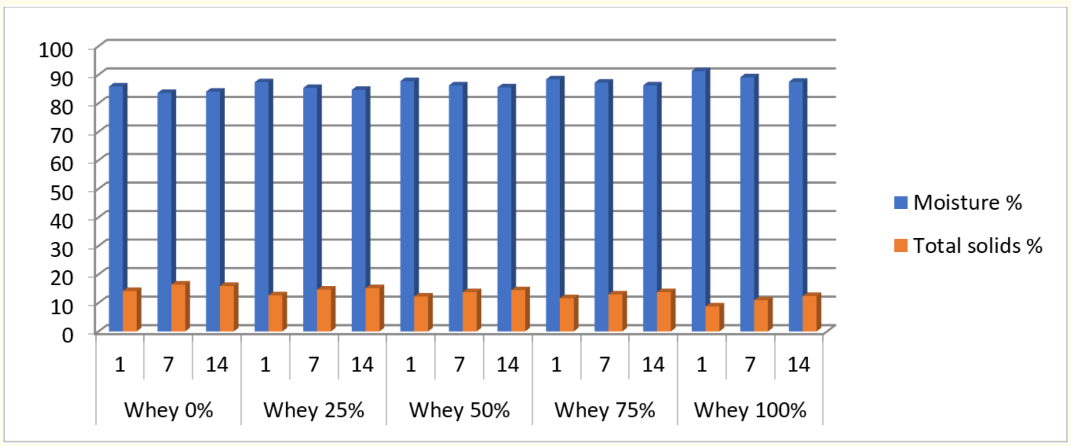

Figure 1: *Interaction effect between whey levels and storage period for yoghurt moisture and total solids.*

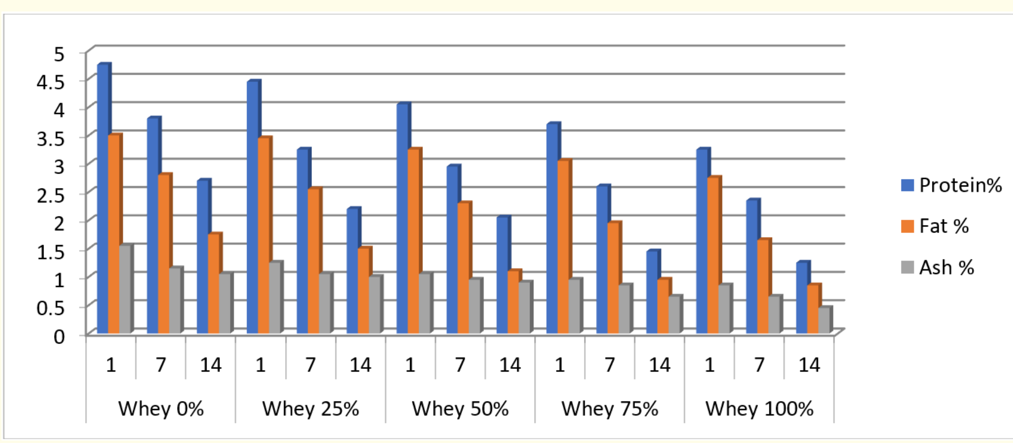

Figure 2: *Interaction effect between whey levels and storage period for yoghurt protein, fat and ash.*

Table 2 shows that the whey levels significantly affected the Acidity and pH of Yoghurt. The highest Acidity content was in B and D (4.17 ± 0.033), while the lowest was in A and C (4.00 ± 0.033). This result was similar to that obtained by Bierzuńska [15], who revealed that the incorporation of polymerized whey protein could increase the Acidity of Yoghurt. The pH content was high in A (3.97 ± 0.033) and low in E (3.47 ± 0.033) The slight decrease in pH was probably due to the production of lactic acid by starter cultures during storage [16] This is likely due to the pH difference among the Yoghurt.

Table 2 and figure 3 shows the acidity and pH of yoghurt during a storage period of 14 days. The acidity content followed the different trend as the pH value increased to a maximum at day 14 (4.66 ± 0.026) and then decreased to (3.24 ± 0.026) at the start ($p < 0.01$). The pH value decreased from (4.26 ± 0.026) on day one to (3.10 ± 0.026) at the end ($p < 0.001$). The results were similar to the findings of Wang [17], who reported that the pH of goat's milk yogurt decreased upon 12-week storage. It can be seen that different WP addition levels did not significantly change the pH values of Yoghurt within the same storage time, which indicated that pH of the yogurt samples was less likely to be influenced by adding WP. Other studies reported that the pH of Yoghurt decreased during storage under refrigeration conditions between 3.8 and 4.5 [18].

