Assessment of Public Health Hazards Associated with Informal Milk Marketing in Tanzania

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1 0 Introduction

It has been estimated that Tanzania produces about 880 million litres of milk annually of which 670 million litres comes from the traditional sector and bout 210 million litres from the improved dairy cattle (MOAC/SUA/ILRI, 1998) . It is estimated that 90% and 30% of milk from the traditional and improved dairy sector is consumed on farm or traded within the vicinity of production. Hence, annually, only about 214 million litres is sold in major and minor urban centres. Out of the this amount, the processing sector handles not more than 40 million litres annually although the processing capacity is about 500,000 litres per day or 182 million litres/annum (Kurwijila, 2001). The implication of this is that the processing industry is working at less than 25% of installed capacity while most of the milk is sold to consumers in the form of raw milk or informally processed, unpacked milk and milk products (Kurwijila, 1998).

Since the market liberalisation in early 1980s and collapse of government milk processing infrastructure, the extent of informal milk market has greatly increased. Given a milk market with a very high proportion of raw milk sales (more than 90%) and the lack of milk quality control measures, concern has been raised over the public health hazards that can be transmitted through milk, particularly zoonotic tuberculosis and brucellosis. Concerns over general milk quality including hygiene practices of informal market agents and drug residues have also been raised (MOAC/SUA/ILRI, 1998). Though many consumers boil milk before consuming, mainly to lengthening shelf life, but also perhaps to avoid milk-borne zoonoses, the extent of risks from consumption of raw milk and informally processed milk is unknown

SUA in collaboration with ILRI, since early 1999, has been carrying out research, which take a producer-to-consumer approach to study milk quality and milk-borne zoonoses. The central objective was to assess public health risks associated with different milk marketing channels and their origin and make recommendations to stakeholders so that they can develop appropriate advisory and/ or regulatory policies and practices which protect health of consumers without discouraging the current milk-market functions. This paper reports results of dry and wet season surveys which were carried out in Dar -es-salaam and Mwanza milk shed areas between October 1999 and May 2001.

2.0 METHODOLOGY

2.1 Field survey

Two surveys on market hygiene and handling practices of milk in the informal market were done using structured and coded questionnaire on milk market agents who had milk available for sampling. In Mwanza, an attempt was made to interview all milk vendors delivering milk through

five major routes, Kamanga ferry, Mwaloni, Pasians, Nyakato and Nyegezi routes. A sample of urban and peri-urban milk producers were interviewed. In Dar -es-salaam milk shed area, a sample of milk collection centre operators were also interviewed in the Coast region, Morogoro and Tanga as well as vendors supplying the milk collection centres. A few raw milk vendors (hawkers) operating in Dar-es-salaam were also interviewed. Milk was also sampled from retail outlets such as kiosks, shops, milk bars as well as street hawkers of Mtindi and boiled milk.

2.2 Laboratory milk analysis

Milk samples were collected in sterile 250ml sample bottles. The samples were then immediately kept in ice cold box and for laboratory analysis at the Department of Animal science (SUA) or Veterinary investigation Centre VIC Mwanza.

2.2.1 Milk density and temperature determination

Determination of specific gravity and milk temperature was done in the field using lactometer equipped with thermometer.

2.2.3 Determination of butter fat content

Butterfat content was determined using the standard Gerber method on frozen samples after thawing them.

2.2.4 Determination of drug residues

Determination of drug residues was done using the Charm-AIM-96 (Charm Science Inc, USA) test kit. The test detects a wide range of anti-microbial (aminoglycosides, β-lactams, sulphonamides, macrolides, tetracycline) at level above maximum residue limits (MRLs) recommended by the European Union (EU). Briefly, 50µl of each sample was added to the 96 well microtitre plate followed by 200µl of a mixture of *Bacillus stearothermophilus* spore tablet and lyophilised medium dissolved in 22mls of distilled water. The plate was then sealed and tightly secured by screws and incubated for 3-4 hours. Positive and negative controls were also included in the assay. The positive consisted of antibiotic free milk determined by using *Micrococcus lutea* inhibition assay mixed with penicillin G standard or sulfamethazine. To 50µl of the positive control milk, 200µl of bacterial spore and lyophilized media were added. The negative control consisted of 50µl of negative control tablet dissolved in distilled water and 200µl of the test bacteria and media dissolved in distilled water. Test results were read using colour contrasts and scored from 1-5 (negative=1-3 and positive =4-5). Information on milk procurement was captured using structured questionnaire.

2.2.5 Detection of Brucellosis-Using the milk ring test (MRT)

MRT was done on fresh milk samples. MRT was conducted by pipetting 1ml of milk into a 1.2-ml tube adding and mixing one drop of stained *B. abortus* antigen. The tubes were thereafter incubated at 37°C for 1hr and results read. Positive and negative control was recorded with each test (Sutra *et al.*, (1990).

2.2.6 Indirect milk ELISA

The methods described by Nielsen et al. (19960) was adopted. Briefly, polystyrene 96-well flat bottomed plates were coated with 100µl of 0.5 mg/well of B.abortus smooth lipopolysaccharide antigen in the coating buffer (0.06M carbonate buffer pH 9.60 and kept overnight in a humid box.

The plates were thereafter washed five times with phosphate buffer (0.01m phosphate buffer of pH 7.2 containing 0.005% Tween 20 and 0.15M Nacl), dried and blocked using 200µl/well of 0.1 gelatin and incubated at 25% for 30 minutes. Plates were washed again, dried and milk samples added at 100µl/well diluted1:2 in milk diluent (0.01M phosphate buffer, pH 6.3, containing 0.15M Nacl, 0.05% Tween 20, 15mM EDTA and 15nM EGTA). The plates were shaken from 2 minutes in orbital shaker and incubated for 30 minutes at 25oC. The plates were then washed and 100µl/well of monoclonal antibody conjugated (dilution1:600) to horse radish peroxidase added and incubated from 1hr at 25oC. The plates were washed again, dried and substrate (0.05 citrate buffer pH 4.5 containing 1mM hydrogen peroxide and 4nM ABTS) was added at 100µl/well. Plates were incubated for a maximum of 15 minutes and the absorbance read at 414 nm. Brucella positive and negative and positive milk control were included. Each milk sample were tested in duplicate. The modification of this procedure was that the cut-off point was determined by using twice the mean of negative control samples (Savingy and Voller, 1980).

2.2.7 Determination of total plate counts

Samples were assessed for total viable bacterial and coliform count using direct culture methods described by Speck (1984). Ten fold dilutions from 10-3 to 10-7 were prepared in peptone water. The ranges of dilutions were selected according to expected variation in bacterial counts.

2.2.8 Determination of Coliform counts

Total plate counts were assessed on 10-4 to 10-7 dilutions. For each dilution, 1ml was transferred using sterile pipette into disposable sterile petri dish. This was mixed with molten standard plate count agar, mixed and left to solidify. It was then incubated in inverted positions at 37oC for 48hrs. Counting of colonies was done using a colony counter. Only plates ranging from 25-300 colony forming unit (cfu) were selected.

