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Technical Note

Influence of Sodium Citrate on the Heat Stability of Buffalo Milk and its Concentrate

ABSTRACT

The influence of added sodium citrate (0·05%, 0·10% and 0·15%) on the heat stability (at 130°C) of buffalo milk and its 2:1 concentrate was determined. It was observed that added citrate caused a decrease in the heat stability of buffalo milk and its concentrate which was statistically significant and progressive as the concentration of citrate was increased. The decrease in the heat stability of buffalo milk and its concentrate due to the addition of citrate may be attributed to an increase in pH to a level of minimum stability. However, with an optimum adjustment in the pH, sodium citrate may be used for the stabilization of buffalo milk and its concentrate. It was also observed that, in all samples of buffalo milk, the normal pH was on the alkaline side of the pH of maximum heat stability.

INTRODUCTION

Sodium phosphate and citrate have been successfully used for making 'corrections' in the salt balance of bovine milk to save its evaporated product from severe losses during the sterilization process (Verma, 1965). However, the influence of such stabilizing salts on the heat stability of concentrated buffalo milk has not been studied. Puri *et al.* (1969) and Ibrahim *et al.* (1974) describe the influence of such salts on the heat stability of fluid milk. The investigation described in this note was carried out to determine the influence of added sodium citrate on the heat stability of buffalo milk and its concentrate (which is of much greater importance from the industrial point of view). The results are reported.

MATERIALS AND METHODS

Twenty samples of bulk milk were collected from the Murrah breed buffaloes of the National Dairy Research Institute herd. Each sample was divided into four lots. While 0·05 %, 0·10 % and 0·15 % of trisodium citrate were added, respectively, to the second, third and fourth lots, the first lot was kept as a control. All four lots were prewarmed at 85 °C for 5 min. After prewarming the sample was cooled to room temperature. A small portion of sample was taken for the determination of heat stability and the remainder was concentrated in the ratio of 2:1 in a rotatory type vacuum evaporator at an absolute pressure of 0·3 mm Hg. The sample was taken in a 2-litre round-bottomed flask connected to the evaporator. Milk was heated by immersing the rotating flask in a water bath maintained at 52 ° ± 1 °C.

The heat stability of all four lots of fluid milk and its concentrate was determined as heat coagulation time (HCT) at 130 ° ± 1 °C according to the method of Davies & White (1966) with some modifications as applied by Jairam *et al.* (1976). The pH of the milk and concentrates was adjusted from 6·4 to 7·2 with 0·1 unit difference by the addition of either normal hydrochloric acid or normal ammonium hydroxide.

RESULTS AND DISCUSSION

The effects of the addition of sodium citrate on the heat stability (determined as heat coagulation time (HCT) at 130 °C) and pH of buffalo milk and its concentrate are shown in Table 1. The results indicate that the addition of sodium citrate caused a reduction in the HCT of buffalo milk, whether determined before or after its 2:1 concentration. Further, this reduction was progressive with increasing concentration of added citrate. Statistical analyses of the data revealed that the decrease in HCT was significant ($P < 0{\cdot}1$). However, the difference between the HCTs of concentrate prepared from normal buffalo milk and milk containing added citrate was significant only when the concentration of added citrate was 0·10 % or higher (as is clear from the LSD value of 2·30 min which is

TABLE 1
Effects of the Addition of Sodium Citrate on the Heat Coagulation Time (HCT) at 130 °C and on the pH of Buffalo Milk and its 2:1 Concentrate*

Type of milk	*HCT (min)*	*pH*
Fluid		
Control	32·9	6·70
Added citrate (0·05 %)	9·50	6·75
Added citrate (0·10 %)	5·50	6·80
Added citrate (0·15 %)	4·50	6·85
Concentrated		
Control (no citrate)	6·50	6·60
Added citrate (0·10 %)	4·30	6·65
Added citrate (0·20 %)	3·20	6·70
Added citrate (0·30 %)	2·15	6·75

* The results represent the average from twenty samples of herd milk.

