Awareness of Hygiene and Safety Practices on Raw Milk Produced and Consumed in Kiambu County, Kenya

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Authors' contributions

This work was carried out in collaboration between both authors. Author SKN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author LGN managed the analyses of the study. Both authors managed the literature searches, read and approved the final manuscript

Original Research Article

ABSTRACT

Background: In Kenya Food safety has been a subject of concern in the recent past due to an increase in chronic illnesses. This was triggered by challenges in quality control, unregulated trade of milk by hawkers, and a minimal level of safety awareness among the farmers.
Objective: The study was aimed at finding out awareness of safety practices on raw milk produced and consumed in Kiambu County.
Methods: A cross-section study was carried out, to examine hygiene standards and safety aspects among dairy farmers at Gatundu South Constituency, mainly in three regions namely Kiganjo, Gatei and Gatundu town. Purposive sampling technique was used to select 33 participants in each locality.
Results: The study showed small scale farmers accounted for (98%) who keep 2 to 3 cows. The quality assurance of the products accounted for more than (97%) hence not significant (p>0.05). The record management at the farm level had less than 40% of farmers, hence no significance

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difference (p>0.05). The milk rejection accounted for 97%, and there was a significant ((p<0.05)). In contamination with antibiotics and preservatives. Brokers who vend milk in the sub-urban centers in Thika town, Ruiru town, and Nairobi accounted for (14%)... The use of health records was not a priority among the farmers, coupled with irregular withdrawal periods; ranging from 48 hours to 72 hours.

Conclusion: Hygiene standards and safety aspects among dairy farmers in Kiambu County are compromised. Subsequently, there is a need to enforce controls in; informal marketing channels, besides training, infrastructural development, code of practice and inspections to enhance the quality and safety of dairy products along the supply chain.

Keywords: safety; antibiotic; withdrawal; training; seminar; Hawking.

1. INTRODUCTION

Dairy farming in Kenya approximates 4.5% of the Gross Domestic Product GDP [1]. According to the Kenya Dairy Board [2], milk production has exceeded 4.6 million tons a year; of this 1.5 million are small scale holders. Officially the total herd size is about 3.5 million heads of dairy cattle [3]. Today the actual herd is seemingly bigger as reported by Kenya dairy board [1]. Rains pattern has changed due to the effect of global warming, seasons have changed; long rains season at times delay as well as short rains seasons. These have brought acute shortage and oversupply hence demand and supply which as a result affect the milk price. KDB has come on board with marketing tools in assisting farmers though much has not to be realized in terms of benefits [2].

During long rains seasons, April to June the quantity and quality of pasture increases hence increase in milk production. Due to high volume, the supply exceeds the demand, hence the effect of supply and demand; leading to low prices. Companies such as Brookside dairy and the New KCC process excess of the supply to powder milk. During a dry spell, most of the powder is reconstituted into liquid and sold in the form of pasteurized fresh milk [4].

In Africa; Kenya's dairy sector is one of the most developed, agricultural enterprises but will suffer a deficit in milk due to an upsurge demand in Nairobi due to an ever-growing influx in urban migration. Dairy farming in Kenya is characterized by small scale farmers having 2-3 cows which account for 70% of dairy farming. According to Smallholder Dairy Research and Development Project (2010), 70% of jobs in the dairy sector are informal [4].

The informal sector is characterized by milk hawking, milk bars and upcoming milk ATMs (Automated machines) [2]. The milk ATMs have taken the markets by storm, with minimal safety precaution to the ultimate consumer. The traceability of milk has been an issue due to the influx of unscrupulous traders. These have led to adulteration of milk with additives such as water and preservers. The milk sold in these places is not pasteurized in some instances it is chilled and at times not. This has triggered the issue of milk preservation, hence the safety aspect of this product to the consumers not assured [5]. The Kenya dairy board has recently championed campaigns on milk safety and control of milk hawking countrywide. They have drummed up support on the use of milk for a healthy nation, especially in school feeding programs [2]. The major dairy industrialists are Brookside dairy limited, New KCC, Githunguri dairy, Sameer Agriculture and Livestock company (Daima brand), and other small scale processors. Their mode of operation is characterized by; collection, chilling, bulking and transporting to a processing facility where the processing takes place. The processed products are distributed for sales in various urban centers [6].