Dilutions for coliform count were from 10-3 to 10-5. The culture for coliform was done using Violet Red Bile (VRB) Agar incubated at 37oC for 24 hrs using the same volume and procedures as above. Plates showing the typical coliform colonies in the countable range of 15-150 cfu per plate were chosen, counted and computed following guidelines by Speck, (1984)

2.2.9 Screening for *E.coli* 0157:H7

After counting the number of coliforms from a sample, the isolates were examined for the presence of *E.coli*. In order to increase chances for detection of *E.coli* and strain 0.157:H7 in particular, up to six colonies per plate were purified on MacKonkey agar (Oxoid) and differentiated from *E.coli* by plating on eosine methylene blue agar (Oxid®) and testing suspect colonies for indole, methyl red, vagues and citrate (IMViC) reactions. Identified isolates were further cultured by streaking onto selective indicator Biosynth culture medium (BCM^{TM} 0157:H7) (+) (Biosynth Biochemica, Biosynth International Inc., USA) and incubated at 35^{0}C for 24h from identification of blue black colonies of *E.coli* 0157:H7. The BCM^{TM} 0157:H7 (+) medium was prepared according to the instruction of the manufacturer. Briefly, 80g of the power was dissolved completely in 1liltre of distilled water containing 5ml N, N-dimethylformammide (sigma). After cooling to 50OC in a water bath, 5 ml of 0.2% (w/v) Sodium novobiocin (Sigma®) and 0.2 ml of 0.1% (w/v) potassium tellurite Sigma®), both filtered and sterilised, were added to the medium, mixed and then poured into petri dishes. It then allowed to solidify and dry at room temperature.

3.0 RESULTS AND DISCUSSION

3.1 Sampling data

Table 1 shows the number of and categories of milk traders sampled in both dar es salaam and Mwanza during the Dry and Wet seasons. A total of 1267 samples were collected from Co-operatives, milk producers, Wholesalers, milk vendors/Hawakers[1]. The samples consisted of 54, 15,18 and 14% raw, boiled, served chilled, boiled served hot/warm and fermented milk ("*Mtindi*") (Table 2).

Table 1 Market agents sampled in Mwanza and Dar-es-salaam milk shade areas in wet and dry season

Trade Type	Dar-es-salaam		Mwanza		Total
	Dry *(October 99– Jan 2000*	Wet *(May –June 2000)*	Dry *(October 2000)*	Wet *(April – May 2000)*	
Cooperatives	4	8	0	0	12
Producers	85	65	51	56	257
Wholesalers	22	15	0	0	37
Vendors/Hawkers	53	44	104	118	319
Retailers	233	390	8	11	642
	397	**522**	**163**	**185**	**1267**

Table 2 Samples collected by product type in each site and season

Product type	Dar es Salaam				Mwanza				Total
	Dry *(October 99– Jan 2000*		Wet *(May –June 2000)*		Dry *(October 99– Jan 2000*		Wet *(May –June 2000)t*		
	N	%	N	%	N	%	N	%	
Raw	170	42.93	192	35.82	155	93.94	167	93.3	684(54%)
Boiled cool/chilled	87	21.97	97	18.1	3	1.82	0	0	187 (15%)
boiled Hot/Warm	75	18.94	143	26.68	3	1.82	3	1.68	224(18%)
Mtindi	64	16.16	104	19.4	4	2.42	9	5.03	181(14%)
Total	**396**	**100**	**536**	**100**	**165**	**100**	**179**	**100**	

3.2 MILK PROCUREMENT-SOURCES

The milk marketing agents procured milk from different sources (Table 3). Majority of traders in Greater Dar-es-salaam (41%) procured milk from individual farmers keeping dairy cattle. While majority of the retailers procured from keepers. Large number of vendors/hawkers procured milk form individual farmers keeping zebu. 54% of all trades in Mwanza milk shed area procured milk from individual farmers keeping zebu. Only few traders (5%) in Mwanza had procured milk from individual farmers keeping dairy cattle.

[1] Milk vendors are defined as milk traders who collect milk from farmers and sell it to intermediaries such as milk collection centers, individual retailers or whole salers. Hawkers peddle milk in the streets or from house to house. Sometimes vendors may double as Hawkers as well.

Table 3:Distribution (%) of milk procurement sources in the informal milk market in Greater Dar-es-salaam and Mwanza.

	SOURCE TYPE						
	Zebu keepers	**Dary keepers**	**coop/self help**	**wholesalers**	**vendors/hawkers**	**own farm**	**Total N**
Dar es Salaam							
Coop/self help groups	1	1	3		6	0	12(1%)
Producers	27	48	0		2		
Wholesalers	7	8	0			0	
Vendors/hawkers	58	11	0	2		6	88(10%)
	53	283	7	118	65	61	587(69%)
	146(17%)	351(41%)	10(1%)	134(16%)	89(10%)	123(14%)	853(100%)
MWANZA							
Producers	48	11	0	0	10	32	101(31%)
Vendors/hawkers	123	2	0	0	80	5	210(64%)
Retailers	7	3	0		9	0	19(6%)
Overall (%)	178(54%)	16(5%)	0(0)	0(0%0	99(30%)	37(11%)	330(100%)

3.3 QUALITY CONTROL METHODS

Table 4 shows the quality control measures used by various market agents. About 71% and 44% of milk market agents in Dar-es-salaam and Mwanza milk shed areas respectively, did not use any form of quality control measures prior to milk procurement. Most of the milk agents in Mwanza (mostly vendors and retailers) used lactometer to control adulteration. Unlike in Mwanza, the use of lactometers in Dar-es-salaam milk shed area was only common among wholesalers and cooperatives at milk collection centres. Visual check was cited as the major control measure for checking milk quality among producers and vendors/hawkers and retailers in Dar-es-salaam. Generally poor and ineffective quality control measures possibly aggravate public health risks and wastage of milk due to spoilage. In Mwanza, inspectors from the City's health department made checks at designated check points, but these were rather ineffective as adulteration of milk could take place after the check points.

3.4 MILK CONTAINERS

Table 5 shows the types of containers used to store and transport milk into the market. About 66% of various milk traders in Dar-es-salaam used plastic containers to transport or store milk, only 6 % of them used aluminum containers. Unlike Dar-es-salaam, 53% milk traders in Mwanza used aluminum cans, only 25% used plastic containers. Among milk vendors/hawkers, 74% used aluminum containers in Mwanza milk shed area (Table 5).

Table 4: Proportions (%) of quality control measures used by various milk traders in Greater Dar-es-salaam and Mwanza milk shed areas

Dar-es-salaam	No of respondents using:						
Trade type	none	Lactometer	Smell	Visual check	Alcohol test	Boiling	Total respondents
Coop/selfhelp	0	6	0	1	5	0	6
Producers	66	1	1	21	1	5	95
Wholesalers	20	1	2	0	0	0	23
Vendors/hawkers	25	0	1	9	0	0	35
Retailers	255	11	15	71	1	13	366
OVERALL (%)	**372(70%)**	**19(4%)**	**19(4%)**	**102(19%)**	**7(1.4%)**	**18(3%)**	**525(100%)**
Mwanza							
Producers	56	26	0	23	3	11	63
Vendors/hawkers	109	88	1	43	0	16	148
Retailers	7	0	1	3	0	8	12
OVERALL (%)	**172 (44%)**	**114 (29%)**	**2 (1%)**	**69 (17%)**	**3 (1%)**	**35 (9%)**	**223(100%)**

Table 5:Types of milk containers used by various traders in Dar and Mwanza milk shed area (n,%)

Dar-es-salaam	No of respondents using						
TRADE TYPE	Plastic	Glass bottles	Aluminum cans	Cups/glasses	Polythene	Others(cool tanks, thermos)	Total respondents
Coop/self help group	1	0	0	0	1	10	12
Producers	117	0	17	2	2	6	114
Wholesalers	9	0	7	0	7	10	33
Vendors/hawkers	74	0	15	0	0	0	90
Retailerts	386	1	16	27	34	150	613
Overall	**587(66%)**	**1(0%)**	**55 (6%)**	**29(3%)**	**44(5%)**	**176(20%)**	**892(100%)**
MWANZA							
Producers	40	2	17	11	5	26	101
Vendors/Hwakers	37	4	151	4	1	6	203
Retailers	4	0	2	4	3	2	15
Total	**81(25%)**	**6 (2%)**	**170(53%)**	**19(6%)**	**9(3%)**	**34(11%)**	**319(100%)**

3.5 MILK HANDLERS TRAINING

About 95% of all milk traders interviewed in Dar-es salaam and Mwanza had no training on the milk hygiene and handling (Table 6). Very few (3%) Coop/producers/vendors/retailers had trained on milk handling .The large number (95%) of untrained milk handlers, could explain why over 70% and 44% of milk traders in Mwanza and Dar-es-salaam, respectively did not practice any form of quality control measure prior to milk purchase. These results clearly show that most dairy farmers have little formal education and limited knowledge of dairy husbandry hygiene and hence a need for short intensive practical training.

