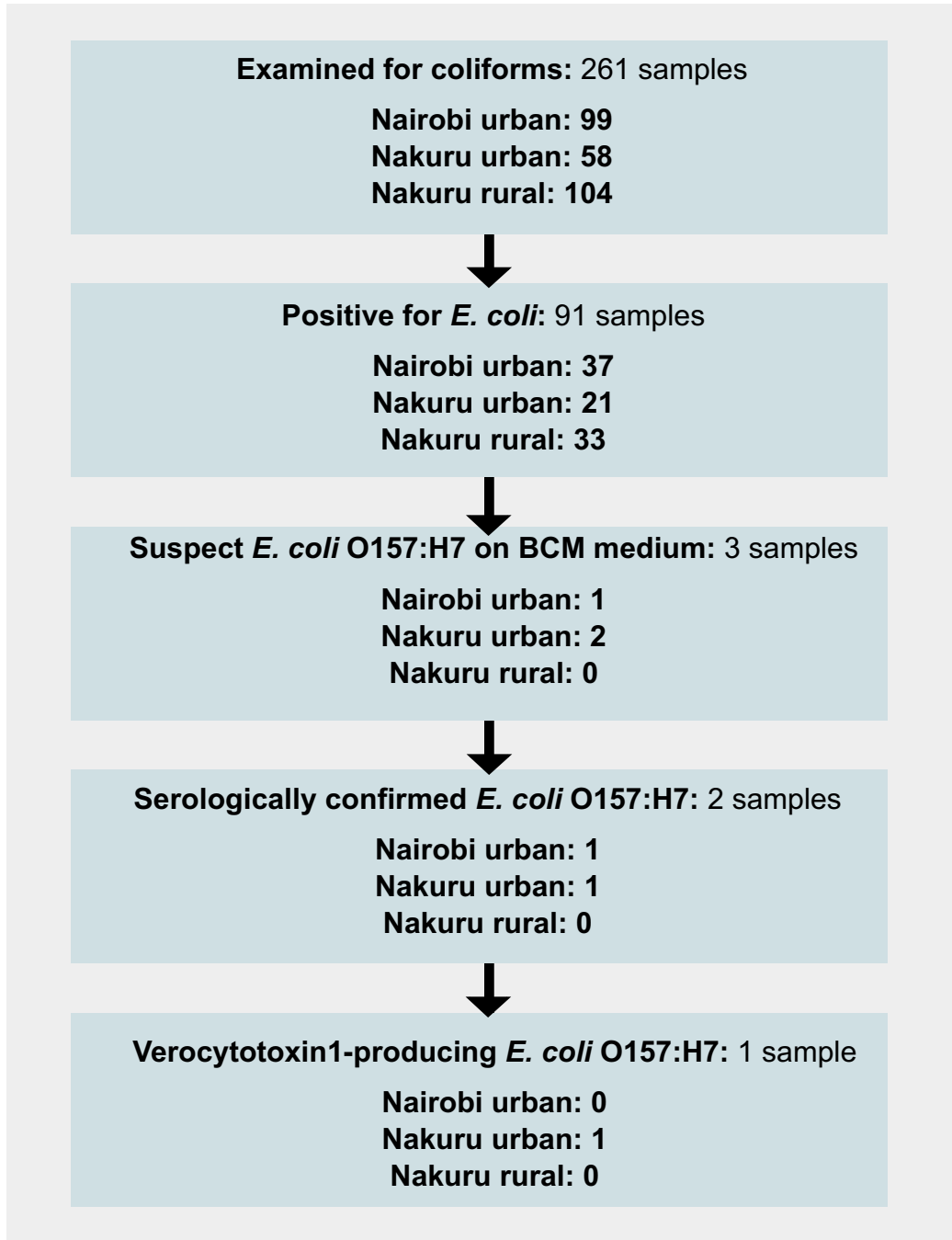


Figure 13 The process of screening consumer-level raw milk samples for *E. coli* O157:H7



The prevalence of *E. coli* O157:H7 was low, being recovered from only two out of 261 samples (0.8 per cent). Although this recovery rate was low, it is noteworthy due to the severity of illness that *E. coli* O157:H7 can cause in form of permanent kidney damage. Still, the impact of *E. coli* O157:H7 in causing food-borne diseases in Kenya is not well known since few studies on the organism have been done locally. However, this study shows that consumers of unpasteurised or unboiled milk are at some risk of getting infected. The prevalence of 0.8 per cent implies that a person who daily drinks marketed milk that has not been adequately heat treated is at risk of being exposed to *E. coli* O157:H7 at least three times a year. Fortunately, this exposure would rarely translate into an infection. This is because of the widespread consumer practice of boiling milk—whether bought raw or pasteurized—before consumption. However, the fact that *E. coli* O157:H7 was isolated from milk samples in two towns that are far apart (150 km) may indicate that its occurrence is widespread.

Bovine tuberculosis

Although bovine TB has not been officially reported in Kenya¹², it has not been widely studied following comprehensive reviews in the 1960s by FAO/WHO/GoK experts (Myers and Steele, 1969) that ruled out the disease. The only sign that the situation could still be the same has been the lack of any reports of TB from passive reporting systems such as post-mortems in slaughterhouses and isolation of *Mycobacterium* from TB patients.