Antibiotic residues in milk have been an issue of great concern; it has been a challenge not only in developed countries but in developing countries [7]. Developing countries' quality assurance channel hence a potential for public health risk [8].due to modernization and evolving in the dairy sector, production in line with antimicrobial usage will be estimated to increase to 67 % between 2010 and 2030, hence greater concern in terms of risk factor [6]. The dairy industry in Kenya is characterized by small farmers who lack proper coordination hence controls are not under check. Studies have shown the presence of antibiotics along the market chain [7]. The antibiotics can be found in contaminated feeds; which end up in milk. [9]. It was found that antibiotic residue in milk was three times higher in rural areas as opposed to urban areas [5]. According to

Kang'ethe 2005 it was found that the level of antibiotic residues at the consumer level was higher than on the market level, being 9.4% and 5.7% respectively [8].

In Kenya Sulfonamides, beta Lactam, aminoglycosides, and tetracycline are mostly used in the treatment of livestock [7]. Drug residue in Kenya's findings above residue limits has increased since market liberalization. In 1978 penicillin was found to be 1% of the milk sample, in the year 2000 the residue was found to be 16% [8], studied farm practices related to veterinary drug usage; only 22% of small scale farmers documented drug usage and 74% of undocumented drug usage [10]. According to Orwa et al (2017) tetracycline was mostly used by 55% of farmers, sulfonamides 21%, and beta-lactam 6% [11]. From earlier study; lack of education and training in antibiotics use and their effects among farmers have been considered as one of the main reasons for antibiotic residue occurrence in Kenya small scale farm milk [10].

In antibiotic residue screening studies, the EU, (European Union) and Codex regulation for MRLs (Maximum Residue Levels) are mainly followed. The sum of Sulfonamides should not exceed 100 µg/kgs (EUR LEX -2010). The MRLs for tetracycline are 100µg/ kgs (EUR.LEX 2010 AND Codex 2012). The MRLs for beta-lactam vary by compounds, but mainly below Sulfonamides 0.01ppm and tetracycline (0.1ppm) limits [12].

Drug residues are also of concern, more so in processed milk products and meat products. This is as a result of poor monitoring of the withdrawal period after administration. If the withdrawal period is well observed, drugs are well metabolized and cleared from the body system of the animal. If the withdrawal period is not observed the minimum residual level will be above the tolerance limits. There are various reports from all parts of the world; USA, EUROPE, INDIA, and Africa at large. In Kenya, various studies have been carried out because of milk safety and quality. It was found that the presence of milk inhibitory substances exceeds CODEX Alimentarius standard (14.9% 2000-2001), beta Lactam 4micro g/kg [22]. Milk should contain zero antibiotic residues. Antibiotics are introduced as a result of the treatment of cow's udder infected by mastitis. It is defined as inflammation of the udder. The residue ends up in the milk system hence posing risk if the withdrawal period is not adhered to [13].

The dairy sector in Kenya is amorphous hence proper guidelines and regulations are not felt at the grass-root level. The poor economic status of producers leads to sell off their produce to vendors for ready cash, to have daily bread [14]. These have contributed to the subsistence nature of the dairy sector. The milk ends up in urban centers such as Nairobi city and its periphery.

The whole value chain poses risk to the consumer, due to poor handling practices hence a need to carry out research to give scoop in terms of quality and safety. The research would lead to how well is the milk sector coordinated with the emergence of policies and regulations at the county level [15].

The dairy industry in Kenya operates mostly in small scale holdings which accounts for 70-80% [2]. The small scale is characterized by keeping 2 to 3 cows and milking 5 to 10 litres of milk/day/cow. They lack tools such as strip cup for mastitis testing at milking site. Contamination may result from milk hawkers and middlemen who are associated with adulteration incidences. Due to harsh economic condition farmer only allow 1 day withdrawal period hence pose a greater risk to the consumer. They have little or no knowledge of associated health risks with residue effects of administered drugs. Therefore risk factors become a matter of importance to food safety regulatory authority [16].

The population growth and reduction in land size, have led to zero-grazing practices. The animals are fed from commercial feeds and grass. Due to economic constraints, most of the small scale farmers end up in feeding animals with grains and vegetable wastes. Antibiotic and other microbial agents gain access to milk, through therapeutic, and prophylactic treatment of animals; or as feed additives or being added directly to the milk [17].

Penicillin residue has been demonstrated in 1.2% of milk delivered to New K.C.C [18]. This poses risks to the consumer in terms of the health hazard, which may result in; bacterial resistance to medical treatment, and allergic reactions due to drug residue or their metabolites according to [19]. It also results in alteration and eventual destruction of gastrointestinal micro flora leading to the growth of opportunist microbes. There has been the concern of inhibition of culture hampering fermentation processes in the industry hence being a technological disadvantage to processors [3].