Table 6 : Proportion of milk agents who had received training on milk handling and hygiene

TRADE TYPE	No of respondents trained for:				
	No training	Up to 6 months	1-6 months	Over 6 months	Total
[illegible]	10	2	0	0	2
Producers	262	14	1	9	286
Wholesalers	34	0	0	4	38
Vendors/hawkers	339	16	1	5	361
Retailerts	667	8	0	7	682
Overall	**1312(95%)**	**40(3%)**	**2(0.1%)**	**25(2%)**	**1379(100%)**

3.6 METHODS OF CLEANING CONTAINERS

Equipment used in milk handling should be adequately cleaned and sanitized to remove solids that precipitate in the container surface and provide suitable condition for the bacteria growth. There should be a detailed account of how the equipment is cleaned and sanitized. Detergents when used in the cleaning help to soften or condition the water, improve the wetting ability in cleaning solution, emulsify or saponify fats solubilize fats, dispense suspended materials and dissolve materials. Different traders pointed out different cleaning methods they are using for regular cleaning of containers used for milk marketing in Greater Dar-Es-salaam and Mwanza milk shed areas as indicated in the Table 7. The majority used soap and either cold (44%) or warm water (47%).

Table 7: Frequency distribution (%) of cleaning methods for milk vessels among different milk market agents in various locations in Mwanza and Dar-es-salaam milk shed areas

TRADE TYPE	No of respondents cleaning by:				
	Soap & cold water	Hot water & soap	Water & Detergent*	Hot water only	Total for trade type
Coop/self help group	12	0	0	0	12
Producers	116	155	2	15	288
Wholesalers	22	16	0	0	38
Vendors/hawkers	110	213	2	36	361
Retailerts	347	267	2	66	682
Overall	**607(44%)**	**651(47%)**	**6(0.2)**	**117(8%)**	**1381(100)**

* special formulated (dairy) detergent

3.7 PRESEVATION METHODS

Perishability of milk requires that some measures are taken to prevent it from souring. Overall results indicate that, 77% of milk traders in Great Dar-es-salaam and Mwanza did not use any form of milk preservation methods during marketing (i.e. between procurement and resale) (Table 8). About 17% of the traders who preserved milk used refrigeration. A general lack of preservation measures taken during storage and transport of milk may have contributed greatly to the increase in the milk bacterial load observed in the present study.

Table 8: Preservation methods used for different milk products in Dar-es-salaam milk shed area.

TRADE TYPE	No of respondents preserving milk by:				
	None	Boil	Refrigeration	Other (cool box)	Total
Coop/self help group	0	0	12	0	12
Producers	161	13	42	1	217
Wholesalers	1	0	31	0	32
Vendors/hawkers	166	11	28	2	207
Retailers	498	32	72	7	609
Overall	**826(77%)**	**56(5%)**	**185(17%)**	**10(1%)**	**1077(100 %)**

3.8 HYGIENE STANDARD

The hygiene standard assessment was carried out on traders (personal), premises and equipment used for milk marketing (Table 11). A checklist was used to categorize hygienic status into very good, good, fair and poor hygienic standards. About 29% and 80% of milk traders had good to very good personal hygiene in Mwanza and Dar-es-salaam respectively. About 70% and 20% of milk traders in the respective areas had fair to poor personal hygiene. About 87% of milk premises in Mwanza milk shed area were of poor hygienic standard. About 60% and 90% of milk handling equipment in Mwanza and Dar respectively were of good hygienic standard. Thus the level of hygiene was generally better in Dar-es-salaam than in Mwanza.

3.9 ADULTERATION OF MILK

Overall results show great variation in adulteration between Dar-es-salaam and Mwanza, whereas only 18% of milk on sale was adulterated with water in Greater Dar-Es salaam (i.e. spg < 1.026) , milk adulteration in Mwanza milk shed areas was 54.6%. The highest adulteration was observed in Mwanza during dry season where over 60% of milk samples sampled were adulterated with water (Table 12). The milk adulteration as determined by solids-not-fat (SNF) was 38% and 39% and 73% and 61% in Dar-es-salaam and Mwanza for dry season and wet season respectively.

Suprisingly, the generally high rate of use of lactometers by both milk traders and consumers in Mwanza did not reduce cases of milk adulteration with water among milk traders. The observed high proportion of adulterated milk in Mwanza as compared to Dar-es-salaam may indicate a widespread tendency among vendors to add water to traded milk in order to increase the retail marginal profit in Mwanza milk shed area. Both PRA and main survey showed that vendors are not discouraged to add water in the traded milk, as some consumers are willing to accept milk adulterated with water at lower price. This results also gives an obvious indication that the quality control measure put in place by Mwanza city healthy authority is inadequate in controlling the milk adulteration. The proportion of milk samples suspected adulterated on the basis of SNF less than 8.5% is much higher than indicated by lactometer reading. While this shows the proportion of milk with SNF level below the prescribed standard, it may not be accurately reflect the level of adulteration unless SNF of the genuine samples from the area are known. In spite of this, the large proportion of milk having SNF less than 8.5 against an expected average of 9% SNF is indicative

problem of diluted undertaken. The problem was absent at cooling centres where regular quality control is

Table 11: Proportional distribution of personal, equipment and premise hygiene among milk traders in Mwanza and Dar-es-salaam round one of survey*.

MWANZA					
Personal hygiene					
Trade type	**N**	**Very good (n)**	**Good (n)**	**Fair (n)**	**Bad (n)**
Producer	56	0	9	43	4
Vendor	155	1	43	108	3
Retailer	14	1	12	1	0
TOTAL	**225**	**2(1%)**	**64(28%)**	**152(68%)**	**7(3%)**
Equipment hygiene					
Producer	56	7	13	31	5
Vendor	156	5	84	67	0
Retailer	14	1	13	0	0
Total	**226**	**13(6%)**	**110 (49%)**	**98(43%)**	**5(2%)**
Premises hygiene					
Producer	52	0	3	11	38
Vendor	17	0	1	0	16
Retailer	14	1	6	4	3
Total	**83**	**1 (1%)**	**10(12%)**	**15(18%)**	**57(69%)**
DAR-ES- SALAAM					
Person hygiene					
		very good	good	fair	bad
Coop/collection centres			6	1	0
Producer			41	26	5
Wholesalers			16	2	
Vendor			25	27	0
Retailers			239	29	0
Total	**436**	**19(4%)**	327(75%)	85(19%)	**5(1%)**
Premises					
Coop/collection centres	7	0	6	1	0
Producer	52	0	44	6	2
Wholesalers	19	0	19	0	0
Vendor	21	0	18	3	0
Retailers	284	12	201	70	1
Total	**383**	**12 (3%)**	**288(75%)**	**80(21%)**	**3(3%)**
Equipment hygiene					
Coop/collection centres	8	0	8	0	0
			50	14	0
Wholesalers			15	1	
Vendor	52		31	14	0
Retailers	284	21	245	18	0
Total	**436**	**40(9%)**	**349 (75%)**	**47(11%)**	**0**

*Data set for second round not included

Table12: Proportional distribution of adulterated (spg<1.026 g/cc) milk samples by trade type from Dar-es-Salaam and Mwanza milk shade areas