¹² *The zoonosis is endemic in all neighbouring countries*

Of the 37 samples from suspect TB patients that tested positive for *Mycobacterium*, none resulted in the isolation of *M. bovis*. Though these findings support the long-held official position that bovine TB is absent in Kenya, they need to be verified and periodically monitored in other areas, given the risk posed by frequent cross-border movement of livestock from neighbouring countries. Those at greatest risk of getting bovine TB would be pastoralist communities like the Maasai who traditionally consume raw milk and/or other raw animal food products.

Antimicrobial residues

Antimicrobial residues in milk are undesirable because of their negative health effects on people who are continually exposed to such risks. In particular, long-term exposure to antibiotic drug residues in milk can give rise to bacterial resistance by killing all but the most potent bacteria strains. This helps create ‘super bugs’ that are immune to common, less expensive antibiotics. Antibiotic residues in milk also inhibit the starter microorganisms involved in the processing of fermented milk products. These residues most often originate from farm-level practices when farmers fail to observe the specified milk withdrawal periods after antibiotic treatment of cows.

Results from consumer and market surveys

Milk samples were examined for residues of five common families of antimicrobials. Overall, 9 per cent and 6 per cent of consumer- and market-level milk samples, respectively, contained



antibiotic residues. This suggests that a person who drinks milk daily is at risk of consuming milk that contains antibiotic residues at least twice every month. On average, 15 per cent of milk samples from rural households had antibiotic residues. This was three times higher than the proportion of antibiotic-positive samples from urban households. At the market level, the proportion of milk samples with antibiotic residues decreased with increasing levels of milk bulking. Thus, milk bars and small mobile traders dealing in relatively small quantities of milk recorded more antibiotic-positive samples than dairy co-operatives that handled milk in bulk (Figure 14). This perhaps indicates dilution of the residues to levels below the detection thresholds of the test.

The higher proportion of rural consumer milk samples (milk from own farms) with antimicrobial residues indicates that the residues are more likely to originate at the farm than due to bad market practices. On the other hand, the relatively higher proportion of pasteurized milk samples with antimicrobial residues (8.2 per

cent) suggests that some antimicrobials may be added after the first milk sale transaction.

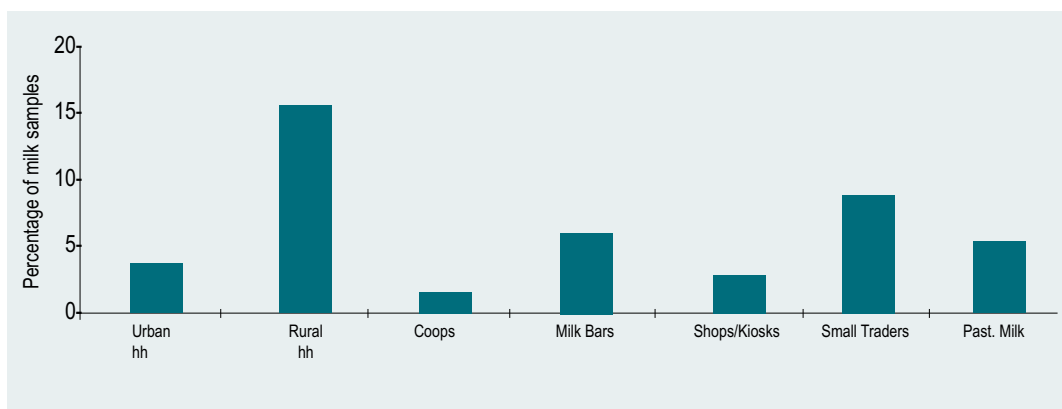
Since heat treatment does not eliminate antibiotic residues, they present a potential health risk in form of bacterial resistance and allergic reactions. The results indicate that an effective solution to the problem of antimicrobial residues in milk needs to be sought through a dual farmer-and-trader-training approach, and monitoring of antimicrobial residue levels along the milk supply chain.

Assessment of quality of pasteurized milk

The microbiological quality of pasteurized and packaged milk was assessed alongside that of raw marketed milk 1) to compare both types of milk according to respective standards, and 2) in response to complaints by some dairy industry stakeholders about high rates of spoilage of pasteurized milk.

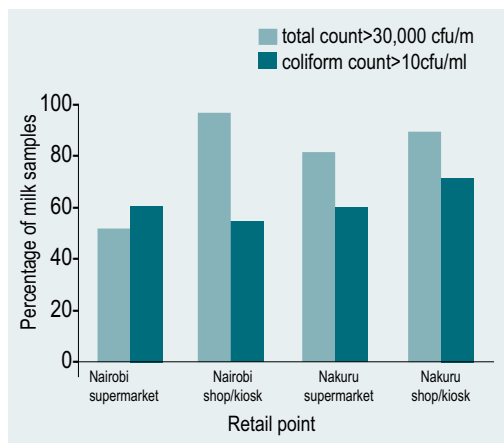
Over half of pasteurized milk samples failed to meet the KEBS quality requirements for

Figure 14. Proportions of consumer- and market-level samples containing antibiotic residues



processed milk (Figure 15). The KEBS maximum allowable levels for total and coliform bacteria in pasteurized milk are 30,000 and 10 cfu per ml, respectively.

