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Microbial quality and associated health risks of raw milk marketed in the Tanga region of Tanzania

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ABSTRACT

Objective: To evaluate microbial quality and associated health risks of raw milk marketed in the Tanga region of Tanzania. **Methods:** A microbial quality assessment of marketed raw milk was undertaken by evaluating 59 samples of milk from selling points (collecting centres =15), bicycle boys (12) and kiosks/restaurants (32) in Tanga city during April-May 2005. Quality and milk-borne hazards were assessed using a combination of tests in order to quantify the occurrence of *Brucellosis* (milk ring test), *Escherichia coli* (*E. coli*) O157:H7 (culture), the coliform bacteria as well as standard plate count (SPC). Specific gravity (SG) determination was used as an indicator of adulteration. **Results:** The mean coliform plate count (c.f.u/mL) of milk handled by bicycle boys (4.2×10^6) was significantly higher than that handled by collecting centres (3.0×10^6) and kiosk/ restaurants (1.4×10^6), respectively ($P < 0.05$). Of the 59 milk samples collected, 33 (56%) were *Brucella* milk ring test (MRT)-positive and 78% and 17% of the samples graded satisfactorily based on SG and coliform plate counts as prescribed by East African Community standards for raw milk. There was no verocytotoxigenic *E. coli* (VTEC) O157: H7 in any of the milk samples collected and analysed during the present study. **Conclusions:** It can be concluded that raw market milk in the study area is of poor bacteriological quality and hazardous for human consumption. This highlights the need to implement good hygiene practices and effective monitoring from production through the delivery chain to the consumer. Further studies are needed for detection of toxins that are produced by *E. coli*, other pathogenic spore forming bacteria (*Bacillus* spp. and *Clostridium* spp.) and other harmful microorganisms.

1. Introduction

In common with other countries in the East and Central Africa region, the informal dairy industry in Tanzania plays a dominant role in milk marketing, handling over 80%-90% of all milk sold[1]. The informal milk markets pathways persist because they provide social and economic benefits to smallholder producers, small market agents and consumers in terms of higher farm gate prices, creation of employment and competitive consumer prices[2-4].

Being a nutritious food, milk serves as an ideal medium for the growth of various microorganisms[5-7]. It is a highly perishable commodity and poor handling can exert both a public health and economic toll, thus requiring hygienic vigilance throughout the production to consumer chain[8,9]. Although freshly drawn milk from animals may possess temporary 'germicidal' or 'bacteriostatic' properties, growth of microorganisms is inevitable unless it is processed by freezing, heat treatment or irradiation[10,11]. Microorganism in raw milk can originate from different sources such as air, milking equipment, feed, soil, faeces and grass[12,13]. The microorganism load and types found in milk shortly after milking are influenced by factors such as animal and equipment cleanness, season, ambient temperature, storage, personnel health, cleanness and animal health[14,15]. On this basis the daily production and eventual marketing and sale of milk requires special consideration to ensure its delivery to the market in hygienic and acceptable condition.

In developing countries such as Tanzania, outlets for the purchase of milk are numerous but most operate under unsanitary conditions and are not adequately monitored or regulated[16,17]. Under such conditions the food-borne zoonotic risk posed by milk and dairy products is of great public concern[18]. However, the need for milk hygiene

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standards as a public health requirement for providing wholesome milk and milk products, consequently protecting the human population against milk borne zoonoses, cannot be overstated. However, there is limited information available on the microbial load contained in raw market milk in Tanzania[19,20]. This paper reports on an assessment of the microbial quality of raw market milk from milk marketing agents in Tanga city, Tanzania.

2. Materials and methods

2.1. Study area

This study was carried out between April and May, 2005 in Tanga city, northern coastal area of Tanzania. The area is located between 4° 21′ - 6° 24′ S, 36° 11′ -38° 26′ E, and characterized by hot and humid tropical climate with two rainy seasons: heavy rains during the months of March, April and May, and light rains occurring in November and December. The mean annual rainfall varies from 500 to 1400 mm/year. The relative humidity ranges from 60% to 90% for most of the year. Monthly mean ambient temperatures range from 15 ℃ between June and August to 35 ℃ between December and March.

