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Research Article

BEHAVIORAL PRACTICES OF SUPPLY CHAIN ACTORS ON QUALITY MAINTENANCE OF RAW MILK IN NEPAL

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ABSTRACT

The quality of milk produced and marketed in Nepal is of sub-standard quality. Behavioral practices of the persons involved in milk production and handling influence the quality of milk. Recognizing this as an important factor, the study was conducted to assess the existing setups and behavioral practices of value chain actors - farmers, collection centers, transporters, and milk chilling centers - engaged in the raw milk supply chain. The study was carried out on 231 dairy households (selected randomly), 38 collection centers, 25 transporters, and 19 milk chilling centers operating within the network of six milk supply chains in Bara, Kavre, Makawanpur, Nawalparasi and Tanahun districts. The findings revealed that the adoptions of good husbandry and hygienic practices at all the levels were below acceptance. Mainly, the management of collection centers was poor in all aspects of the quality requirements. There was an inadequate awareness, and lack of required knowledge and skills in handling milk among collection center personnel (about 31% without any training). The infrastructure, utensils, equipments and facilities at collection centers were of primitive state; many of them of non-food grade that are likely to add further contaminants in collected milk. Time management at the collection centers (average milk holding time 2.8 hours) was also inefficient. All the collection centers and milk chilling centers must improve their facilities and reorganize their collection schedule so that the milk reaches milk chilling centers within a stipulated time of about three hours of milking at the farm.

Key words: Milk quality, raw milk, collection center, milk chilling center

INTRODUCTION

Agriculture Development Strategy (ADS) of the Government of Nepal recognizes dairy as one of the top five commodities with the potential for growth and commercialization (MOAD, 2015). Dairy is considered as the backbone of the country's economy as thousands of stakeholders are involved in the collection, transportation, processing and distribution of milk and milk products. Dairy farming is a one of the major economic activities, and the organized milk marketing support livelihoods of more than 500,000 smallholder and marginal farmers in Nepal (MOAD, 2016). Dairy sector offers regular cash income to farmers and provides nutritious foods, farm power and manure. Dairy is one of the highest income contributors to rural farmers (55%) in Nepal (Chaudhary & Upadhyaya, 2015).

Though the dairy sub-sector contributes largely to the national economy, the quality and safety issues have been the major challenges of this sub-sector. One of the reasons for the high bacterial load in raw milk is unhygienic practices in milk handling and poor know-how to clean milk production. The other important factor is the time spent in the supply chain before the milk is chilled - long hours before it reaches either at chilling or pasteurizing units that checks bacterial growth. In addition, raw milk quality also deteriorates due to some malpractices, which include the addition of water for increasing volume, sodium bicarbonate for reducing acidity, starch, sugar; and urea for increasing solid content and preservatives for longer shelf-life (FAO, 2010). The impacts of poor milk quality are severe on the growth of the dairy sub-sector and public health in Nepal. Such impacts are reflected in short shelf-life of processed products, limited range of manufactured dairy products, additional costs incurred in milk processing, and reduced opportunity to supply milk in the export markets.

Adoption of good dairy farming practices, i.e. in animal health, milking hygiene, nutrition (feed and water), animal welfare, environment and socio-economic management is essential for quality milk production (FAO & IDF, 2011). Developing and adopting a system of Good Manufacturing Practice (GMP) for the supply of raw milk to the processor is widely accepted as fundamental steps to maintain raw milk quality. In line with this requirement, the Ministry of Livestock Development (MOLD) in Nepal released the 40 points policy commitments, of them improving the quality standards of milk (MOLD, 2016) is in priority. Samarth-

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NMDP supported two studies on milk marketing situation in Nepal in 2015 (NDDB, 2015). Those studies revealed that mostly dairy smallholders did not adopt even the minimum methods of clean milk production. Similarly, problems existed in the collection and chilling centers in milk handling, storage and processing. This study complements the existing general studies with assessing the setups and behavioral practices of the value chain actors in the six raw milk supply chains in Nepal.

MATERIALS AND METHODS

This study was conducted in five districts of Nepal in 2016. The primary data required for the study were collected using interview schedules administered to farm households, Collection Centers (CCs), Milk Chilling Centers (MCCs), and milk transporters operated within the network of six milk supply chains in five districts namely Bara (Dumarwana Milk Producers Cooperative), Kavre (Setidevi Milk Producers Cooperative and Timal Multipurpose Cooperative), Makawanpur (Manakamana Milk Producers Cooperative), Nawalparasi (Gyanodaya Dairy), and Tanahun (Tanahun Milk Producers Cooperative).