Figure 15. Pasteurized milk samples with microbial counts above KEBS limits



In Nairobi, 82 per cent and 59 per cent of milk samples had unacceptably high numbers of total and coliform bacteria, respectively. A similar trend was observed in Nakuru, where 89 per cent and 70 per cent of samples had total and coliform counts, respectively, that were above KEBS specifications. In addition, a substantial number of samples recorded total counts above 1 million cfu per ml.

In both Nairobi and Nakuru, over 90 per cent of milk samples from shops and kiosks had unacceptable total bacteria counts. This was significantly greater than proportions of similarly sub-standard milk from supermarkets in Nairobi (52 per cent) and Nakuru (81 per cent). The lower incidence of high bacteria counts in pasteurized milk in Nairobi supermarkets may be attributed to the use of chilling facilities,

which are largely absent in most shops and kiosks. About 60 per cent of pasteurized milk from outlets in Nairobi and Nakuru had unacceptable coliform counts, but samples from supermarkets did not consistently have lower coliform counts compared to retail outlets without chilling facilities.

These results show that by the time pasteurized and packaged milk reaches its “sell-by” date, the number of total bacteria in the milk will be quite high. The main factors contributing to this are a high initial bacterial load in raw milk, the lack of chilling facilities in kiosks and unhygienic handling of milk after processing. KEBS standards only assure quality immediately after pasteurization and assume that the milk is chilled at all retail points.

The cross-cutting failure of both pasteurized and raw marketed milk samples to meet their respective KEBS specifications for microbial quality indicates that these standards may be unsuited to prevailing local conditions, which include the widespread absence of cold chains in both formal and informal market pathways, poor road networks, predominant sale of raw milk and the common consumer practice of boiling milk before consumption.

It is noteworthy that chilling of pasteurized milk at supermarkets did not markedly reduce average coliform counts compared to pasteurized milk purchased from kiosks. This indicates that a CCP for pasteurized milk may exist during transportation from processing plants to retail points, or that storage temperatures are not kept low enough at retail outlets, even those with chilling facilities.



Identification of risk factors and critical control points



Market risk factors that influence milk quality

Milk marketing pathways

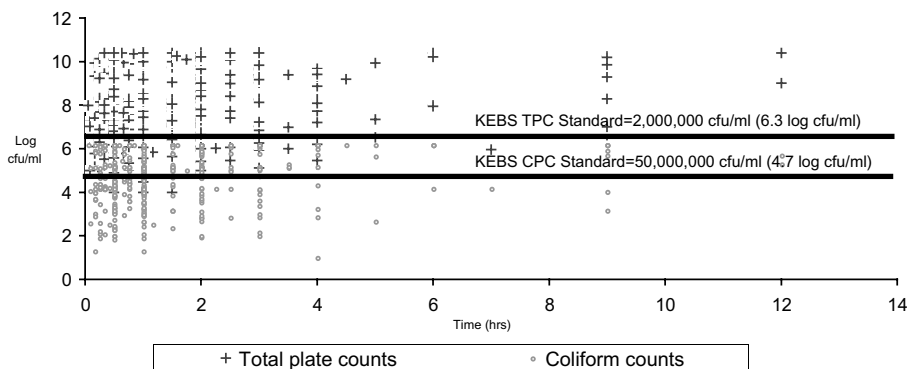
Two main types of marketing pathways were identified according to how the traders got their raw milk:

- direct sourcing from the farm without intermediaries (70.8 per cent), and
- pathways with one or more intermediaries (29.2 per cent)

Majority of small mobile traders handled less 120 litres/day and travelled an average of 30 kilometres to the retail outlets. Milk sold in milk bars was transported over the longest distance to market (35 kilometres). Although milk that was sold through one or more intermediaries was transported over longer distances than that sourced directly from the farm, no significant difference in milk microbial quality was noted between the two pathways. Thus, the risks associated with use of intermediaries in marketing of raw milk are considered to be insignificant.

Figure 16 indicates the bacterial counts in milk after time of milk collection. It will be noted that even 1-2 hours after milk was collected, more than half of the milk samples had total and



Figure 16. Bacterial counts vs. time since milk collection by market agents

coliform bacteria counts that exceeded KEBS specifications. Again, this suggests that the standards, which are based on those in countries where milk is marketed through cold chain systems, are not appropriate to local milk marketing conditions. Thus, judging the quality of informally-sold raw milk according to the current KEBS specifications may in fact unfairly penalize otherwise “good” quality milk.

Milk handling methods

The methods used in handling of raw milk varied across the different scales of business. Most of the small-scale milk hawkers handled milk in plastic jerry cans unlike the larger dairy co-operatives that preferred to use metal churns. Eighty-nine per cent of hawkers and only 10 per cent of co-ops used plastic containers. On the other hand, 6 per cent of hawkers and 86 per cent of co-ops used metal containers. The use of plastic containers was associated with high coliform counts in raw milk. This is likely due to the fact that plastic containers are difficult to clean and sterilize.

