

Technical Note

Evaluation of Extent of Water Adulteration of Milk Produced and Marketed in Morogoro Municipality, Tanzania

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Abstract

A study was conducted to evaluate the extent of water adulteration of milk produced and marketed in Morogoro municipality in Tanzania. A total of 90 milk samples were collected from institutional, private and smallholder farms and milk vendors. The samples were analysed for lactometer reading (LR), butterfat (BF), solids-not-fat (SNF) and total solids (TS). Overall adulteration (AD) was calculated as the difference between SNF of standard/genuine milk obtained at the farm gate and respective milk samples. It was observed that lactometer reading for the farm milk ranged from 25.32 to 26.75 and was significantly higher ($P<0.05$) than vendors' milk, which ranged from 23.01 to 23.58. The butterfat content for farm milk which ranged from 3.56 to 4.12 % was significantly higher ($P<0.05$) than that of the vendors' milk that ranged from 2.86 to 3.03 %. The SNF content for farm milk ranged from 7.18 to 7.67 % and was significantly higher ($P<0.05$) than that of vendors' milk, which ranged from 6.47 to 6.63 %. Furthermore, TS of farm milk which ranged from 10.81 to 11.87 % was significantly higher ($P<0.05$) than vendors' milk, which ranged from 9.38 to 9.74 %. The overall adulteration for farm milk ranged from 6.57 to 9.48 % and was significantly lower than that of vendors' milk, which ranged from 19.28 to 21.13 %. It was concluded that water adulteration of milk in Morogoro municipality was rampant and starts from the farm level. Therefore, there is a need for the Government to educate dairy farmers, milk vendors and the consumers on the importance of producing, selling and consuming respectively un-adulterated milk.

Key words: Milk, water adulteration, Morogoro Municipality

Introduction

Total annual milk production in Tanzania is estimated to be at 724,000 metric tons (FAO, 2003). The milk is marketed through informal channels comprising mainly small market agents who sell raw milk and /or traditionally processed dairy products. Thus it is estimated that informal markets account for over 98 % of the marketed milk in Tanzania (FAO, 2001). Recent studies on the quality of the informally marketed raw milk found water adulteration to be an issue of concern (ILRI, 2003). There are mainly two types of water adulteration of milk, either by intentional adulteration where, dishonest producers or vendors add water into milk to increase profit margins or accidental adulteration, which occurs during cleaning of utensils used for handling of

milk (Siegenthaler and Schulthess, 1977). Adulteration of milk by addition of water may introduce chemical and microbial health hazards as well as reducing nutritional and processing quality, palatability and market value of the milk. Despite the fact that informal milk marketing is common in most cities and towns in Tanzania, very little has been done to enhance a better understanding of milk from this marketing channel with regard to its quality and antibiotic status (Kweka, 2002). Standard methods used in assessing water adulteration include: lactometer which is designed to detect the change in density of adulterated milk; butter fat test which determines the percentage of milk fat in order to make accurate adjustment of butterfat % in

standardised milk and milk products; freezing point test which is very accurate and sensitive to added water in milk, (detects whether milk is of normal composition or adulterated), and lactometer test carried out together with the Gerber butter fat test, which enables the milk processor to calculate the milk total solids and solids not fat. (FAO/CTP/KEN/6611 Project, 2004). Therefore the objective of this study was to evaluate the extent of water adulteration of milk from common vendors and farms in Morogoro.

Materials and Methods

Study site

This study was carried out on farms and market agents operating in and around Morogoro municipality in Tanzania.

Milk samples collection

A total of 90 milk samples were collected during the dry and wet seasons to determine the extent of water adulteration in the milk. Sampling was done once a month over a period of three months from five different sources, namely: six institutional farms, four private farms, six smallholder farms, five shop vendors and nine street vendors. These sources were similar for all the three months. Milk in cans was thoroughly mixed to disperse the milk fat before sampling. Milk samples were collected in sterilized plastic bottles (500 mls) and labelled. Samples were taken to the Animal Science and Production Department's Dairy laboratory for analysis of butterfat (BF), lactometer reading (LR), solids not fat (SNF) and total solids (TS).

Chemical analysis of milk samples

Milk BF was determined by using Gerber method (ILCA, 1988).

LR was done using hydrometer (ILCA, 1988).

TS were calculated using the following standard formula (ILCA, 1988):

$$TS = L/4 + (1.22 \times \% \text{ butter fat}) + 0.72$$

Where L is lactometer reading

SNF was computed using equation given by ILCA (1988) as:

$$\text{SNF} = \text{TS} - \text{BF}\%$$

The percentage adulteration was calculated by using the formula below:

$$\% \text{ Adulteration} = \frac{\% \text{ SNF}_G - \% \text{ SNF}_S}{\% \text{ SNF}_G}$$

G and S stand for genuine and suspect samples respectively.

Genuine milk was sampled from known farms under the supervision of the author while suspected milk was sampled from unsupervised sources.

