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Formation and storage stability of coconut water based whey beverages prepared from camel and goat milk

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Abstract
Coconut water-based beverages are rich source of minerals and protein. Whey is major environmental pollutant and by-product from dairy industry but excellent source of proteins and calcium. Honey can be used for the development of low-calorie hypoglycaemic beverages because honey have good sugar. Preparation of whey beverages from different ratio (30:70, 70:30 and 50:50) of camel and goat milk but best result obtained on the basis of whey quality and nutritional, properties of camel milk obtained the combination of 70% camel milk and 30% goat milk. The formation of whey beverages blended in various combinations of whey, *Aloe vera* juice and coconut water was done under study. The selected whey beverages (T_0 and T_2C_3) were subjected to refrigerated (4 ± 1 °C) storage temperature and quality characteristics were evaluated at every 3 days' interval up to a period of 12 days. The mean ± SE values of pH showed highly significant (P<0.01) decrease with increase in refrigerated storage. Titratable acidity was also found to be increased significantly (P<0.01) with increase in storage period. TBA values of whey beverages were found significantly (P<0.01) higher on the 3rd, 6th, 9th and 12th day of refrigerated storage. The statistical analysis of data revealed that there was a highly significant (P<0.01) decrease on storage in the ABTS % radical scavenging activity of all samples or the antioxidant value of whey beverages. As per result of study the 79% whey and 15% coconut water (T_2C_3) were found best for overall acceptability and antioxidant properties. These whey beverages have lots of nutritional quality and health benefits. They are good source of minerals, protein and used as a source of energy.

Keywords: Coconut water, ABTS % radical scavenging activity, TBA values, pH, TA, whey beverages etc

1. Introduction
The camel (*Camelus dromedarius*) has significant socioeconomic importance in arid and semiarid regions of the world and its milk constitutes an important component of human diets in these regions. The camel milk consists of protein (3.4 percent), fat (3.5 percent), lactose (4.4 percent), ash (0.79 percent), lactose (4.4 percent) and water (87 percent) (Al Kanhal 2010) [1]. The second largest fraction, which occupies 20 to 25 percent of camel milk protein, is whey protein. The whey of the dromedary camel has a range of 0.63 and 0.80 percent whey protein (Khaskheli *et al*., 2005) [7]. Goat (*Capra hircus*) milk contains 12.2% total solids, 3.8% fat, 3.5% protein, 4.1% lactose and 0.8% ash, it contains more fat, protein and ash and less lactose than cow milk. Smaller and more friable curds of goat milk would be attacked more rapidly by stomach proteases and giving better digestibility (Jenness, 1980) [6]. Honey can contribute to the health and nutritional status of humans. These beneficial actions have been ascribed to its antimicrobial, anti-inflammatory and anti-oxidant potential. Interestingly, honey is gradually receiving attention as a complementary and or an alternative source of treatment in modern medicines (Manyi-Loh *et al*., 2011) [9]. In the fruit, coconut *(Cocos nucifera)* water naturally shapes and contains 94% water and very little fat. Coconut water can be beneficial for blood pressure control and helps to lower the risk of heart diseases. Coconut water can help in balancing the electrolytes of the body that contain; potassium, magnesium, calcium and lots of electrolytes. Coconut water can help for regulating the level of blood sugar and prevent diabetes. Coconut water can improve cardiovascular health and lower the risk of serious cardiovascular disease by lowering the cholesterol/triglyceride levels. Coconut water is rich in calcium, which helps to reduce oxidative stress and improve antioxidant status and bone density (Bhagya *et al*., 2010) [2]. In perspective, the present study was aimed to formulate the coconut water based whey beverages and further studied for storage stability parameter like pH, TA, ABTS activity and TBA value of whey beverages.

2. Materials and Methods

2.1 Formation of Coconut water-based whey beverage

Formulation of whey was done by using different ratio of camel and goat milk. Best results were obtained on the basis of yield and consistency of whey by using combination of 70% camel milk and 30% goat milk was used for the preparation of good quality whey. The milk was heated in a stainless-steel vessel to 90 °C. The hot milk was acidified by adding citric acid (2%) followed by continuous stirring resulting in complete coagulation of milk protein (casein). The liquid (whey) was filtered using a muslin cloth and stored for further use.