Regarding the methods used by informal traders to clean milk containers, majority (89 percent) used hot water and soap/disinfectant. This indicates a conscious awareness among the traders of the need to reduce milk spoilage and ensure cleanliness during milk handling. This positive mindset needs to be reinforced by training and use of improved handling practices, such as sterilizable metal milk containers.

Refrigeration or chilling of milk was used by 47 per cent of market agents, and most of these were milk bar traders. Boiling of milk as a method of preservation was practised by 19 per cent of traders, the majority being shop and kiosk traders. Though boiling was mainly done to lengthen shelf life, it had an added advantage of killing pathogens in milk, thereby eliminating these microbial risks. On average, 28 per cent of all traders, mainly co-ops and hawkers, sold milk without preserving it in any way. Notably, hardly any chemical preservatives were recorded as being added to milk to lengthen storage life. Only 2 per cent of traders (one milk bar and one large-scale mobile trader) said that



they used hydrogen peroxide and none indicated using lactoperoxidase or antimicrobials.

Level of training and experience of traders

Overall, only 12 per cent of milk handlers were trained in milk handling and quality control but this was wide-ranging, from only 4 per cent of mobile traders to 43 per cent of dairy cooperative workers. The lack of training in milk quality may be a contributing factor to unhygienic milk handling by the informal sector traders. Small-scale milk traders had been in business for an average of 2.5 years, a substantially shorter time than farmer groups (average 21 years). This may indicate a high turnover in the milk market business or an expanding market with several recent entrants. These factors need to be considered alongside any efforts undertaken to improve milk hygiene among these groups of traders.

Major constraints cited by milk traders

Harassment by regulatory authorities was the most commonly cited constraint by half the traders. Milk spoilage, seasonality in supply, high competition and transportation problems due to poor roads were the other major constraints cited. Though mobile traders—who are mainly unlicensed—faced more harassment, there was no significant difference in milk quality (based on coliform counts) between the quality of the milk they sold and that of licensed traders who had fixed premises. This raises questions on the validity of the official regulations governing licensing of milk traders;

currently traders must have fixed premises in order to qualify for a milk handling licence from the KDB. However, licensing can still play an important role in improving the quality of milk sold in the informal sector if it is put in place as a means to promote training and certification of informal milk traders. In this way, licensing forms an operating framework where the activities of the informal milk sector can be effectively monitored and evaluated from time to time.

Risk factors identified at consumer households

Shops and kiosks sold milk that had the highest average total and coliform bacteria counts. Adulteration was also found to be more likely associated with milk sold at kiosks (collected from co-operatives). However, adulteration of milk varied depending on the season, with more cases being noted during the dry season when milk supply is low and prices are higher.

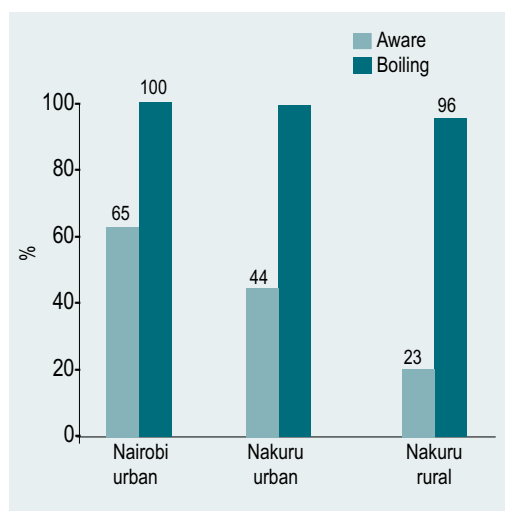
More consumers in Nairobi (65 per cent) were aware of the public health risks associated with raw milk consumption compared to Nakuru rural (23 per cent) and Nakuru urban (44 per cent). All sampled urban households and 96 per cent of sampled households in Nakuru rural reported boiling milk (alone or in tea) before consumption (Figure 17). About 6 per cent of sampled rural households, mostly from Nakuru rural, consumed home-made fermented milk (often unboiled before fermentation) in the previous one month before each seasonal survey.

Boiling of raw milk attains a higher temperature



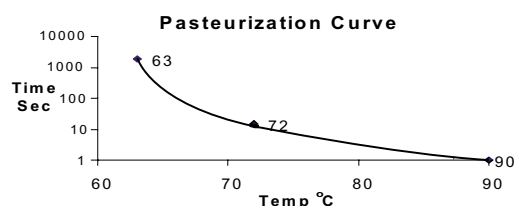
than pasteurization and therefore effectively destroys all pathogens in milk¹³ (Figure 18). Given the widespread consumer practice of boiling milk before consumption, the public health risks from bacterial pathogens were determined to be very low. This practice should be encouraged, especially in rural/pastoral areas, where a small proportion of households reported consuming milk that had been naturally fermented without prior heat treatment.