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The dairy farming management for small scale farmers becomes more complicated due to lack in keeping; and follow-up operations. The farmer at a time, due to the cost of veterinary doctor treat their animals based on past treatments. They lack proper administration on drugs and withdraw periods are not followed to the letter [20].

The dairy industry accounts for 14% of agriculture GDP and 6-8% of the country's GDP. According to USAID, the industry generates an estimated 1 million jobs at the farm level and an additional 500,000 indirect waged employment and 750,000 jobs in support services [21]. the dairy sector is vital in poverty alleviation in both the rural and urban areas as it contributes to food and nutritional security and increased household incomes. Kenya's 1 million stockholders keep the largest dairy herd in Africa (larger than S. AFRICA) according to Jimmy Smith, Director ILRI. The sector contributes USD 2 billion to the country's GDP; according to USAID, this includes farmers, traders and vendors, collections centers, and retailers [21]. Proper record-keeping enhance tracking and evaluation of performance at the farm. There is the provision of up to date information which eases decision making, therefore better supervision and realization of good herd management. The farm income and expenditure are determined, easily hence the profitability of the farm. The farmers can identify problems and set future goals, and improvement of the farm as a business [21].

The study aimed to investigate practices that compromise milk safety at the farm.

2. MATERIALS AND METHODS

2.1 Study Site

Gatundu south sub-county about 29 km, latitude 1.0500 (1° 1'0'' S), longitude 36.9200(36°56' 0" E). Agriculture is the predominant economic activity in the county and it contributes to 17.4 % of the county's population income. The current average on the land size under small scale farming is 0.36 Ha and 69.5 large scales. According to 2009 census number of livestock account to 230294 cattle milk valued to 5.0 billion [22]. Main milk processors in the county are Brookside Dairy, Githunguri Dairy, and Palmside Dairy among others.

2.2 Study Setting

The study was carried out by the use of a questionnaire framed with questions that gave a

scoop of good farm practices at the farm level. The questionnaire was used to get dairy practices carried out at the farm level coupled with subsequent laboratory analysis.

2.3 Study Design

A cross-sectional study was carried out with an analytical component; to establish the effect of `dairy practices on the quality of raw milk and pasteurized fresh milk marketed in Kiambu County; and analysis and quantification of antibiotic residue.

2.4 Sample Size Determination

The study population consisted of open dairy farmers. A simple random sampling technique was used to get the farmers who participated in the study. To determine the sample size Fischer's formula was used [23].

$$n = \frac{Z^2 pq}{d^2}$$

where,

- n = desired sample size
- p = proportion expected to have the features under study; in this case, those who sell milk (50%) = 0.5
- z = standard deviation set at 1.96 (95% confident interval)
- q = 1-p i.e. proportion not expected to have the features under study (50%) =0.5
- d = degree of accuracy/sampling error-±10% = 0.1

Using the formula

$$n = \frac{Z^2 pq}{d^2}$$

$$n = \frac{1.96^2 \times 0.5 \times 0.5}{0.1^2}$$

$$n = 3.8416 \times \frac{0.25}{0.01} = 96.4$$

Four farmers were added to this number *n* to cater for attrition.

2.5 Sample Preparation

2.5.1 Sample collection

A questionnaire was prepared and administered in the Gatundu South sub-county. The

questionnaire helped to substantiate; type of dairy farming practice, mode of feeding and storage of feeds, how drugs are administered, type of drugs and treatment, records keeping in treatment, mode of disposal of milk from the treated animal, and the withdrawal period. In was also aimed at addressing how milk was handled and stored at the farm; and mode of quality parameter monitoring, deviation, cause of rejection and corrections. Consequently the evolution of experience and educational level; the experience of a farmer in dairy practice, level of formal education, level of knowledge of farm records management, how to trace the source of milk within the farm.

Three research assistants were hired and trained in conducting the survey. The study aimed to investigate dairy practices that contribute to the presence of commonly used antibiotics in raw and processed milk. This was to ascertain the quality and safety of consumed milk in the County.

The questionnaire was administered to the randomly selected dairy farmers who were present in the respective milk collection centers during the interview period. Those who could read and write were given to fill the questionnaire on their own while those who could not be interviewed by well-trained enumerators were translated the questions and the form filled in response to the respondents.

2.5.2 Study ethics

Before answering any question, consent was sought from the respondents. The respondents were taken through the purpose of the study, asked to voluntarily participate in the study and assured of the confidentiality of their responses. They were then asked to sign a consent form to show that they agreed to participate in the study.

2.6 Data Analysis

Data obtained were coded and entered into SPSS for Windows software (IBM version 25) and analyzed. Descriptive statistical percentages and frequencies were used to express the results of socio-demographic characteristics of the study population and the different milk handling practices. A chi-square test of significance was used to test for any existing significant associations between the various variables understudy with a p-value = 0.05 being set as the level of significance.