Factor (A) (Whey levels)	Acidity	pH
0%	4.00^{b}	3.97^{a}
25%	4.17^{a}	3.87^{b}
50%	4.00^{b}	3.70^{c}
75%	4.17^{a}	3.57^{d}
100%	4.13^{a}	3.47^{e}
± S.E	0.033	0.033
Sig	**	**
Factor B (Storage Period)		
One day	3.24^{c}	4.26^{a}
Seven days	4.38^{b}	3.78^{b}
Fourteen days	4.66^{a}	3.10^{c}
± S.E	0.026	0.026
Sig	**	**
Factor A and Factor B		
± S.E	0.058	0.058
Sig	**	**

Table 2. *Effect of whey levels and storage period on Acidity and pH of yoghurt.*

a-e: Mean within column with different superscript letter are significantly different at $p < 0.01$.

S.E: Standard Error.

Sig: Significant Level.

The minerals of Yoghurt from each plant during the storage period are presented in table 3. The results show that minerals (Ca^{++}, Na^{+}, K^{+}, and P^{++}) showed an irregular pattern during the storage period, slightly decreasing towards the end in E, while the content slightly increased in A, these results are closely related to those of Nergiz [19].

Table 3 and figure 4 shows the minerals of Yoghurt during the storage period of 14 days. The Ca^{++} content regularly increased from day one (1.50 ± 0.023) to a minimum at day 14 (0.69 ± 0.023), beyond which the content decreased ($p < 0.001$).

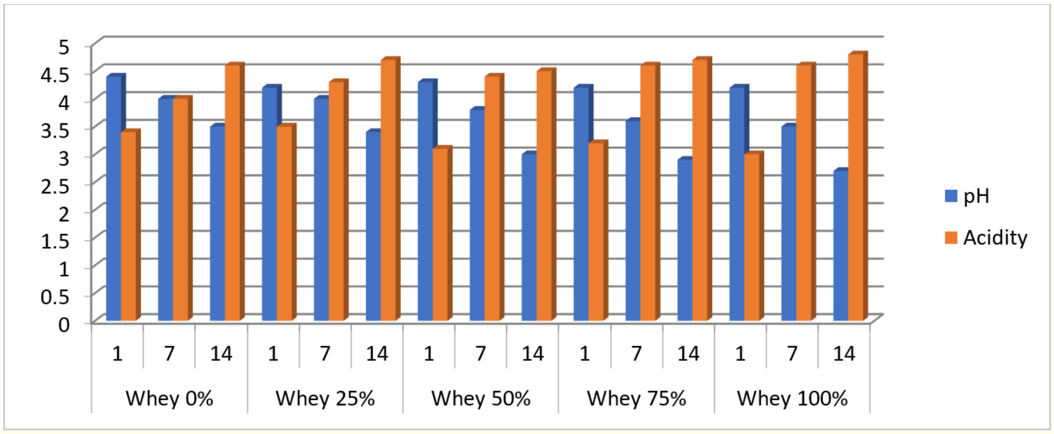

Figure 3: *Interaction effect between whey levels and storage period for yoghurt acidity and pH.*

The Na^+ content steadily decreased to a minimum at day 14 (0.64 ± 0.015) when the value at start of storage (was 1.16 ± 0.015) ($p < 0.001$). The K^+ content followed, increasing to a maximum at day one (1.23 ± 0.015) and then decreasing to (0.60 ± 0.015) at the end ($p < 0.01$). The P^{++} content decreased from (0.06 ± 0.012) on day 14 to (0.18 ± 0.012) at the start ($p < 0.001$).

Factor A (Whey levels)	**Ca^{++}**	**Na^+**	**K^+**	**P^{++}**
0%	1.15[a]	1.01[a]	1.04[a]	0.17[a]
25%	1.10[ab]	0.96[b]	0.98[b]	0.15[ab]
50%	1.07[bc]	0.91[b]	0.90[c]	0.12[bc]
75%	1.03[c]	0.83[c]	0.86[cd]	0.08[cd]
100%	0.96[d]	0.82[c]	0.82[d]	0.05[d]
± S.E	0.023	0.019	0.019	0.016
Sig	**	**	**	**
Factor B (Storage Period)				
One day	1.50[a]	1.16[a]	1.23[a]	0.18[a]
Seven days	1.00[b]	0.92[b]	0.93[b]	0.11[b]
Fourteen days	0.69[c]	0.64[c]	0.60[c]	0.06[c]
± S.E	0.023	0.015	0.015	0.012
Sig	**	**	**	**
Factor A and Factor B				
± S.E	0.040	0.033	0.034	0.028
Sig	**	**	**	**

Table 3: *Effect of whey levels and storage period on minerals of yoghurt.*

a-e Mean within column with different superscript letter are significantly different at p < 0.01.

S.E: Standard Error.

Sig: Significant Level.