The dairy farmers registered as members with the cooperative and collectors affiliated to partner MCC and supplying milk (based on farmers' list maintained at the CCs) constituted the population frame for selecting farmers. A total of 21 CCs out of 38 were selected randomly as a population frame for sampling farm households (HHs) for surveys. A total of 231 Households (HHs) out of 3,699 farmers of the sampled CCs (about 6% of the population) were randomly sampled for the HH survey. All the CCs (38), MCCs (19) and transporters (25) operating in the six milk supply chains were surveyed (interviewed and observed).

The data was analyzed using SPSS software and MS-Excel program. The descriptive statistics reflected the major findings of the study. Besides, direct observations during the field visits provided qualitative information in the study findings. The study findings on dairy households reflected the behavioral practices on feeding practices and animal nutrition, animal health, housing, personal hygiene of milking personnel, routine milking practices, milk filtration practices, milk storage, and cleaning of milk utensils and transport cans. The findings on CCs and MCCs were interpreted based on routine tasks carried out there and CCs/MCCs' premises, facilities, utensils and equipment being used. Bulking of milk and carrying to MCCs for chilling, cleanliness of the vessels used, water quality, time in transport and personal hygiene were the key components assessed on milk transporters.

RESULTS AND DISCUSSION

Socioeconomic description of dairy farming

Average number of dairy livestock holding per household was 3.45 (± 0.23 SE) with 1.27 adult cattle and 0.82 adult buffalo. Livestock holding showed a significant but weak positive correlation with family size ($r = 0.236$ $p \leq 0.05$) and land holding size ($r = 0.312$; $p \leq 0.05$). About 65% of HHs had allocated land for forage cultivation with average area of 0.12 hectare (range 0.01 to 1.35). Livestock holding had a positive correlation ($r = 0.464$; $p \leq 0.01$) with land area allocated for forage cultivation. This correlation should have been much stronger, implying there is still need to tie up forage promotion programs in dairy pockets that supports in the reduction of milk production cost. The cost of milk production in Nepal is higher than that in neighboring countries (NEPC, 2014).

The dairy animals were mostly crossbred types - cattle either Jersey or Holstein Friesian crosses and buffaloes Murrah crosses. The mean yield of these crossbred animals was below the breed potential - cattle 1,821 (± 726 SE) (range 300 to 3,734) and buffalo 1,288 (±573 SE) (range 300 to 2,888) liters/lactation. This wide variation in productivity indicates there is enough room for increasing milk yield by selecting the top performing animals as future parent stock and by improving feeding and husbandry practices.

The average milk produced on a household was 11.05 (±0.49 SE) liters/day and milk sold was 9.36 (±0.46 SE) liters/day. The annual mean income/HH from sales of milk was NPR 160,680. This income in cash is substantial for a smallholder farmer suggesting dairy could be one of the important sources of cash income of rural smallholders in areas where formal milk collection network and marketing exist.

Milk loss

Overall, 24.2% HHs reported loss of milk during various stages from milking to transportation to CCs. The highest quantity (about 90%) of the milk loss was due to bad storage facilities and unforeseen circumstances. The loss during milking, transportation and selling was negligible in comparison to losses due

to unforeseen circumstances like strikes, calamities, etc. Total loss of milk was less than one percent with respect to total milk sold. The milk loss from rejection due to quality issue at the CC was almost absent. It was surprising to note that milk loss due to spoilage of milk at CCs and MCCs was almost absent. Considering the poor quality of the milk at some CCs and MCCs, it is speculated that some manipulative efforts to alter milk composition is practiced. Bastola & Nepali (2016) did laboratory analysis of milk samples and found that milk was adulterated (from salt and sugar) at some of the MCCs in western Chitwan. Quality issues in milk due to deliberate adulteration by the supply chain actors exist in many developing countries (Mu et al., 2013).