3. RESULTS

The uses of equipment at the farm contribute significantly when you use significantly give p-value to quality control as depicted in Fig. 1(Chart 1). It was found that 26 % of farmers practice dairy farming. Among the farmer, the farmer 64 % have adopted the use of aluminum containers while 34% still use plastic containers. The storage methods devised varied from refrigeration 7%, cold bath 42% while 47% have adapted none. The farmer still uses manual milking method 96%, while only 2% use the machine in milking. At the farm level, it was found that 42% have improvised cold bath storage, while 7% were using refrigeration methods and 44% did not have any form of preservation.

Quality control at farm level is poorly practiced as depicted on; Fig. 2; only 16% of farmers commented on quality monitoring and correction, hence 47% have their milk rejected. Only 2% took a step in quality correction; through improved feeding, hygiene improvement, and proper storage. Concerning quality challenges at the farm, only 2 % would seek professional guidance.

As depicted from (Fig. 3), quite a significant number of farmers have experienced the use of antibiotic treatment (46%), while 75% practice record keeping. Milk disposal from treated animals mostly is given to pet only 37%, damping-off 19%, a considerable number of farmers 95% understand about withdrawal period, which varied from 48hrs (9%) to 72 hrs. (51%) while 32% adhered to vet instructions, 6% did not have any information on the same.

From Fig. 4 it was found that, most of the farmers milked at around 4.30 am and 6.00 am (72%), while 22% milk three times, 79% have adopted to cold bath storage before delivery to buying stations, 83% sold to society while 14% to brokers, 1% sells to their neighbors. The farmers deliver milk to the buying centers within 2 hours hence minimal milk spoilage due to microbial growth. The farmers who have experience spoilage due to poor handling of evening milk delivered in the morning. Those farmers who do not deliver evening milk due to low volumes have adhered to separation of evening and morning milk to avoid spoilage of entire morning delivery. The rejection was due to off-smell and alcohol positive (85% alcohol v/v). Other factors included low density which attributed to poor feeding and

suspected adulteration incidence. The incidents of antibiotics at delivery were not determined; the milk is bulked and delivered to the company.

4. DISCUSSION

The study revealed that equipment used and storage has improved significantly, as compared to an earlier study [20]. Considerable numbers of farmers have adapted to the use of aluminum cans but quite number are still stack in plastic use. Though with power connectivity across the nation still, quite a significant number of farmers use manual milking while very small percentage have embraced the use of milking machines which still concurs from an earlier study [4]. The present study matches an earlier study in the elaboration of subsistence nature of dairy farming the cost of equipment deter improvement
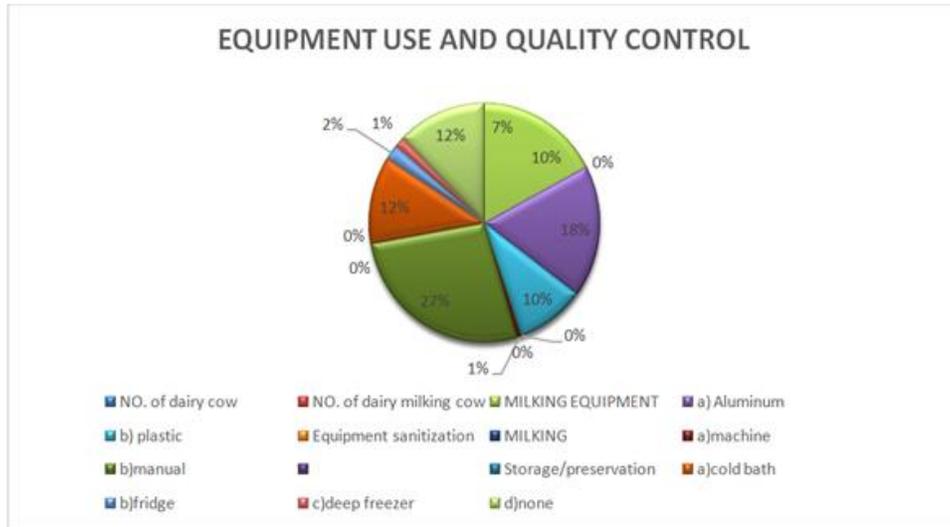
Chart 1. Use of equipment and quality control at farm level expressed in %
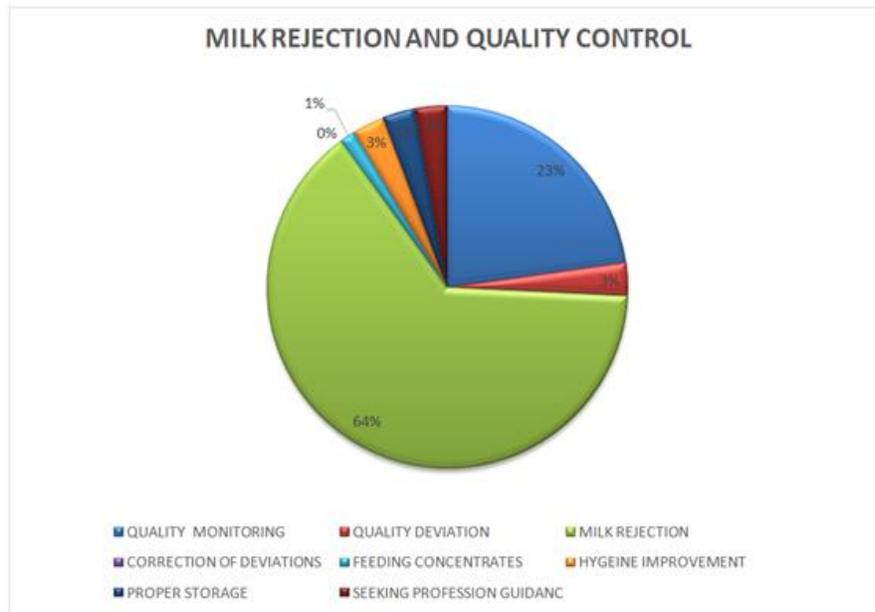