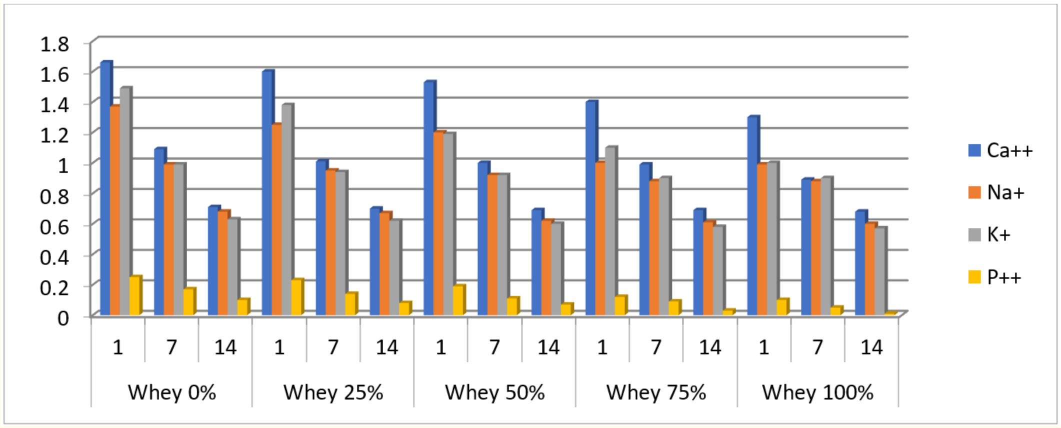

Figure 4: *Interaction effect between whey levels and storage period for yoghurt minerals (Ca++, Na+, K+ and P++).*

Conclusion

The objectives of the study were to use whey in different proportions in the manufacture of yogurt and to evaluate some chemical and physical properties under different storage periods 1/7/14 days of manufacture at a temperature of 5°. The final product is edible, as there were no additives to the product, whether whey or culture to raw milk (both from milk) and whey is equivalent to half total solids in milk. The chemical analysis showed that the total solids (%), moisture (%), fat (%), protein (%), ash and pH in the whey-added yogurt samples were lower than the pure yogurt, with the decrease in the values of the above components with the progression of the storage period, while the acidity was higher in the yogurt with added whey compared to the pure yogurt.

Bibliography

1. Adolfsson O., *et al*. "Yogurt and Gut Function". *The American Journal of Clinical Nutrition* 80 (2004): 245-256.
2. Cultures for Health "What is Yoghurt" (2015).
3. Chandan RC., *et al*. "Manufacturing Yogurts and fermented milk". First Edition, Blackwell Publishing, Blackwell Publishing Professional 2121 State Avenue, Ames, Iowa 50014, USA (2006).
4. Han X Lee F L., *et al*. "Chemical Composition of Water Buffalo Milk and its Low-Fat Symbiotic Yogurt Development". *Journal of Functional Foods in Health and Disease* 2.4 (2012): 86-106.
5. Paszczyk B., *et al*. "The effect of storage on the yogurt fatty acid profile". *Mljekarstvo* 70.1 (2020): 59-70.
6. Gajendra Bohora. "Preparing a whey-based pineapple beverage and its storage quality evaluation". B. Tech Thesis, in Food Technology Tribhuvan University Nepal (2018).
7. Baldasso C., *et al*. "Concentration and purification of whey proteins by ultrafiltration". *Journal of Desalination* 278.3 (2011): 381-386.
8. Lacta SA. "Biotechnological valorisation of whey". *Journal detail: Innovative Romanian Food Biotechnology* 10.3 (2012): 1-8.

9. AOAC "Curd Protein in yogurt". (12th edition.) Association of Official Analytical Chemists 981.10. (2003).

10. Authority of India Ministry of Health and Family Welfare Government. "Manual of Methods of Analysis Food (Milk and milk product)". Food safety and standards of India P128 (2015).

11. AOAC "Official Methods of Analysis". (12th edition) Association of Official Analytical Chemists Washington D.C. (2005).

12. AOAC International. "Official Methods of Analysis" 20th edition AOAC International, Gaithersburg, MD (2016).

13. Schorsch C., *et al*. "Gelation of casein-whey mixtures: Effects of heating whey proteins alone or in the presence of casein micelles". *Journal of Dairy Research* 68 (2001): 471-481.

14. Vukic VR., *et al*. "The effect of kombucha starter culture on the gelation process, microstructure, and rheological properties during milk fermentation". *The Journal of Texture Studies* 45 (2014): 261-273.

15. Bierzuńska P., *et al*. "Storage stability of texture and sensory properties of yogurt with the addition of polymerized whey proteins". *Foods* 8.11 (2019): 548.

16. Shah NP., *et al*. "Survival of *Lactobacillus acidophilus* and *Bifidobacterium bifidum* in commercial Yoghurt during refrigerated storage". *The International Dairy Journal* 5 (1995): 515-521.

17. Wang W., *et al*. "Consistency, microstructure, and probiotic survivability of goats' milk yogurt using polymerized whey protein as a co-thickening agent". *The International Dairy Journal* 24 (2012): 113-119.

18. Olson DW and Aryana KJ. "An excessively high *Lactobacillus acidophilus* inoculation level in yogurt lowers product quality during storage". *LWT - Food Science and Technology* 41.5 (2008): 911-918.

19. Nergiz C and Seçkin AK. "The losses of nutrients during the production of strained (Torba) yoghurt". *Food Chemistry* 61-1-2 (1998): 13-16.

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