Farm level practices and behavior for hygienic milk production
Animal nutrition

Reduced productivity and altered composition of milk is associated with inadequate feed and water supplied to the dairy animals. The feeding cost constituted about 58% of the total cost of dairy farming in Nepal (NEPC, 2014). The feeding schedule followed for cattle in general (similar ranges for buffaloes) was 53.6 liters of water, 4.4 kilograms (kg) ration feed, 8.8 kg dry straw, and 11.7 kg of green forage per animal per day. The findings revealed that legume forages and protein sources (i.e. pulse/bean byproducts) in the concentrate were too low. Water supply was restricted (2-3 times/day) and quantity was not proportional to milk yield. There is a knowledge gap among farmers about the water requirement of an animal based on physiological maintenance, i.e. by body size and the milk it is producing.

Animal health records

The animal health recording system allows tracing the health services, disease occurrence and drug use. However, no reliable animal health recording system existed at the farm level except a few notes/ prescriptions here and there. Department of Livestock Services (DLS), Animal Health Directorate has a system of reporting of epidemics of animal diseases, if any, in districts/locality, but lacks recordings at the individual farm level. Ignorance and lack of information has promoted repeated occurrence of common diseases leading to milk contamination with microorganisms when clinical or sub-clinical mastitis exists, and also increased the chance for occurrence of drug residues in milk.

Animal housing

Housing conditions determine the level of contaminants likely to enter in raw milk. Livestock shed floor and its cleanliness status becomes important factor for clean milk production. About 45% of the livestock sheds were in unacceptable conditions in terms of dryness of the shed (Figure 1). Wet sheds are more likely to be the source of infection for contagious diseases like mastitis and also for contaminants while milking that increase the microbial load of the milk at source. About 51% of the sheds were of unacceptable conditions in terms of cleanliness. This is one of the major factors affecting the cleanliness of udder and thereby causing contamination of milk while milking itself. Less than 30% of animal sheds had enough space for animals. Animals should have enough space to move and lie freely.
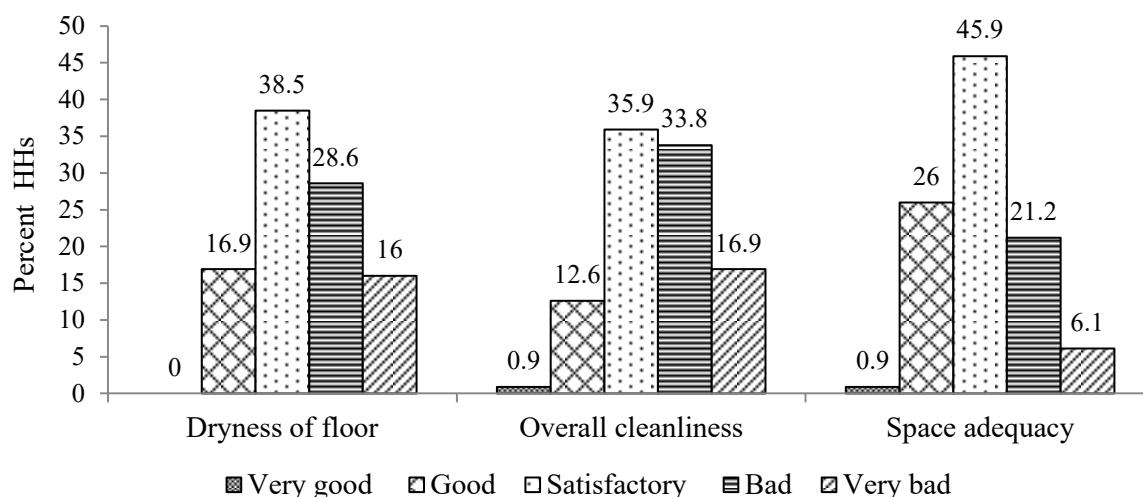

Figure 1. Housing conditions of livestock shed in the study sites (n=231)

Personal hygiene of farmers and milking personnel

The observations revealed that personal hygiene and behavior of milking personnel contributed the foreign particles and microbial load to raw milk at farm level. Dirty hands, clothes and wrong behavioral practices of milk handlers are major sources of contamination of milk. Cleanliness of the milking personnel and milk handlers was found just satisfactory (53%), bad (22%), very bad (7%), and good (18%) at farm households. It was noted that less than 20% of the milking personnel had an acceptable level of personal hygiene for milk handling. More than four fifth HHs reported milking or handling of milk by other healthy family member or a neighbor when the milk handler or milking personnel is sick. Awareness of personal hygiene requirements, behavior and preparedness for bringing these into practices are necessary. A study conducted in Chitwan district found that though the majority of farmers (95%) were aware of the importance and techniques of clean milk production, but they did not routinely adopt the procedures into practice (Bastola & Nepali, 2016).