Chart 2. An expression in % of quality control and milk rejection components at farm level

at the farm [10]. These have consequently affected milk storage from quite several farmers, who use the cold bath to lower the temperature after milking. Only 5% could afford the use of cooling equipment; which is depicted by subsistence nature of farming. It shows quite some farmers do not practice any form of storage (44%); this clearly shows the cause of rejections at milk collection centers.Quality monitoring is a very important tool in quality control; it is at minimal levels at the farm as portrayed by the high proportions of milk rejection at the buying centers. This is a correction of various causes varying from handling, poor hygiene and poor storage at the farm. Correction measure is still at its minimal since after rejection only 2% of the participants took further action to curb future milk rejection. About 79% were able to cool milk through a water bath while 81% percent sanitize their equipment.

From the study, quite a substantial number of participants understood the use of antibiotic, but a need to take it seriously in terms of monitoring and understanding dangers that comes with its presence in milk paramount. They understood the use of records, but their use is minimal hence change is inevitable. Disposal of milk from treated animals varied across the participant, therefore, showing minimal understanding of dangers that come with antibiotics in milk. Findings in the present study partly match the earlier study on smallholders which showed a poor understanding of antibiotic residues in milk [24].

The farmers do not understand the risks associated with antibiotics since rejected milk by the companies are either given to pet or given for feeding the calves secretly selling back to brokers. They have minimal know-how, on drugs administration hence solely depends on vet guidance on its use. All farmers should know that hazards exist when it comes to selling milk during antibiotic treatment, and maybe they do, but the problem could be an economic aspect. Most smallholder farmers operate subsistence farming, not farming as a business (TechServe Kenya 2008*),* which makes it understandable why a farmer is forced to sell the milk. According to Shitandi and Sternesjö (2005), the farmers' most common reason for not discarding milk from recently treated cows was related to limited food supply and poverty which differs partly from the present study [10]. An earlier study shows,

the origin of antibiotic residues mostly comes from farm-level which partly matches the present study, though farmers have little knowledge about it and control measure at farm level [20]. Currently, big buyers such as Brookside dairy company have implemented rapid antibiotic detection at their cooling collection stations all over the country.

Farms have not adapted to use of record; they find them tedious since they do not take farming as a business. From previous studies, the finding was similar to the present study in that only the large scale farmers were serious in record keeping [10]. This helps in monitoring the productivity and prospects of dairy farming as the business. Farmer is encouraged to adopt records keeping to enhance dairy management and promotion of productivity in terms of economic gain. They also help to deter misuse of material and health management of the herb as well as improving in breeds [25]. In case of future treatment by a different veterinarian, it eases retrieval of medical history. Efficient record keeping enhances accountability and prospective future growth farming business [26]. The records enhance knowledge in ancestry origin, heat period dates, breeding, pregnancy, bulls used, vaccinations, milk production performance growth rates among others [27].