Dar-es-salaam	Dry season		Wet season		Overall
trade type	n (spg<1.026)	(%)	n (spg<1.026	%	n
coop/selfhelp group		0	1	13	1 (1%)
Producer	13	19	8	17	21 (18%)
wholesalers	0	0	4	31	4 (15%)
vendors/hawkers	10	20	13	33	23 (26%)
Retailers	14	16	25	15	39 (15%)
Total	**37**	**16**	**38**	**19**	**88 (18%)**
Mwanza					
Producer	5	11	8	18	13 (9%)
vendors/hawkers	80	84	59	60	139 (91%)
Total	**85**	**61**	**67**	**47**	**152(54%)**

Table 13. Proportional of potentially adulterated milk (as determined by SNF<8.5) from different milk traders in Dar and Mwanza milk shed areas

Dar-es-salaam	Dry season		Wet season		Overall
Trade type	n (<8.5)	%	n (<8.5)	%	n
coop/selfhelp group	0	0	1	13	1
Producer	36	53	25	54	61
wholesalers	3	21	3	25	6
vendors/hawkers	22	47	20	61	
Retailers	23	25	48	32	71
Total	**84**	**38**	**97**	**39**	**181 (39%)**
Mwanza					
Producer	12	27	12	27	24
vendors/hawkers	86	96	71	77	157
Total	**98**	**73**	**83**	**61**	**181(67%)**

3.10 BUTTERFAT CONTENT

Overall results indicate that Dar-Es salaam had substantially (39.2%) more milk with below KBS minimum standard (BF<3.5%) as compared to Mwanza (32%).(Table 13). Among traders the highest proportion of samples with low BF% was high among retailers (Table 13). With regards to source of milk procurement, high proportion of milk with low BF% was procured from wholesalers, vendors and individual farmers keeping dairy cattle in Great Dar-es-salaam. Relatively low proportion of samples with low BF% was recorded from milk samples collected Mwanza. Low BF contents observed in Dar-es-salaam particularly among milk samples collected from producers could be due to the fact that large proportion of Dar producers keep dairy cattle which are well

known to produce milk with low butterfat content. However the high proportion of milk samples with low butterfat content among retailers and wholesalers could be intentional through removal of cream to make more profit by selling the cream separately from skimmed milk. The fact that large proportion of milk samples from Mwanza milk shed area were collected from the Zebu cattle whose milk has high milk butter fat content could explain the difference in overall proportions of milk with BF% below acceptable standard between Mwanza and Dar-es-salaam.

Table 13. Proportion of milk from different milk traders in Dar and Mwanza milk shed areas with BF below 3.25%

Dar-es-salaam	**Dry season**		**Wet season**		**Overall**
trade type	**n (<3.25%)**	**%**	**n (<3.25%)**	**%**	**n**
Coop/selfhelp group	2	50	0	0	2 (18%)
Producer	22	27	20	31	42 (31%)
wholesalers	7	35	6	40	13 (33%)
vendors/hawkers	6	12	12	31	18(22%)
Retailers	97	47	167	45	264 (47%)
Total	**134**	**37**	**205**	**41**	**339 (40%)**
Mwanza					
Producer	16	33	16	29	32 (31%)
vendors/hawkers	44	46	22	20	66 (32%)
	5	63	3	30	8(44%)
Total	**65**	**42**	**41**	**23**	**23(31%)**

Table 14 shows a summary of three parameters used in estimating the extent of adulteration of milk. SNF gives consistently higher estimates than specific gravity. Results of %BF are variable in relation to the other two parameters. This is not surprising as %BF per se was quite variable and is influenced by many variables including the differences in breeds. Much more water would have to be added to zebu milk before the butterfat level falls below 3.25% than with milk from dairy cattle.

3.11 MILK BACTERIOLOGICAL QUALITY

Milk is highly perishable food and a good medium for microbial growth as it provides a suitable environment for micro organisms to multiply when stored above 10^{0}C and allowed to stay over 3-4 hours before processing. An increase in temperature and with holding time increases the bacterial load. Other risk factors such as poor hygiene result from contaminated milking hands/machine, milk containers and milk handlers. Common sources of bacterial contamination are cow's faeces, personnel water and containers. A high bacterial count reduces the shelf life of milk and enhances the risk of milk-borne infections and intoxication if not pasteurized or boiled

Table 14: Proportion of milk samples with butterfat content (BF%,3.25), Specific gravity (SPG<1.026kg/lt), low solid-not-fat (SNF<8.5) and overall mean indices

	BF <3.25%		S.P.G <1.026kg/lt			
Source of sample	**n**	**%**	**N**	**%**		**%**
Site						
Dar-es-salaam	346	39.68	86	17.23	189	39.79
Mwanza	107	32.04	154	56.66	185	67.52
Dry season	204	38.71	142	38.27	197	55.34
Wet season	249	36.67	98	23.61	216	45.04
Marker agent						
Cooperatives	2	18	1	8	1	9
Producers	74	30	33	16	84	42
wholesalers	13	37	3	12	6	23
Vendors/Hawkers	84	28	160	57	199	76
	272	46	33	13	72	31
Overall mean indices						
N	544		494		465	
Mean	3.66		1.027		8.15	
Std.Dev	1.01		0.005		1.347	
Range	0.5-7		1.01- 1.041		4.11-11.74	
KBS standards	3.25		1.026		8.5	

3.12 TOTAL BACTERIAL COUNTS

Out of 674 raw milk samples analyzed for total bacterial count from Dar and Mwanza only 37% met acceptable TBS (i.e.<2,000,000 cfu/ml). Among traders wholesalers and producers had relatively high proportion of milk with acceptable standards. Only 17% of milk samples collected from the Cooperative were of acceptable standard. On the other hand total bacterial counts for various milk products sold ready for consumption show only 32% and 16% for boiled hot/warm and boiled cool meet acceptable standard (<40,000 cfu/ml) (Table 15). Table 16 shows the geometric mean for total bacterial counts among various milk traders. The mean TPC are lowest for producers followed by wholesalers, vendors/hawkers, retailers and Coop. The milk quality deterioration follows the market chain interms of time and number of intermediaries involved. Fig 1 shows however that the bacteriological quality is also quite high at time of initial procurement reflecting high initial contamination, lack of cooling facilities and other factors operating at farm level.

Of all raw milk samples analyzed for total coliform count from Dar and Mwanza only 44% met acceptable TBS standard (i.e.<50,000 cfu/ml). Among traders producers and producers had relatively high proportion of milk with acceptable standards (Table 16). Only 33% of milk samples collected from the Cooperative were of acceptable standard. On the other hand total bacterial counts for various milk products sold ready for consumption showed that relatively large proportion (64%) of boiled hot/warm milk met TBS acceptable standard (<1 cfu/ml). Only 30% and 25% of boiled cool milk and Mtindi respectively met acceptable standard (<1 cfu/ml). Geometric mean for total bacterial counts for various milk traders (Table 16) indicate that the mean coliform count for raw

milk were much higher in Cooperatives, retailers and Vendors in that order. However, mean for coliform count for wholesalers and producers were much lower (Table 16). Fig 2 shows that the coliform count is quite high reflecting high at time of sampling initial contamination, poor hygiene during milking and other factors operating at farm level. Table 17 gives an overview of bacteriological quality of milk across sites, seasons, different products and market agents.