Fresh and best quality green coconut was procured from the local market and water extracted from green coconut then filtered through a double layered muslin cloth and a clear coconut water was stored. The preparation of juices was done under strict hygienic conditions.

The different formulations (treatments) of coconut water-based whey beverage were prepared by using constant level of honey 5% and black salt 1% in different combinations of whey and coconut water viz. T_0 (94% whey: 0% coconut water), T_2C_1 (89% whey: 5% coconut water), T_2C_2 (84% whey: 10% coconut water), T_2C_3 (79% whey: 15% coconut water). The treatments so prepared were thoroughly mixed. The treatments were heated to 90 ^{0}C for 5 minutes to dissolve the added ingredients followed by filling in the sterilized glass bottles then sealed.

2.2 Storage study of prepared whey beverages

The antioxidant activity (ABTS activity), lipid peroxidation (TBA value) pH and titratable acidity (percent lactic acid), of *Aloe vera* based whey beverages were measured during storage at (4 ± 1 °C) for various durations of time (0, 3, 6, 9 and 12 days). The changes in parameters and oxidative stability of *Aloe vera* and coconut water-based whey beverages over a period of 3 days in refrigerated storage (4 ± 1 °C) up to 12 days were detected.

2.3 Statistical analysis of whey beverages

All the experiments of study were repeated three times and samples were drawn in duplicate. Data collected during the present investigation were subjected to statistical analysis by adopting appropriate methods of analysis of variance as described by Snedecor and Chochran (1994) [17]. Wherever, the variance ratio was found significant at 5% and highly significant at 1% levels of probability, the significance of mean differences was tested by Duncan's New Multiple Range Test (Duncan's Range Test) as modified by (Kramer, 1957).

3. Result and Discussion

3.1 Formation of Coconut water-based whey beverage

A lot of reviews have been collected and studied before formulating the whey beverages under the present investigation i.e., Shukla *et al.* (2013) [15], Kumar *et al.* (2013), Pareek *et al.* (2014) [10], Gupta *et al.* (2015) [5], Gorachiya (2017) [3], Rohit *et al.* (2020) [12]**.** The formulation of whey beverages blended in various combinations of whey, coconut water is shown in table 1. The following treatment combinations were formulated which presented in table1.

Table 1: Formation of Coconut water-based whey beverage

Ingredients	T_0 (Control)	Coconut water based whey beverage		
		T_1C_1	T_1C_2	T_1C_3
Whey	94%	89%	84%	79%
Aloe vera juice	-	5%	10%	15%
Honey	5%	5%	5%	5%
Black salt	1%	1%	1%	1%
Total	100%	100%	100%	100%

3.2 Storage study of prepared whey beverages

Formation of *Aloe vera* based whey beverages in strictly hygienic condition then stored in refrigerator at (4 ± 1 °C). After formation of these whey beverages further used for storage study. Among of them only two treatments T_0 (Control) and T_1C_3 were selected for determination of storage stability. Following parameters were used for determination of storage stability which was as under-

The determination of the ABTS activity (% inhibition) was done to test the antioxidant properties of coconut water-based whey beverage as compared to control whey beverage. The analysis of ABTS activity (% inhibition) of whey-based beverage was done under refrigerated storage condition (0, 3, 6, 9 and 12 days). The data of ABTS activity (% inhibition) has been shown in table 2

The mean ABTS activity (% inhibition) at 0 day of sample $T_0$and T_2C_3 were observed 12.06 ± 0.017and 28.54 ± 0.024, respectively. However, the mean ABTS activity (% inhibition) at day 12 of sample T_0 and T_2C_3 were observed 6.83± 0.017and 15.94± 0.014 respectively. The statistical analysis of data revealed that there was a highly significant (P≤0.01) decrease in the ABTS activity of whey-based beverages of samples T_0 (Control) and T_2C_3. Same trend of significant decrease of the ABTS activity and DPPH activity with respect to the storage period were also reported by Gorachiya *et al.* (2018) [4], Prajapat (2019) [11] and León-López *et al*. (2020) [8].

The determination of the lipid per oxidation was done by Thio Barbituric acid (TBA) value, which gave the idea about rancidity of whey based beverages under refrigerated storage condition (0, 3, 6, 9 and 12 days). The data related to TBA value of whey based beverage has been shown in table 2.