Figure 17. Proportions of households in urban and rural areas that are aware of milk-borne risks and boil milk



The risks of consuming naturally fermented milk need to be studied further. This practice was reported by 6 per cent of rural households. Such milk is often not boiled before fermentation, which, despite increasing the acidity of milk, may not kill all pathogens present in raw milk.

Figure 18. The time-temperature combinations for pasteurisation



Thus, such fermented milk could be a source of milk-borne infection. The survival of these and other pathogens in unboiled fermented milk also needs further investigation.

It is noteworthy that all the respondents reporting a household member diagnosed with brucellosis were from rural Nakuru, where some unboiled and/or home-made fermented milk was consumed. This study also shows that bulking of raw milk by large-scale raw milk market agents can increase the risks of infection with *Brucella* or any other zoonotic agent, particularly if the milk is not boiled before consumption. Likewise, failure to achieve the pasteurization conditions may result in survival of some milk-borne pathogens.

Critical Control Points

Critical control points (CCPs) are specific links in the food chain where identified potential public health risks can be reduced or eliminated in order to protect the health of consumers. The CCPs can therefore be used as target points for

¹³ Pasteurization involves heating milk to 72 degrees Centigrade for 15 seconds to destroy pathogens. The pasteurization curve (Figure 18) gives the highest temperature required to kill all pathogens as 89 degrees Centigrade for one second. Boiling attains a higher temperature and longer time and thus destroys all pathogens.



interventions aimed at minimizing risks. Using the principles of HACCP, the following health risks were analysed: high total and coliform

bacteria counts, milk adulteration, *Brucella* antibodies and antimicrobial residues. The results are summarized in Table 2.

Table 2. Critical Control Points in informal milk market channels

Health risk	Critical Control Point	Seasonal variation
High total bacteria counts	Farm-to-shops/kiosks pathway Farm-to-milk bar pathway in Kiambu/Nairobi (IHMA) Use of plastic containers in Nakuru/Narok (EMMA) Small-scale milk traders	Increase during wet season
High coliform bacteria counts	Farm-to-coop pathway in Nakuru/Narok (EMMA) Farm-to-shops/kiosks pathway in Kiambu/Nairobi (IHMA) Use of plastic containers Non-cooling of milk Small-scale milk traders	Decrease during wet season
Adulteration with solids	Cooperative-to-shops/kiosks pathway	More during wet season
<i>Brucella abortus</i>	Farm-to-milk bar pathway in Narok	
Antimicrobial residues	Farm-to-mobile trader pathway*	

** It is likely that these residues originated at the farm since no mobile traders used antimicrobials to preserve milk, and milk sourced directly from rural farms had relatively high levels of antibiotic residues.*



Testing of training of informal sector traders on hygienic milk handling and quality control



Rationale for the testing of training informal milk traders

The results of the market-level survey indicated that only 12 per cent of all raw milk handlers reported receiving any form of training in hygienic milk handling and quality control, although this was wide-ranging, from 4 per cent of mobile milk traders to 43 per cent of dairy co-op workers.

These findings pointed to a need to test training of informal milk traders on hygienic milk handling operations, such as the use of sterilizable aluminium milk churns as opposed to the commonly used non-food grade plastic containers. It was anticipated that training would result in improved quality of milk sold by small-scale traders.

Training methodology

A pilot study was carried out in Murang'a, Nakuru and Thika districts to test the potential gains that could be achieved through training and certification of informal milk traders. All three districts have vibrant small-scale informal milk market systems that emerged following the liberalization of milk marketing in 1992.



The informal milk market in Nakuru district is characterized mainly by bicycle traders who collect milk from the rural milk-producing areas and cycle long distances over poor roads to markets in urban Nakuru. Conversely, most milk traders in Murang'a and Thika use public transport (*matatu*) to ferry milk to market. Most of the small-scale traders in Murang'a are women and few have received formal training in milk hygiene. Thika traders often face problems of milk spoilage and adulteration by some unscrupulous farmers. These unique features characterizing informal milk trade in the three districts offered the opportunity to

- 1) develop an appropriate milk container suitable for carriage on a bicycle,
- 2) examine the impact of training and use of improved milk containers on raw milk quality, and
- 3) train small-scale traders on simple methods of testing the quality of raw milk before purchasing it from farmers.

Two approaches were used to collect information and train the milk traders: a series of participatory rural appraisals (PRAs) and a structured questionnaire. The objective of the PRAs was to use a group-based process to arrive at viable, applicable improvements to milk handling practices. This was done by getting information on the milk handling methods used by the traders and their reasons for using those methods. The information was then used to collaboratively develop an appropriate milk container that would contribute to improved milk quality. The questionnaire was used to obtain more detailed information on milk

procurement, handling and sale; and the impact of training and use of improved milk containers on milk quality and business operations.