In the management of dairy farming, planning is one of the basic functions as it entails assessing internal and external factors that affect farming as a business. They are harmonized through the interaction of various management elements by setting objectives that are designed purposefully to achieve set goals. Through planning, activates are derived toward resource mobilization, enhance through setting key performance indicators and monitoring methods [25]. The emergence of milk societies has brought farmers together hence promoting quality through field day training and seminars, hence there has been an improvement in milk handling as compared to previous studies. These have minimized selling to brokers which accounts for 14%. The quality control at the farm level for antibiotics is critical since no control at the buying center through at the company's reception. The milk is often used for none fermented products. This poses danger to the consumer in terms of the health effects associated with antibiotics.
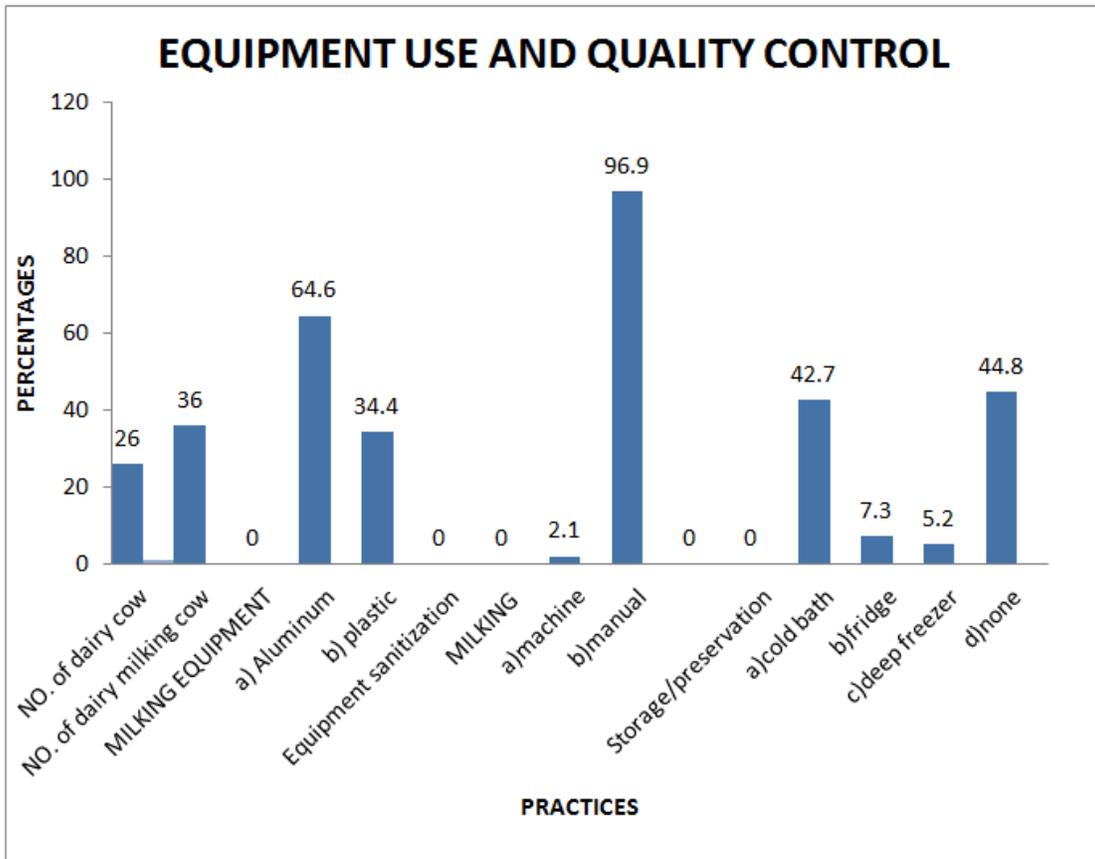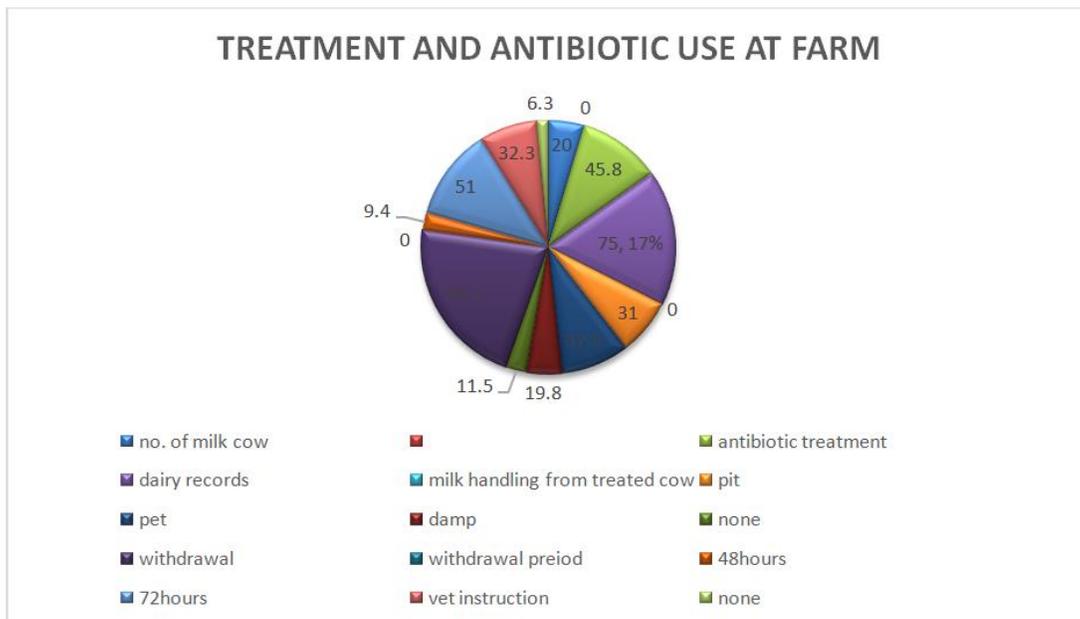
Fig. 1. Equipment use and quality control chart