Data analysis

Data obtained from chemical analysis of milk samples was analysed using Statistical Analysis System (SAS, 1998). One way analysis of variance was carried out to compare the milk variables from different sources.

Results and Discussion

Specific Gravity (Lactometer reading)

Milk samples from farms were significantly different ($P < 0.05$) from milk collected from vendors (Table 1). It was noted that samples of milk from different vendors were not statistically different from each other. Harvey and Hills (1967) reported that milk with lactometer reading below 27 (specific gravity 1.027) is suspected as being adulterated with water. Based on this criterion all milk samples from all sources studied were below the standard. However, milk from vendors had significantly ($P < 0.05$) lower lactometer readings compared to those collected from farms. Thus milk from vendors were likely deliberately water adulterated.

Butterfat (BF)

Milk samples collected from farms contained butterfat that was significantly higher ($P < 0.05$) than vendors' milk (Table 1). However, there was no significant difference between farms ($P > 0.05$). Harvey and Hills (1967) reported that normal wholesome milk should contain at least 3 % butterfat. Based on this criterion vendors' shop milk was the only one found to have BF that was below this level and therefore in terms of BF levels the milk was considered as being water adulterated. In addition, since butterfat of milk from shop vendors did not differ significantly ($P > 0.05$) from street vendors' milk, one might consider that milk from the street vendors was also adulterated.

Table 1. Least squares means and standard error of means (SEM) for milk quality variables

Source of milk	Variables				
	LR (°L)	BF (%)	SNF (%)	TS (%)	AD (%)
IF	26.75 ± 0.57 ^a	4.13 ± 0.20 ^a	7.67 ± 0.17 ^a	11.87 ± 0.34 ^a	6.57 ± 1.99 ^b
PF	25.32 ± 0.70 ^a	3.56 ± 0.25 ^{ab}	7.18 ± 0.21 ^a	10.81 ± 0.41 ^b	12.40 ± 2.44 ^b
SHF	26.17 ± 0.57 ^a	3.93 ± 0.20 ^a	7.46 ± 0.17 ^a	11.51 ± 0.34 ^{ab}	9.48 ± 1.99 ^{ab}
MVS	23.01 ± 0.63 ^b	2.86 ± 0.22 ^c	6.47 ± 0.18 ^b	9.38 ± 0.37 ^c	21.13 ± 2.18 ^a
STV	23.58 ± 0.47 ^b	3.03 ± 0.16 ^{bc}	6.63 ± 0.14 ^b	9.74 ± 0.28 ^c	19.28 ± 1.63 ^a
SEM	0.36	0.13	0.11	0.24	1.37
SL	***	***	***	***	***

Within the column, means followed by the same superscript do not differ significantly at ($P > 0.05$) according to DMRT

Key:
LR = Lactometer reading; BF= butterfat; SNF= Solid not fat; TS = Total solids; AD = Adulteration; IF= Institutional farms; PF= Private farms; SHF= smallholder farms; MVS = milk vendor shop; STV = street vendor and SL= significance level.

Solids –Not-Fat (SNF)

Milk samples from farms had significantly higher ($P < 0.05$) SNF than vendors' milk (Table 1). Normal milk has been reported to contain SNF of 8.5 % (Harvery and Hills, (1967). Basing on these values, all the milk samples

from the farms and vendors agents, were found to be below the standard value, thus one may consider them as being adulterated but the values were within the accepted range (6. 82 to 11.6 %) as shown by Bath et al. (1985).

Total solids (TS)

Among samples from the farms, milk from institutional farms differed significantly ($P < 0.05$) in total solids from milk from private farms. Milk samples collected from vendors had significantly ($P > 0.05$) lower total solids compared with milk from farms. De Witt (1990) reported a range of 9.3 – 17.6 % for normal milk. Thus, all the milk samples were within this range. However, though milk from vendors had TS level within the range, the values were very low and close to the lower limits, prompting one to believe that the milk was water adulterated.

Adulteration (AD)

Milk samples collected from the farms were not significantly different ($P > 0.05$) in terms of adulteration (Table 1) but had significantly lower ($P < 0.05$) adulteration level than vendors' milk.

The milk vendors are middlemen dealers between producers (farms/farmers) and consumers, therefore the easiest way of increasing their profit margins is to increase the volume of milk by adding water, which is not organoleptically easy to detect. Adulteration observed in some of the milk from farms might have been unintentional one, such as carelessness during cleaning of dairy utensils (Egan et al., 1981; Atherton and Newlander, 1987) or adulteration by unfaithful farm workers.

Conclusion

Milk sold at farm level in Morogoro Municipality had higher densities, butterfat, solids-not-fat, and total solids and was less adulterated than the vendor's milk. Milk vendors being middle agents between farms and milk consumers, adulterated milk by adding water to more than 19 %. It was concluded that water adulteration of milk in Morogoro municipality is rampant and it starts from the farm level. Therefore, there is a need for the Government to educate dairy farmers, milk vendors and the consumers on the importance of producing, selling and consuming respectively un-adulterated milk.

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