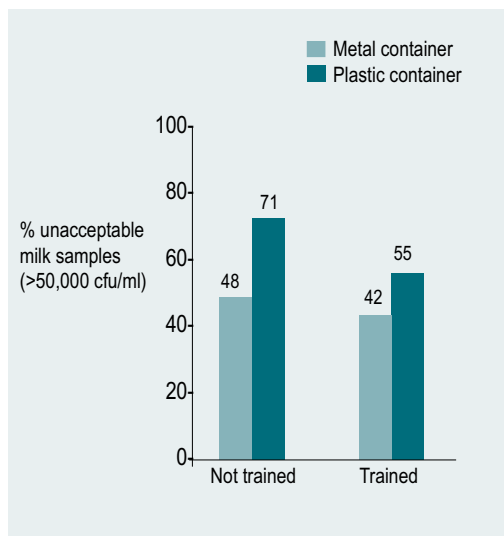
About 80 milk traders from all three districts were involved in the training exercise, which was carried out in two phases between April and December 2002. Traders were trained on general milk hygiene, factors leading to milk spoilage and simple tests that can be used to examine the quality of raw milk before purchase, namely organoleptic, alcohol, and clot-on-boiling tests. They were also trained on how to use lactometers to measure the specific gravity of milk and thus establish whether or not milk has been adulterated by addition of water or solids, or removal of cream. The second training phase was held three months after the first phase in order to test for significant changes in milk quality attributable to training in improved milk handling techniques. The use of newly designed metal milk cans of appropriate size and shape was also examined to test for their effect on raw milk quality. The quality criteria used were KEBS microbiological quality thresholds for coliform counts in raw milk, i.e. 50,000 cfu/ml.

Training results and discussion

The proportion of unacceptable milk samples reduced significantly after training, and this was particularly so for those traders who used plastic containers. Likewise, the use of sterilizable metal milk churns resulted in lower incidence of unacceptable milk samples as compared to the use of plastic containers (Figure 19). These positive results imply that training of informal sector milk traders combined with the use of more hygienic metal containers will significantly



Figure 19. Proportion of unacceptable milk samples (coliform counts over 50,000 cfu/ml) sold by trained and untrained traders



reduce the health risks associated with raw milk of poor bacteriological quality, and in so doing, provide consumers with a higher degree of product quality assurance.

Among the Nakuru-based bicycle traders, the use of the metal churns was beneficial to their business operations, in form of less spillage of milk during transportation, reduced cases of milk spoilage (since the cans are easy to clean and sterilize) and fewer incidences of harassment by public health officials. Additionally, many traders reported that their customers preferred to buy milk that was

handled in the more appealing aluminium containers as opposed to plastic jerry cans.

Prior to the training sessions, most traders had little or no knowledge of objective tests that can be used to assess raw milk quality. They mostly relied on organoleptic (sight and smell) assessment and other informal tests, which though useful, may not always effectively detect adulteration of milk¹⁴. After training, many traders appreciated the need to use more objective milk quality tests and consequently, the use of lactometers increased significantly with many traders buying their own after SDP availed them at a subsidized cost. Those who could afford to buy ethanol for the alcohol test preferred to use this test instead of the clot-on-boiling test because of its higher sensitivity in detecting milk that has started souring. The traders also used the quality tests during storage and before sale of milk, to monitor the effectiveness of the storage methods and ensure that only good quality milk was sold to consumers.

These outcomes indicate that training of informal sector traders can lead to improved milk quality and business operations. However, in order for the impact of training to be fully effective, it must be accompanied by a system of licensing and certification of traders in order to properly monitor and evaluate their operations.

¹⁴ Many traders reported using an informal "match stick" test to check for added water in milk. A match stick head is dipped in the milk then struck. Failure of the match to light immediately means the milk has been adulterated with water.



Risk of exposure to milk-borne pathogens from soured milk sold in Nairobi milk bars



Background

In the market-level survey, 25 per cent of milk traders recorded unsold leftover milk of about 7 per cent of the previous day's sales. This leftover milk was either consumed by the family or fermented and sold as soured milk. Milk bars are a key outlet for these soured milk products. Because the milk is often left to sour naturally without being boiled, there are chances that some milk-borne pathogens—which would otherwise have been killed by boiling the milk—may survive the acidity developed in the soured product and pose a health risk to consumers.

Thus, a study was undertaken to quantify the risks of exposure to milk-borne pathogens from soured milk sold in milk bars within Nairobi. The specific aims of the study were to determine 1) the extent of sales of raw milk, 2) the extent of sales of non-heat treated sour milk and 3) the extent to which consumers of soured milk bought from milk bars in Nairobi are exposed to milk-borne pathogens.



Methodology

The study was undertaken between November and December 2003. Survey data were collected from randomly selected milk bars in five divisions in Nairobi (Githurai, Kangemi, Kawangware, Kibera and Riruta). The divisions were chosen based on their high human population densities and the common sale of raw and sour milk in milk bars. Milk samples were collected only from those milk bars selling naturally soured milk.

A questionnaire was used to get information on how the milk bar owners procured and sold their milk, the fate of leftover unsold milk and the methods used to ferment leftover milk. The pH (degree of acidity) of the sour milk samples was measured; the lower the pH value, the more acidic the milk. The duration of souring was also recorded.

The established thresholds of pH 4.2 and souring time of 66 hours were used to assess the risks of consumers being exposed to milk-borne pathogens in naturally soured milk. For the purposes of this study, soured milk samples of interest were those whose fermentation conditions did not meet the set thresholds, that is, samples of sour milk with pH above 4.2 (less acidic) and those that were fermented for less than 66 hours.