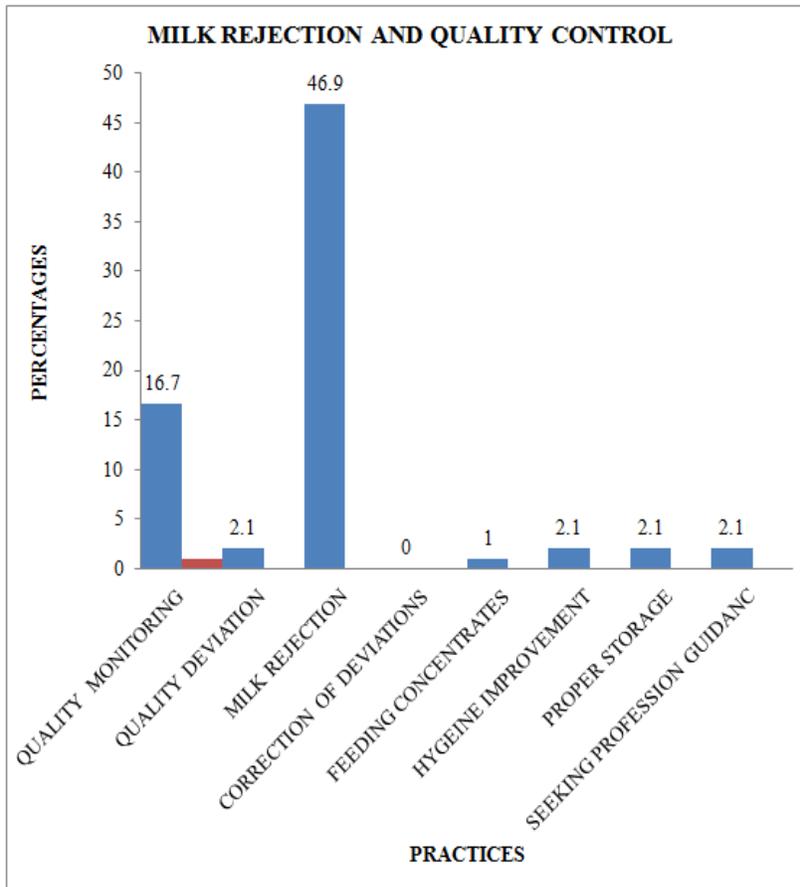**Chart 3. Animal treatment and use of antibiotic at farm level expressed in %**