Table 15 Proportion of different milk products with acceptable bacterial quality (TPC)

Trade type	Not -ready -to -consume products[a]					
	Raw Milk		Boiled served hot/warm		Boiled served cold/chilled	
	n (acceptable)	%	n(acceptable)	%(acceptable)	n (acceptable)	% (acceptable)
Coop/selfhelp group	2	17				
Producer	93	44	9	39	2	17
Wholesalers	14	54	0	0	1	50
Vendors/hawkers	92	32	1	17	0	0
Retailers	46	34	60	32	27	16
Total	247	**37**	70	**32**	30	**16**

Table 16: Proportion of dairy products meeting the standard from coliform counts

Trade type	Not -ready -to -consume products[a]		Ready -to- consume- heat -treated products[b]					
	Raw Milk		Boiled hot/warm		Boiled cold/chilled		Mtindi	
	n (accetable)	%(acceptable)	n (acceptable)	%(acceptable)	n (acceptable)	%(acceptable)	n (acceptable)	%(acceptable)
Coop/selfhelp group	4	33	0	0	0	0	0	0
Producer	128	61	18	82	4	33	3	33
Wholesalers	11	42	1	50	1	50	1	20
Vendors/hawkers	102	35	3	50	0	0	1	14
Retailers	54	40	116	62	50	30	40	26
Total	299	**44**	138	**64**	55	**30**	45	**25**

[a] =<(50,000 cfu/ml)
[b] =<1 cfu/ml)

Table 17: Proportion of milk samples with acceptable high coliform plate counts (CPC) and total coliform plate counts (CPC)

Source of raw milk sample	CPC<50.00 cfu/ml		TPC<2,000, cfu/ml	
Site	**n**	**%**	**n**	**%**
Dar-es-salaam	193	53.2	127	35.08
Mwanza	106	32.92	120	37.27
Season				
Dry season	149	45.29	102	31
	150	42.25	145	40.85
Trade type				
Cooperatives	4	33	2	17
Producers	128	61	92	44
Wholesalers	11	42	14	54
Vendors/Hawkers	102	35	92	32
Retailers	54	40	46	34
	CPC < 1cfu/ml		**TPC<40,000/ml**	
Other products				
Boiled hot/Warm	138	64	70	32
Boiled cold/chilled	55	30	30	16
Mtindi	45	25	NA	NA

Table 18 shows the geometric means of the bacteriological quality of milk across sites and seasons as well as various trade types and dairy products. Although the TPC is lower in Mwanza than in Dar es Salaam, the coliform counts are much higher reflecting a lower level of hygiene which may be associated with the high level of adulteration and the generally lower level of hygiene reported earlier (see section 3.7)

Table 18: Geometric means of bacterial counts in Raw milk

Source of sample	N	Mean CPCX10^5	Mean TPCX10^6
Season			
Dry season	341	1.81	3.46
wet season	363	2.17	2.38
Site			
Dar-es-salaam	381	1.11	3.28
Mwanza	323	4.07	2.42
Trade type			
Cooperatives	12	5.98	4.27
Producers	208	0.85	1.7
Wholesalers	28	1.92	1.84
Vendors/hawkers	297	3.18	3.44
Retailers	150	1.61	3.91
Other product			
Boiled warm/hot	171	0.012	0.38
Boiled cool/chilled		0.60	1.02
Mtindi		1.6	22