Results and discussion

A total of 47 milk bars were surveyed, 38 (81 per cent) of which sold soured milk. Mostly, the fresh milk was left to ferment naturally without the use of commercial cultures, though in some cases a portion of previously fermented milk was

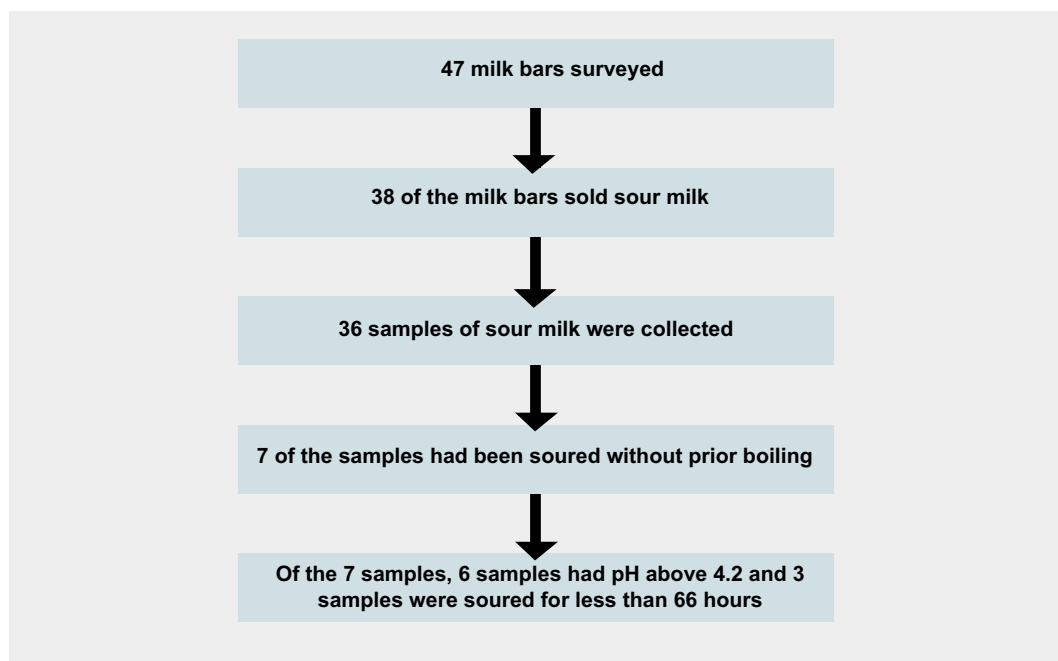
added to a batch of fresh milk to initiate the souring process. Soured milk samples were obtained from 36 of the 38 milk bars selling sour milk at the time of the survey. The average pH of the sour milk was 4.3. Most of the sour milk samples were fermented for 18-48 hours but generally the fermentation time was wide-ranging across all milk bars, from 2 to 168 hours.

Of the 36 soured milk samples, seven (19 per cent) were not boiled before souring, thus presenting a possible pathogen risk. Figure 20 illustrates the process used to screen samples of soured milk for potential risks of exposure to milk-borne pathogens.

Of the seven non-boiled and soured milk samples, six did not meet the pH threshold of 4.2 and three were soured for less than 66 hours, suggesting a prevalence of 8.3-16.7 per cent of soured milk samples that were not rendered safe by any practice (Table 3). This translates to a potential risk of exposure to milk-borne pathogens of 30-61 times a year for a person who daily drinks soured milk bought from milk bars in Nairobi. However, the actual health risks from bacterial contamination are judged to be low because of the common practice—by 81 per cent of sampled milk bars—of boiling milk before souring it. This practice should be encouraged.

Regarding the awareness of milk bar personnel on the health risks associated with raw milk, 93 per cent of them were aware of these risks and knew that boiling and hygienic handling of milk can greatly reduce health risks to consumers. Indeed, over 90 per cent of the sampled milk bar personnel said that they boiled milk before consumption or sale. Only 2 per cent of milk



Figure 20. Screening of naturally soured milk samples for risks of exposure to milk-borne pathogens**Table 3. Proportions of the 36 soured milk samples that pose pathogen risks**

Risk factor	Number	Percentage
Soured without boiling	7	19.4
Soured without boiling and pH more than 4.2	6	16.7
Soured without boiling for less than 66 hours	3	8.3

bar owners cited pasteurization as a method of making raw milk safe. This level of awareness on milk safety needs to be reinforced through appropriate education efforts aimed at both milk bar traders and consumers. It is further recommended that all milk bar personnel be advised to subject raw milk to effective heat treatment—boiling or pasteurization—before souring and selling to consumers.



Conclusions



This study was undertaken to arrive at valid, scientific evidence on the health risks associated with milk sold in Kenya. This information is useful to consumers as it allows them to balance the risks and potential benefits and make informed choices on which milk products to buy, and what steps they can take to minimize the identified risks.