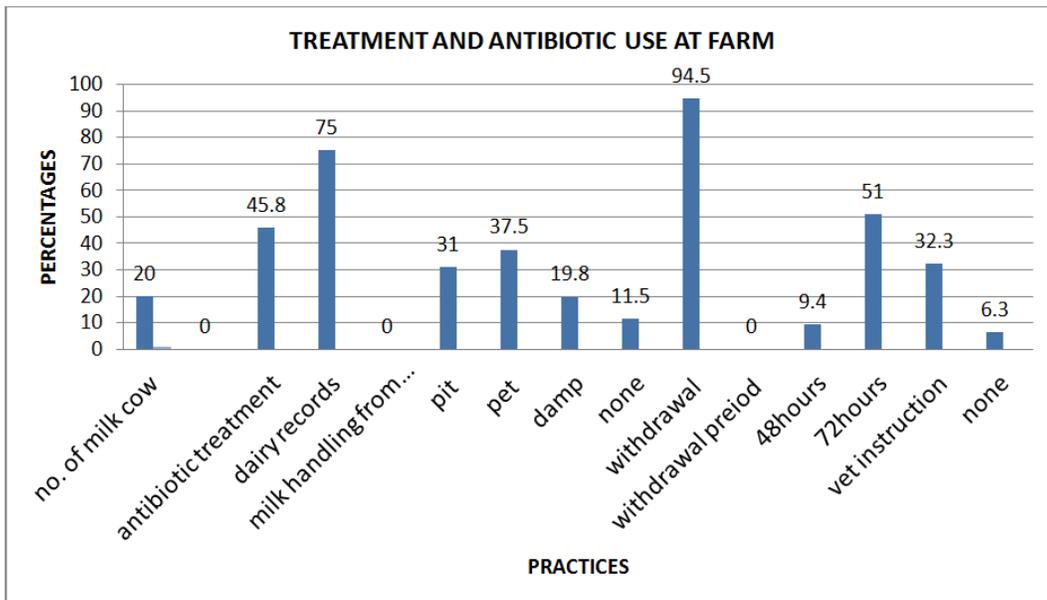**Fig. 2. Milk rejection and quality control**

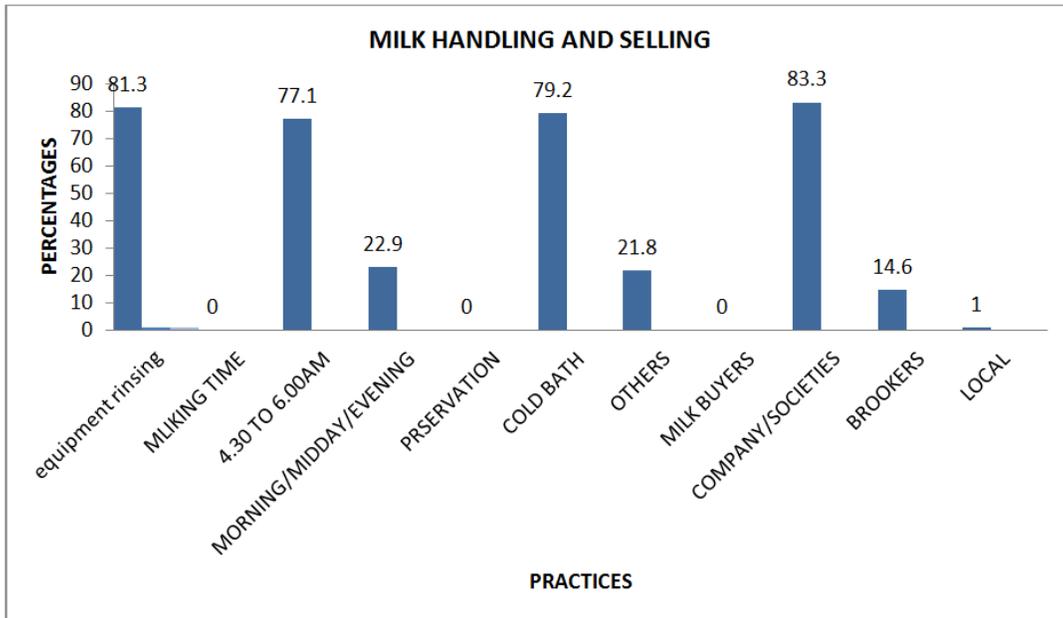**Fig. 3. Animal health practices and quality control**

Fig. 4. Milk handling and selling

Chart 4. Milk handling equipment's, preservation, and selling practices

5. CONCLUSION

It has been demonstrated that farming practices and dairy management are lacking at the farm level; this has been contributed by the dairy sector comprising of small scale holding. The milk and milk products are used in every household, hence the quality and safety become paramount in health wellbeing of the growing nation. The dairy farming in Kenya is characterized by small scale holding hence its subsistence in nature. The coordination and quality control of supply becomes a challenge despite milk safety campaigns by the Kenya

Dairy Board. The scrupulous traders still hawk milk in sub-urban centers and the capital city Nairobi. This makes it difficult to control the quality and safety of milk to consumers.

6. RECOMMENDATIONS

Putting a stringent measure in terms of sensitization and training on quality assurance at the farm level is vital. This involves the use of qualified animal health specialists, drug administration management, and observation of the withdrawal period. The farmers should also be trained on the consequence of selling milk of animals under treatment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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