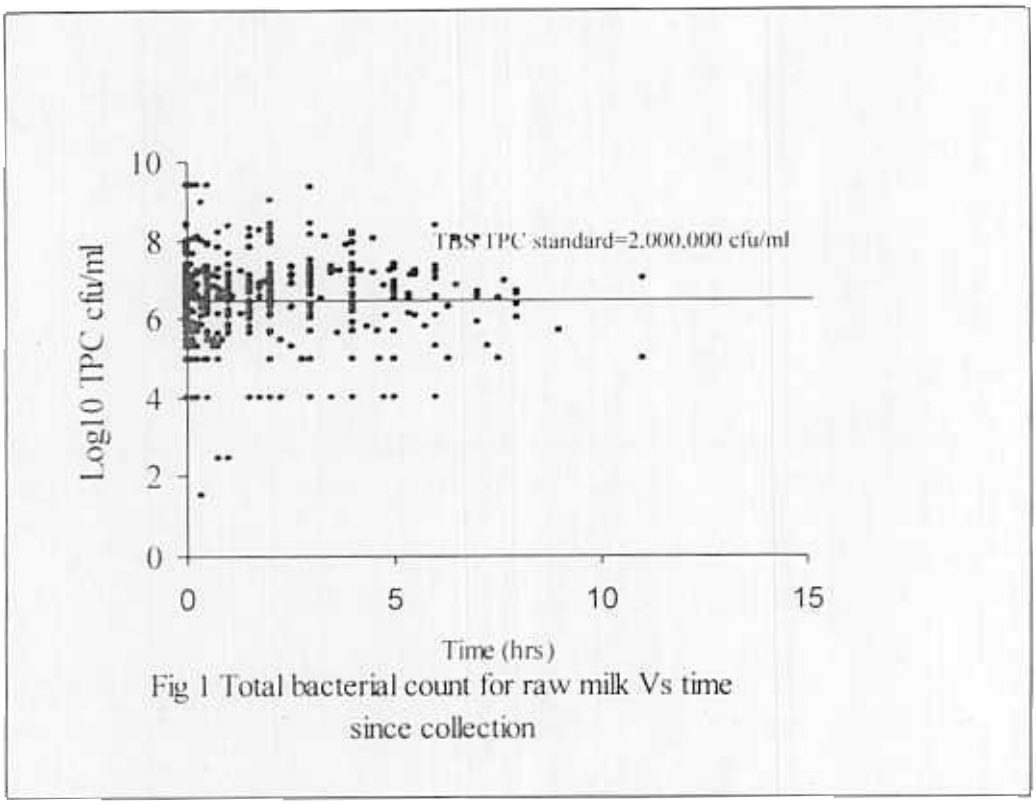

Fig 1 Total bacterial count for raw milk Vs time since collection

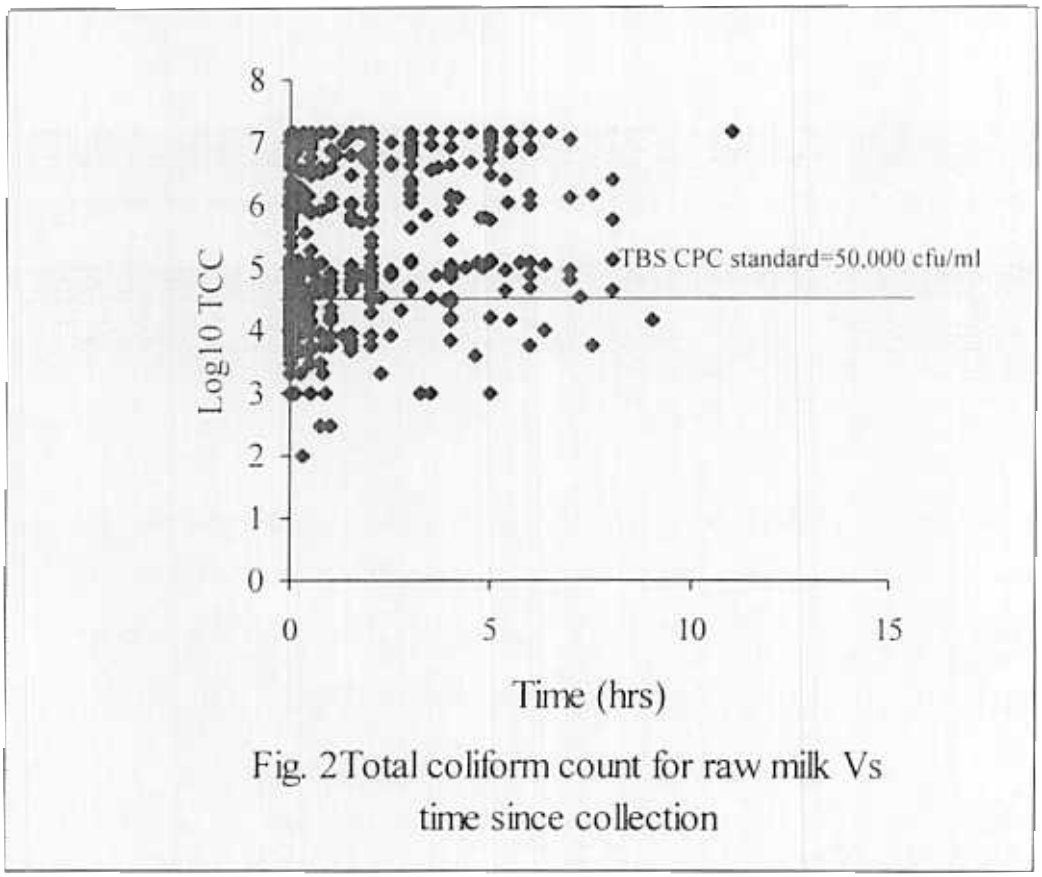

Fig. 2Total coliform count for raw milk Vs time since collection

In order to explain the factors involved, regression analysis was done for $\log_{10}$ total bacterial count. The association between high bacterial count and dry season and milk procured from individual farmers keeping zebu cattle were highly significant ($p<0.0001$). Amount of milk (lt) sold per day and SNF were significantly and positively association with total bacterial counts ($p<0.07$) (Table 19). Time since collection to resale showed no significant association with total bacterial count.

In a regression analysis for $\log_{10}$ total coliform count (Table 19), presence of coliforms in the milk was highly significantly associated with milk procured from vendors and time from collection to resale ($p<0.0000$). Bulking of milk had significant positive association with coliform counts ($p<0.05$). Use of plastic containers was also positively associated with total coliform counts ($p<0.01$)

The generally high bacterial counts resulted into poor quality milk in the market, which may be going to waste or posing health risks to the consumers. The finding that most of raw milk samples had high total bacterial and coliform count at time of sampling may reflect poor production and handling hygiene during milking, transport and storage. Initial bacterial load at the production stage may be high, unsanitary handling during transport may add to contamination. Long withholding time by vendors and even households at farm level and from buying to resale points coupled by hot weather encourage rapid microbial growth.

Bulking and amount of milk sold per day were observed to be highly associated with both higher total bacterial and coliform count. Milk from different farmers have different bacteria load which may be introduced through diseases such as mastitis or contamination due to poor hygiene, so mixing them encourages more bacterial contamination.

Generally high mean and proportions of total bacterial count observed among Cooperatives/ cooling centres and vendors may be a result of poor hygiene, long with holding period and bulking. In most of the cooling centres we visited milk handled by vendors without adequate control of hygiene.

Due to scarcity of milk during dry season milk vendors travel long distance (therefore more time) to collect milk. In Mwanza vendors use more than 4 hours to collect milk during the dry season. Long withholding time and increased number of bulking/pooling of milk from various farmers due to milk scarcity can possibly explain the association of total bacteria count and dry season. Mixing of evening and morning milk can add to contamination of milk therefore high bacterial count during dry season. The significant positive association between SNF and Total bacterial count indicates that addition of contaminated water has greatly contributed to higher bacterial count observed in the present study.

The significant association between plastic containers and total coliform count could be attributed to difficulties in cleaning the plastic containers as they have had many curves and grooves that could still hold some milk particles even after cleaning with hot water and soap.

Table. 19: Regression Analysis results of log10 total bacterial and coliform count for raw milk collected in Greater Dar-es-salaam and Mwanza in both season

Parameter	TPC			CPC		
	R^2=0.59; F (61, 195)			R^2=0.57; F (58, 252)		
	Est (t value)	S.E	p-value	Est (t-value)	S.E	p-value
Study area						
Dar-es-salaam	-1.8	0.24	>0.07	-2.05	0.50	0.01
Quality measures						
Log TPC	NA	NA	NA	10.23	**0.0000**	
Log CPC	8.4	0.44	**<0.0001**	NA	NA	NA
SNF	1.8	0.07	**0.07**	0.05	-2.9	0.003
Market pathways						
Coop-vendors	-1.7	1.56	0.08			
Producer -Zebu cattle	3.2	0.45	**0.001**	-2.05	0.50	0.04
Producer -Dairy cattle	-0.14	0.93	0.88	-1.09	0.78	0.27
Producers-vendors	0.002	1.3	0.9	-3.63	1.12	0.000
Retailers-vendors	0.16	1.1	0.8	-3.86	1.09	0.000
Type of containers						
plastic	-0.97	0.18	0.33	2.56	0.17	**0.01**
polythene	0.09	0.35	0.92	-0.07	0.35	0.9
others	0.1	0.28	0.9			
Sorce type						
Individual farmers (zebu)	-2.76	1.024	0.006	0.36	0.55	0.7
wholesalers	-2.08	0.95	0.038	1.64	1.49	0.1
vendors	-1.59	1.29	0.13	3.7	1.12	**0.000**
Own farm	-2.1	0.91	0.04	-0.24	0.69	0.81
Trade type						
Cooperatives	1.45	1.04	0.1	-2.06	0.84	0.04
producers	-1.30	0.45	0.1	-0.15	0.37	0.87
wholesalers	-0.75	0.83	0.45	-1.42	1.38	0.15
Vendors/hawkers	1.30	0.56	0.23	-1.6	0.51	0.1
Sorce of water						
Piped water	-0.85	0.58	0.39	1.25	0.67	0.2
river	0.04	0.62	0.96	0.81		0.42
Milk bulking	0.31	0.24	0.76	2.07	0.22	**0.05**
Amount sold per day	1.84	0.0006	**0.06**	-1.43	0.00059	0.15
Sale price	0.45	0.0004	0.65	-1.76	0.00050	0.07
Hours since collection	-0.68	0.02	0.49	3.59	0.02	**0.0000**
Maximam number of sources	-1.08	0.01	0.07	0.11	-1.44	0.15
Quality test done	-0.56	0.14	0.59	-1.6	0.51	0.1
Milk preservation	0.31	0.24	0.76	0.53	0.99	0.59

The association of total coliform count and hours since collection indicate that most of traders stay with milk for many hours before resale. This coupled by poor handling hygiene observed among the milk traders particularly vendors/ hawkers leads to high bacterial contamination. Unless the milk is chilled immediately after milking it will quickly get spoiled my microorganisms.

Among traders Vendors/hawkers were high associated with coliform counts, this is due to effect of bulking, poor hygiene and adulteration with unsafe water which is very common among vendors especially in Mwanza.

The consumption of raw milk may be associated with high risk of zoonotic diseases such as Brucellosis and Tuberculosis. The fact that large proportion of boiled milk served hot/warm milk met acceptable standard signifies the importance of boiling milk before consumption to reduce the risk of zoonotic disease and shows that a significant proportion of ready to consume milk in the informal market is handled in way which reduces public health risks. On the other hand the low proportion of Boiled cool milk and "Mtindi" with acceptable standard indicate a problem of post boiling/pasteurization contamination. This emphasizes the importance of drinking milk while hot. Milk intended for production of Mtindi should be boiled prior to fermentation to kill pathogens. In many circumstances unsold raw milk is converted by milk shop owners to "Mtindi" which is not heat-treated and still constitute a risk for human health. If the milk is consumed unpasteurized, the chance is that human can acquire infection if the disease exists in the domestic animals or introduced by human in the milk.

Cooling centres allow collection of milk in remote areas and deliver it to urban centres. Milk must be chilled within three hours of milking. This requirement is difficult to meet at collection centres as vendors use an average of 3 hours from collection to resale, (leave alone time used by farmers). To reach this goal it is necessary to deliver milk at reasonable time and ensuring that milk-handling hygiene is adhered to. Much work remains to be done to improve hygienic practices from production to consumption level. All these will contribute to ensuring safe supply to milk of appropriate quality.