Least significant differences were 6·15 min and 2·30 min, respectively, for fluid milk and its concentrates.

greater than the difference (2·20) between the HCT values of control and concentrate containing 0·05 % citrate). Milk pH was also influenced by the addition of sodium citrate. Milk containing added citrate had a higher pH and the increase in pH was progressive with increasing sodium citrate concentration. To determine the effect of the increased pH, due to the addition of citrate, on the heat stability of milk and its concentrate, ten samples of herd milk were used for the determination of the effect of pH on the HCT of normal and citrate-enhanced buffalo milk and its concentrate. The results from one such sample are given in Table 2. (It was not possible to give the average of the ten samples since each sample behaved uniquely, depending on its normal pH, although the trend towards a decrease or increase in the HCT values due to the alteration in the pH value was similar in all ten samples.) It is clear from the results in Table 2 that a change in milk pH due to the addition of acid or alkali caused an alteration in the HCT of buffalo milk and its concentrate. The maximum HCT was found in the acidic pH range. In the case of fluid milk this was 6·6 (which was 0·1 unit lower than the normal pH of 6·7).

In other samples, also, the maximum HCT of fluid milk was found in the acidic pH range, from 6·55 to 6·7, depending on the normal pH (6·65

TABLE 2
Effect of pH on the Heat Coagulation Time (HCT) of Normal and Sodium Citrate-Treated Buffalo Milk and Its 2:1 Concentrates*

Milk pH	*HCT at 130°C (min)*			
	Fluid milk		*Concentrated milk*	
	Control	*With added sodium citrate (0·1%)*	*Control*	*With added sodium citrate (0·2%)*
6·4	0·50	4·50	1·10	1·00
6·5	31·00	49·00	20·00	26·50
6·6	43·00	63·00	10·50*	16·40
6·7	35·00†	20·0	9·20	2·20†
6·8	22·00	11·15†	9·10	2·00
6·9	11·50	10·30	3·35	1·50
7·0	10·00	10·00	2·50	1·20
7·1	6·00	9·30	2·40	1·10
7·2	6·10	9·00	3·10	0·50

* Results are for a particular sample of herd buffalo milk out of the ten samples analysed. The trend for other samples was the same but the magnitude was different.
† Denotes the HCT at normal pH of milk or concentrate.

to 6·8). On the other hand, the increase in pH from the normal value caused a decrease in the HCT. The minimum HCT in some samples was found at pH 6·9 while in others it was at pH 7·2. In the case of concentrate the maximum HCT was also found in the acidic pH range. In some samples it was at pH 6·6 while in others it was at pH 6·5, depending on the normal pH of the concentrate which ranged from 6·5 to 6·7. The HCT of milk containing added sodium citrate was also influenced by the alteration in pH. In both fluid milk and its concentrate a decrease in pH caused an increase in the HCT while an increase in pH had a reverse effect, i.e. a decrease in the normal HCT. Further, in the acidic pH range (6·4 to 6·6) the HCT of citrate-enhanced milk was higher in comparison with the control. However, at normal pH (6·8) or at 0·1 unit lower (6·7) than normal, the HCT of citrate-containing milk was lower than that of the control at the same pH. The concentrate prepared from citrate-enhanced milk also had a lower HCT at normal pH compared with the concentrate prepared from normal (control) milk.

The present findings regarding the influence of added citrate on the heat stability of buffalo milk are contradictory to the earlier reports on milk from the same species (Puri *et al.*, 1969; Ibrahim *et al.*, 1974) and on bovine milk (Miller & Sommer, 1940; Pyne, 1962). While these studies revealed that added citrate acts as a stabilizer, the present findings indicate a strong destabilizing effect of added sodium citrate on the HCT of buffalo milk and its concentrate. Such a destabilizing influence can be attributed to an increase in the pH of the milk. This increased pH was in the range of minimum HCT. Therefore, the citrate-enhanced milk had a lower stability compared with the control. However, the addition of citrate can enhance the stability of buffalo milk and its concentrate provided the pH is decreased, with the addition of acid, to an optimum level at which the HCT of such milk or concentrate is at a maximum.

The results in Table 2 indicate that, if the pH of buffalo milk and its concentrate containing added citrate is decreased to a level of 0·1 unit lower than that of the original pH, the HCT is remarkably enhanced. The results from a more recent study (Sweetsur & Muir, 1980) on bovine milk were in agreement with the present results. These workers found a decrease in the heat stability of skim milk and its concentrate at normal pH due to the addition of 0·1 % sodium citrate or disodium phosphate. Further, they observed that these salts may enhance the stability of skim milk and its concentrate provided the pH is adjusted to between 6·4 and 6·5.

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