2.2. Study design

Limited information concerning milk quality coupled with logistic problems affected the ability of this study in estimating the required sample size. Furthermore, given the fact that most raw milk marketing is undertaken in urban and peri-urban areas where market opportunities are high, the study sampling frame (n=107) was limited to milk market agents (MMAs) confined to a radius of 40 km around Tanga City. Sampling frame consisted of all milk collection centres(CC), both cooperative and private owned, and kiosks and restaurants (KR) selling milk in town. In addition to these, bicycle boys (BB), who act as traders or middlemen and are important for marketing milk from peri-urban and rural areas around Tanga, were also included. Overall, 59 milk market agents were randomly selected and sampled.

2.3. Data collection and milk sampling

Data on milk handling practices by MMAs were collected during the sampling. Important data collected included categorization of MMAs (cooperative/private centre, restaraunts/hotel, kiosk, bicycle boys), number of litres collected/handled per day, number of suppliers, source of milk (from traditional herds or smallholder crossbred cow), type of containers (plastic or metals) and whether there were any quality checks conducted (based on specific gravity, acidity test and visual cleanness), or pre-treatment of milk prior to selling (cooling, boiling, *etc*). Milk samples (30 mL in duplicate) were aseptically collected from each milk marketing agent by a sterile syringe into sterile bottles for laboratory analyses. The samples were kept in a cool box on melting ice and transported within 5 h of collection to the laboratory. The collected milk samples were tested for *Coliforms* and *Brucella* sp., as well as for adulteration.

2.4. Determination of coliform plate counts

Milk samples for evaluation of quality as defined by specific gravity (SG), exposure to *Brucella* pathogen (MRT) and coliform plate count (CPC) were examined at the Veterinary Laboratory, Tanga, using standard procedures[21]. Briefly, ten-fold serial dilutions of each sample from 10^{-3} to 10^{-6} were prepared in phosphate buffered saline solution (PBS), using disposable pipettes. The wide range in dilutions was selected due to the expected wide variation in bacterial counts. From each dilution, 1 mL was placed on a sterile Petri dish followed by the addition of 15-20 mL sterilized (autoclaved at 121 ℃ for 15 min) of Levine eosin methylene blue agar (Levine EMB) (Oxoid) and then cooled to 45 ℃ onto the dish. The sample and agar were then mixed and left to solidify after which the plates were incubated in inverted positions at 37 ℃ for 24-48 h. Plates showing green colonies with metallic sheen in the countable range of 15-250 colony forming unit per plate (c.f.u/plate) were chosen and counted.

2.5. Determination of specific gravity (density)

Adulteration with water was tested for by specific gravity (SG) using a lactometer at a standardized milk temperature. The lactometer was allowed to float freely in a cylinder, containing sufficient milk sample, until it reached equilibrium and readings taken below the meniscus. A SG below 1.026 kg/L[22] was considered suspicious of adulteration by adding water.

2.6. Brucella milk ring test (MRT)

The MRT was performed by adding 30 μL of stained *Brucella abortus* (*Br. abortus*) antigen (VLA, UK), both to a volume of 1 mL and 3 mL, of whole milk that has been stored at 4 ℃ for at least 24 h. The height of the milk column in the tubes was at least 25 mm. The tubes were thereafter incubated at 37 ℃ for 1 h. The test is read using a uniform light source. If the blue colour in the cream layer at the top of the fluid column is deeper than the remaining milk column (*i.e.* presence of a blue coloured ring) the test is considered positive. If the intensity of colour in the cream layer is equal to or less than that in the milk portion, the test is considered negative. The MRT, when compared to indirect enzyme linked immunosorbent assay (iELISA), has shown a sensitivity of 68% and a specificity of 98.9% on bulk milk and has been described by other researchers[23,24]. Confirmation of positive samples with tests of higher sensitivities and