3.13 DRUG RESIDUES

About 35% and 40 % of the milk collected from Dar es Salaam and Mwanza, respectively, were positive on Charm AIM test. Out of the 251and 445 milk samples screened for drug residues in Dar-es-salaam in the dry and wet season, 35% and 34% respectively were positive for drug residues. Seasonal variation of samples testing positive from drug residues was observed among traders in Dar-es-salaam milk shed area. High proportions of samples tested positive were detected in the Cooperatives, Wholesalers and vendors/hawkers in dry season. In Wet season no sample from the cooperative was drug residue positive and relatively low proportion (17%) of samples collected from the wholesalers were positive. In Mwanza there was no great variation of milk samples testing positive in the two seasons. However relatively large proportion of milk samples collected from producers tested positive for drug residues.

By and large, across both seasons and sites, large proportion of samples testing positive for drug residues were observed in milk samples procured from individual farmers keeping zebu and milk traders' own farms (Table 20).

The finding that higher proportion of cooperatives, wholesalers and vendors milk samples had anti-microbial residues would indicate that the residues resulted from the bulking/pooling effect. Most of milk traded by vendors and collection centres is procured from the pastrolists who in most cases

don't adhere to the withdrawal period of drugs used to treat animals. Therefore mixing milk samples from different farmers increase a chance of milk contamination with drug residues)

The observed slightly lower level of antimicrobial residues in milk samples from individual farmers keeping dairy cattle as compared to milk samples from farmers keeping zebu cattle may imply that small holder dairy farmers keeping dairy cattle are more aware on the veterinary requirements of milk withdrawal after animal treatment. This awareness might be mainly due to access to the information dairy farmers get from veterinarians and dairy cooperatives which generally do not reach traditional cattle keepers). Table 21 shows the results across sites, season as well agents and different milk products.

Table 20: Proportions of milk samples from different milk traders procured from various sources testing positive for antimicrobials on charm AIM test in both Dar-es-salaam and Mwanza.

Dar-es-salaam	**Dry season**			**Wet season**			**Overall**
Trade Type	**N**	**n (charm test +Ve)**	**% positive**	**N**	**n (Charm test +Ve)**	**% positive**	**n**
Coop/Selfhelp Group	5	3	60	7	0	0	3
Producer	64	20	31	54	12		32
Wholesalers	10	4	40	12	2	17	6
Vendors/Hawkers	35	14	40	31	14	45	28
Retailers	237	47	34	341	123	36	170
Total	**251**	**88**	**35**	**445**	**151**	**34**	**239 (34%)**
Mwanza							
Producer	45	23	51	46	20	43	
Vendors/Hawkers	88	32	36	96	35	36	67
Retailers	7	3	57	8	2	25	5
Total	**140**	**59**	**42**	**150**	**57**	**38**	
Dar-Es-Salaam							
Source Type							
Zebu	51	20	39	51	20	39	40
	85	24	28	166	65	39	89
Coops	1	0	100	6	1	17	
Wholesalers	30	10	33	76	21	28	31
Vendors	19	7	37	56	16	29	23
Own	45	17	38	47	15	32	32
Total	**231**	**79**	**34**	**402**	**138**	**33**	**216(34%)**
Mwanza							
Individual (Zebu)	69	27	39	83	33	40	
Individual (Dairy)	5	2	60	6	2	33	
Vendors/Hawkers	45	17	38	39	12	31	29
Own Farm	23	14	61		5	45	19
Total	**142**	**61**	**43**	**139**	**54**	**38**	**112(40%)**

Table 21: Proportion (%) of milk samples testing positive for drug residues

Source of sample	N	%
Site		
Dar-es-salaam	243	34.52
Mwanza	118	40.14
Season		
Dry season	151	36.65
Wet season	210	35.84
Market agent		
Cooperatives	3	30
Producers	75	36
Wholesalers	6	27
Vendors/Hawkers	94	38
Retailers	175	36
Source type		
Zebu farmers	100	39
Dairy farmers	94	36
Cooperatives	4	40
wholesalers	31	29
vendors	52	33
Own farm	51	40

The high antibacterial residue in milk on sale in Tanzania is an indication of poor veterinary delivery system which does not ensure adequate information over the farmers over the on-farm use of veterinary drugs especially withdrawal time following drug therapy. The advisory role of veterinary extension system has not kept pace with the liberalisation of economy, could be the reason accounting for the observed antimicrobial residues in milk on sale in Tanzania. Although in a liberalized economy, matters of trade are left to the market forces of supply and demand, more strict rules and controls of drugs should keep in-check these new developments.

3.14 BRUCELLOSSIS-MRT RESULTS

Overall prevalence of Brucellosis as detected by MRT were 16.3% and 36.2% in Mwanza and Dar-es-salaam respectively. Generally, informally traded milk from producers and vendors in Greater Dar-es-salaam and Mwanza had the highest proportion of MRT positive samples. Indirect ELISA classified 19.7% and 22.5% from Dar-es-salaam and Mwanza respectively, as positive. Informally bulked milk from Cooperatives, wholesalers and vendors had the highest proportion of ELISA positive samples in Dar-es-salaam during dry season. Generally low proportion of samples testing positive for ELISA was detected from milk samples collected from producers and retailers. With regards to source of milk procurement, both ELISA and MRT detected relatively large proportion of samples procured from individual farmers keeping zebu, Cooperatives and vendors/hawkers as positive.(Table 22 & 23)

Table 22. Proportions of milk samples from different milk traders procured from various sources testing positive for MRT in both Dar-es-salaam and Mwanza.

DAR-ES-SALAAM	Dry season			Wet season		
trade type	**N**	**n**	**%**	**N**	**n**	**%**
coop/selfhelp group	3	1	33	6	1	17
Producer	85	44	52	38	11	29
Wholesalers	18	7	39	10	6	60
vendors/hawkers	59	35	59	21	9	43
Retailers	208	55	26	189	70	37
Total	**373**	**142**	**38**	**264**	**97**	**37**
MWANZA						
Producer	41	7	17	61	11	18
vendors/hawkers	64	11	17	105	14	13
Retailers	3	0	0	12	1	8
Total	**108**	**18**	**17**	**178**	**26**	**15**
DAR-ES-SALAAM						
SOURCE TYPE						
Individual Farmers (Zebu)	90	36	40	22	9	41
Individual Farmers (Dairy)	145	51	35	105	38	39
Coop/Self Help Group	2	1	50	3	2	67
Wholesalers	30	5	17	46	17	37
Vendors/Hawkers	22	9	41	31	8	26
Own Farm	69	31	45	23	5	22
Total	**358**	**133**	**37**	**230**	**86**	**35**
MWANZA						
Individual Farmers (Zebu)	49	12	24	110	17	15
Individual Farmers (Dairy)	6	0	0	9	9	14
Vendors/Hawkers	25	2	8	48	43	10
Own Farm	29	4	14	2	2	0
Total	**109**	**18**	**17**	**169**	**143**	**15**

Table 23. Proportions of milk samples from different milk traders procured from various sources testing positive for ELISA in both Dar-es-salaam and Mwanza.