In addition, the study has shown that the informal milk sector does indeed play an important role in milk marketing in Kenya by linking producers and consumers in a timely and efficient manner. Thus, constructive policies are needed to support improvements in milk marketing sectors. Those policies should aim at safeguarding public health without impeding the efficient marketing of milk.

The key conclusions of the study are summarized as follows:

Milk production

Residues of antimicrobials in raw milk are likely to originate at the farm rather than from market-level malpractice. This is because raw milk from many rural farms had high levels of antibiotic residues. However, the study does not rule out the possibility of unscrupulous milk traders adding antibiotics to raw milk to prolong its storage life. Thus, a closer look at this potential hazard is needed, given that boiling or pasteurization of milk will not destroy antimicrobial residues.



Milk bulking and marketing

Bulking of milk from different sources increases the risk of exposure to milk-borne zoonoses, particularly among people who drink unboiled milk. Thus, market agents handling bulked milk (such as dairy cooperatives) should ensure the milk is adequately processed before sale.

Lack of formal training, use of plastic containers and the absence of cold chains are the main factors that contribute to the low quality of raw milk sold by small-scale informal milk traders and hawkers. However, training in milk hygiene and quality testing, combined with the use of more hygienic metal containers can significantly improve the quality of milk sold by informal small-scale traders.

The study found that there was no significant quality difference between milk sold by licensed and unlicensed traders, whether or not they had fixed premises. Thus, the current KDB requirement that traders have fixed premises before they can be licensed seems to be unjustified. Thus, licensing should be implemented as the means towards improving milk quality and not merely as an end in itself. However, licensing alone is not likely to have much impact and would need to be accompanied by a formal system of training and certification of informal traders.

Milk consumption

Risks of being exposed to milk-borne pathogens are minimal, since the incidence of *Brucella* and pathogenic *E. coli* in raw and processed milk was low and almost all consumers boil milk before

they drink it, thus effectively eliminating any bacterial pathogens that may be present.

The small proportion of rural households who drink naturally fermented milk could be at some risk of certain zoonoses, particularly if the milk is not boiled before souring. This is because some zoonotic agents present in the raw milk may survive the acidity developed during spontaneous fermentation.

Milk quality assessment

The failure of most milk samples, whether raw or pasteurized, to adhere to KEBS specifications for microbial quality suggests that the standards are not relevant to local milk marketing conditions. Because these standards have been borrowed from countries where all milk flows through cold chains and is always pasteurized before sale, there is a need to develop local milk quality standards that specifically address the prevailing conditions under which milk is sold in Kenya. These include the widespread lack of cold chains, tropical weather conditions, poor road networks and the almost universal consumer practice of boiling milk before consumption.



Summary of recommendations of the dairy public health committee



A nine-member Public Health Committee (PHC) convened by the KDB and MoLFD identified key recommendations on the management of milk-borne public health risks in Kenya. The PHC representatives were drawn from the KDPA, MoLFD, KDB, KEBS, MoH, and SDP. The PHC was appointed at the end of a stakeholders' workshop held on 14 February 2001 at KARI Headquarters to review research findings on milk-borne health risks. The stakeholders' workshop discussed various recommendations arising from the research study. These recommendations were revised and finalized by the PHC on 26-27 March 2002.

The terms of reference for the PHC were to:

- finalise recommendations (interventions, plans of action, institutional roles for implementation and financing) agreed at the workshop;
- ensure institutional ownership and consensus on issues raised with regard to ensuring good milk quality in a liberalised market;
- oversee the proposed testing of interventions to improve milk quality;



- set up appropriate reporting mechanism to stakeholder/key-player institutions; and
- convene a follow-up key-player/stakeholders' meeting to report progress.

Details of the revised recommendations are in Annex 2, but they are summarized below, indicating the key roles of some dairy industry stakeholders:

Consumer education

Consumers need to be educated on the risks of drinking raw milk and the need to ensure that milk is adequately heated (boiled or pasteurized) before drinking it. Since boiling of milk was noted as an almost universal practice among Kenyan consumers, the practice needs to be reinforced by appropriate media campaigns. Consumers also need to be educated on the potential risks of drinking fermented milk that was not heated before souring.

Retailers

Small-scale retailers of raw milk, particularly traders in kiosks and milk bars, should be made aware of the need to ensure that milk is boiled or pasteurized before being sold. However, customers who prefer to buy raw milk should boil it before drinking.

Researchers

More studies are needed on the survival of milk-borne pathogens in naturally fermented milk and the extent of sale of such milk in informal milk market outlets. Regarding farm-level milk handling, the specific farm practices that lead to

unacceptable levels of antibiotic residues in milk need to be examined in order to arrive at effective training solutions for dairy farmers. The use of LPS to preserve raw milk also needs to be tested under field conditions as one of the technology-based interventions aimed at reducing bacterial spoilage of milk.

Policy stakeholders and legislators

A system of licensing and training/certification of informal sector traders is needed to improve the quality of milk sold and monitor the operations of the raw milk sector. Additionally, the regulations governing the quality of marketed milk need urgent review to keep pace with the current conditions of milk marketing in Kenya. There is also need to harmonize the policies and laws affecting the dairy industry.



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