The mean TBA value at 0 day of sample T_0 and T_2C_3 were observed to be 0.053 ± 0.014, 0.071± 0.020 and 0.068 ± 0.011, respectively.

The mean TBA value at 12 days of storage period for all the beverages was found to be increased from 0.053 ± 0.014 to 0.196 ± 0.018 in the sample $T_0$and 0.068 ± 0.011 to 0.319 ± 0.023 in sample T_2C_3.

TBA values of whey beverages were found significantly (P≤0.01) higher from 0 to 12 days of storage. Similar result of TBA value were also observed by various research workers like Prajapat (2019) [11] and Singh (2020) [16].

The determination of pH of prepared whey beverages was done under refrigerated storage condition (0, 3, 6, 9 and 12 days). The data of pH has been shown in table 2.

Table 2: Storage study of prepared whey beverages

Parameter	Day 0		Day 3		Day 6		Day 9		Day 12	
	T_0	T_1A_3	T_0	T_1A_3	T_0	T_1A_3	T_0	T_1A_3	T_0	T_1A_3
pH	4.74±0.047	4.70±0.040	4.68±0.029	4.67±0.035	4.61±0.032	4.57±0.055	4.56±0.047	4.52±0.016	4.41±0.020	4.43±0.031
TA	1.70±0.012	1.79±0.044	1.83±0.028	1.85 ± 0.018	1.92±0.028	1.98±0.011	2.13±0.02	2.14±0.025	2.24±0.017	2.32±0.051
ABTS	12.06eA±0.017	28.54eB±0.024	11.93^{da}±0.017	25.33dB±0.014	9.84^{cA}±0.024	22.16cB±0.015	8.34^{bA}±0.024	19.34bB±0.014	6.83^{aA}±0.017	15.94aB±0.014
TBA	0.053^{aA}±0.014	0.068aB±0.011	0.082^{bA}±0.011	0.103bB±0.025	0.126^{cA}±0.012	0.143cB±0.038	0.167^{dA}±0.014	0.253dB±0.026	0.196^{eA}±0.018	0.319eB±0.023

The initial pH of control T_0 was 4.68^{e} ± 0.052 which decreases to 4.37^{a} ± 0.023 and initial pH of was T_2C_3 4.68^{e} ± 0.052 which decreases to 4.37^{a} ± 0.023 after 12 days of storage The pH value of the whey beverages decreased highly significantly ($P \leq 0.01$) was also reported by Gorachiya *et al.* (2018) [4].

The determination of titratable acidity (TA) of prepared whey beverages was done under refrigerated storage condition (0, 3, 6, 9 and 12 days). The data of titratable acidity has been shown in table 2.

The mean titratable acidity value at 0 day of sample T_0 and T_2C_3 were observed to be 1.70 ± 0.012, 1.82 ± 0.018 and 1.79 ± 0.044, respectively.

The mean titratable acidity value at 12 days of storage period for all the beverages was found to be significantly ($P<0.01$) higher from 1.70 ± 0.012 to 2.24 ± 0.017, 1.82 ± 0.018 to 2.45 ± 0.030 and 1.79 ± 0.044 to 2.32 ± 0.051 in sample T_0 and T_2C_3 respectively. Similar results of significantly increase in titratable acidity were also observed in the study conducted by Sasi (2015) [14] and Sabokbar *et al*. (2015) [13].

4. Conclusion

Formation of whey from 70% camel milk and 30% Goat milk then incorporated with coconut water and prepared the coconut water based whey beverages. These whey beverages prepared in 4 combinations like T_0 (94% whey: 0% coconut water), T_2C_1 (89% whey: 5% coconut water), T_2C_2 (84% whey: 10% coconut water), T_2C_3 (79% whey: 15% coconut water). Among of these whey beverages T_2C_3 (79% whey: 15% coconut water)was found antioxidant properties and give best results in the overall acceptability and have lots of nutritional quality and therapeutic properties and. Coconut water-based whey beverages have good amount of minerals and used in summer season as a hydration drink replace of high sugar cold drinks. These beverages very useful for bodybuilders as a source of energy and minerals. The findings of this study will enable household clients and related industries to sell this overall health-oriented whey beverage focused on coconut water-based beverage and *Aloe vera* based whey beverage.

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