Dar-es-salaam	Dry season		Wet season	
TRADE TYPE				
	n (ELISA +ve)	**% ELISA +ve**	**n (ELISA +ve)**	**% ELISA +ve**
coop/selfhelp group	2	50	2	40
Producer	12	18	7	25
Wholesalers	7	70	1	20
vendors/hawkers	24	45	2	14
Retailers	44	15	37	18
Total	**89**	**21**	**47**	**19**
MWANZA				
Producer	2	7	12	26
vendors/hawkers	11	14	29	32
Retailers	2	29	5	42
Total	**15**	**13**	**46**	**31**
DAR-ES-SALAAM				
SOURCE TYPE				
Individual Farmers (Zebu)	33	41	3	21
Individual Farmers (Dairy)	23	12	20	19
Coop/Self Help Group	2	50		
Wholesalers	6	14	6	12
Vendors/Hawkers	11	46	10	32
Own Farm	6	9	0	0
Total	**81**	**20**	**39**	**19**
MWANZA				
Individual Farmers (Zebu)	5	10	20	23
Individual Farmers (Dairy)	1	20	1	17
Vendors/Hawkers	8	22	19	39
Own Farm	1	5	2	100
Total	**15**	**13**	**42**	**29**

Table 24 give a summary of the results obtained by bothe MRT and ELISA across sites, seasons, trade types and product types. Generally ELISA gives same of lower values of the prevalence.

Table 24: Proportion of milk samples positive for *B.abortus* using MRT and ELISA antibody test

	MRT		ELISA	
Source of sample	n	%	n	%
Site				
Dar-es-salaam	241	36.24	140	19.69
Mwanza	45	16.3	58	22.48
	140	32.79	84	19.44
	146	28.4	114	21.23
Cooperatives	2	22	2	40
Producers	73	32	34	20
Wholesalers	13	46	8	
Vendors/Hawkers	69	28	66	
Retailers	126	31	87	17
Source type				
Zebu farmers	74	27	61	26
Dairy farmers	100	38	45	15
Cooperatives	4	44	4	50
wholesalers	22	29	12	13
Vendors	23	19	48	34
Own farm	40	33	9	9

The high prevalence of Brucellosis in bulked milk from vendors wholesalers and cooperatives as detected by ELISA indicate that bulking of milk from different farmers/areas could pose significant health risks if milk is not pasteurized or adequately boiled before consumption. Most of the bulked milk are collected/procured from pastrolists who keep zebu cattle. Prevalence of Bovine brucellosis have been documented in different regions of Tanzania basing on serological test (SAT) and /or milk Ring test (Table 18). The finding that higher prevalence of brucellosis was detected in milk collected from pastrolists in general reflect the previous studies indicating higher farm-level prevalence of Brucellosis in extensive and /or grazing area than in small holder system

3.15 Haemorhagic E.coli 0157:H7

Out of 1254 milk samples analysed for coliforms, 655 yielded coliforms on culture (Table 26). Of all coliform isolates, 123 proved to be positive for *E.coli*. Only three *E.coli* isolates produced blue black colonies on BCM® 0157:H7 medium. These were highly regarded to be pathogenic E.coli.0157:H7. Currently the isolates are preserved for further serotyping and testing for production of verocytotoxin.

Table 25: Previously documented prevalence of bovine brucellosis in Coastal and Mwanza region

	›n	Prevalence range(%)	Reference
Coastal		37.1-90.5	Minga and Balemba (1990)
		5.6	Swai (1997)
	Dar-es-salaam	3.2	Swai (1997)
	Mwanza	1.6-19.6	Mahlau and Hammond (1962)
Lake Victoria			Kagumba and Nandokha (1978)
			Msanga et al, (1986)
	Kagera		Mahlau and Hammond (1962
			Msanga et al, (1986)
	Mara		Mahlau and Hammond (1962
Our findings	Mwanza		Field survey 2000-2001
		32.96[a]	"
	Mwanza	22.5%[b]	"
	Dar-es-salaam	19.7%[b]	"

[a] =MRT
[b] =ELISA

Although only three isolates proved to be positive for *E.coli* 0157:H7 strain, the finding however is significant considering the importance of pathogen in causing haemorrhagic colitis with bloody diarrhea and haemolytic ureamic syndrome which always lead to kidney failure. Contamination from animal or human feaces and contaminated water at different stage of milk handling is sources of milk contamination. All isolates tested positive were isolated from raw fresh milk samples. Implication here is that people who consume raw milk stand a high risk of getting infected. It is also of public health significance that none of the ready to consume products yielded haemorrhagic *E.coli* strains

Table 26: Number and milk samples screened for *E.coli* and identification of strain 0157:H7

	Number	
	Mwanza	Dar
Examined for E.coli	237	387
Positive for E.coli	69 (29.11%)	43 (11.12%)
E.coli0157:H7on BCM® medium	2	1

3.16 BOVINE TUBERCLOSIS

The results show that out of 641 samples analysed so far 64 (10%) were positive from mycobacterium species. Further identification to the species level did not result in isolation of *Mycobacteria bovis*, which cause bovine tuberculosis in both animals and humans. The 64 positive samples however, yielded different species of atypical mycobacterium. These species are abundant in the environment e.g soil and be easily get in the milk if milking hygiene is not adhered to. Some

human TB patient biopsies/sputum samples collected in Mwanza and Shinyanga are undergoing analysis to determine if any of the cases have *M.bovis* as the causative agent.

3.17 Peroxidase test

Lactoperoxidase is the most abundant enzyme in milk. The lactoperoxidase unlike alkaline phosphatase enzyme, is not destroyed by pasteurisation (72 °C for 15s or 63 °C minutes for 30 minutes) of milk. However, the enzyme is destroyed when milk is heated to over 80 °C for 15 - 30 seconds or when milk is boiled. It is thus used to detect whether or not milk has been boiled or in the case of pasteurised milk whether milk has not been overpasteurised. In the EU, pasteurised milk should be peroxidase test POSITIVE.

The results show that 9% of the milk which was presented as raw milk had actually been boiled while 32 and 23% of liquid milk presented as boiled milk served cool and hot respectively may have been pasteurised but not boiled. Similarly 47% of Mtindi may have been pasteurised or not heated at all. These results show that processors need to be aware of the quality of raw milk received as some is pre-boiled presumable for preservation purposes. A further disgregation of the boiled samples is required to know which ones were pre-packed pasteurised milk.

Table 27: Peroxidase test results of various liquid milk samples

	Peroxidase positive (not Boiled) (n)	% Peroxidase positive samples
Raw milk	608	91
Boiled, served cool	59	32
Boiled,served hot/warm	49	23
Mtindi	79	47
Total	797	65

4. CONCLUSIONS

These results show that quality of milk marketed in the informal sector is still weak especially with regard to adulteration with water, which is rampant in Mwanza.

Lack of infrastructure, procedures and facilities for quality surveillance by public health officials in local government authorities and lack of awareness by various stakeholder poses a public health risk with regards to the consumption of milk and milk products traded in the informal sector

- However, consumers practices such as boiling of milk takes care of large proportion of that risk as demonstrated by relatively lower rate of prevalence of public health elements in the ready to consume products compared to raw milk as such. A large proportion of ready to eat milk products was free from coliforms compared to raw milk.

- Results of the research show that by and large ready to eat products especially those of served hot/warm were safer for human consumption. However, there is a need to increase awareness of farmers , milk traders, processors and alike on the practices that reduce public health risk of all kinds (drug residues and pathogenic bacteria) as well as milk spoilage bacteria that reduce marketability of milk and milk products.

  Results obtained with regard to poor bacteriological quality of the milk, high rate of adulteration with water and present of drug residues have implications for the formal milk processing sectors as well as no good quality dairy products can be made from poor quality milk whatever level of technology being used in their manufacture. Moreover, the presence of drug residues, apart from being risk to human health, affects the quality of cultured milk products such as cheese and yoghurt. Hence concerted efforts are required to improve milk quality by all key players in Tanzania.

5 ACKNOWLEDGEMENT

The authors wish to acknowledge the financial support by DFID and the technical support received from various staff at ILRI, SUA, the Veterinary Investigation Centre Mwanza , funded by DFID, the Mycobacterium Laboratory at faculty of Veterinary Medicine SUA for processing of samples for mycobacterium, Mwanza City council Health Department for collaboration during field surveys. Their support and collaboration is highly appreciated

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