Cleanliness of milking and milk storage utensils and equipment

Cleanliness of milking vessels, storage vessels and transport cans was observed satisfactory to very bad in the majority of HHs. Dirt, fat and other deposits in such utensils harbor microbes that contaminate milk and grow to greater number during the phase before chilling and reduce milk quality. Only about 16 to 20% of HHs in different sites had clean utensils. Moreover, there was no consistency in the use of cleaning chemicals. The farm households used different cleaning substances for cleaning utensils such as ash (4.8% HHs), detergent powder (16% HHs), soap (16.5% HHs), liquid soap (0.4% HHs), water only (3.9% HHs), and more than one substance (58.4% HHs).

Milking practices

Dairy farmers should be confident in the safety and quality of the milk they produce as they produce food for direct human consumption (FAO & IDF, 2011). Milking routine was practiced by only 28.1% HHs specifically by washing and drying the udder before milking, while 15.2% only by washing, not drying (Table 1). None of the farmers used to clean the udder properly. More than 43% HHs used to milk from dirty udders and teats. The impact of absence or improper washing and drying of the udder may cause dung contamination, soiling and entry of other solids that contaminate milk. About three-fourth HHs provided feed or water to animals immediately after milking, which is a good farming practice. If not practiced it may cause animals with open teat canals to lie down, allowing dirt and bacteria entering into the teat canal and causing teat/udder infections. Only 54.2% HHs reported that they discard milk from infected dairy animals, while 28.4% reported not doing so at all; 17.5% of HHs had not encountered any such kind of diseases. More than 95% HHs did not check foremilk for abnormality. About 60 and 20.3% of HHs were feeding calves through suckling and pot feeding, respectively. Some farmers followed both practices.

Large diversity was found in the type of vessels farm-households used in milking as aluminum can/bucket (34.2%), plastic bucket (17.3%) and stainless steel can/bucket (16.1%). About 18.6% HHs used more than one type of vessels, and 13.8% HHs used other materials as milking vessels. Plastic buckets are difficult to keep clean and are often used for multiple purposes, which pose contamination risk to milk.

Table 1. Pre-milking and post-milking practices in dairy animals

Parameters	Response	Percent response (n = 231 HHs)
Washing and drying of udder before milking	Yes	28.1
	No	56.7
	Washing but not drying	15.2
Provide feed/water just after milking	Yes	74.0
	No	26.0
Discard of milk in case of systemic sickness and mastitis	Yes	54.1
	No	28.6
	No disease noticed	17.6
Foremilk and check it for any abnormality	Yes	4.3
	No	95.7
Feeding calves	Suckling	59.4
	Pot feeding	20.3
	Both	3.5
	No feeding	16.8

Milk filtration

Only 52.4% of HHs reported adopting milk-filtering practices, and rest of the HHs did intermittently. They used different types of materials for sieving milk at home. About 40.3% HHs were not using any types of milk filters, while 33.2% HHs were using tea filter, followed by cloths filter (8.7%), plastic filter (7.8%), stainless steel filter (3.5%), general filter (1.3%), and more than one type of filter (5.2%). Cleanliness of the sieve farmers used was a matter of great concern.

Storage of milk at farm household

The practices such as keeping evening milk for selling on the next day, dirty utensil, keeping milk at warm temperature are key reasons for milk spoilage. About 22% HHs were storing milk overnight for selling on the next day. Overall, chilling of evening milk was not practiced in the HHs. About 68.4% HHs were not keeping milk can overnight in cold water, and 94.4% HHs were not wrapping the can with wet cloth. Adulteration practices like mixing of materials in milk for its preservation and/or fat/Solids Not Fats (SNF) improvement were reported in about 8% HHs only. The adulterants in milk have the potential to cause serious health related problems for consumers (Salih & Yang, 2017).

Practices and behavior of milk Collection Centers (CCs)
Milk sampling and testing at collection center

Cleanliness of sampling tools and testing area was observed satisfactory to very bad in the majority of CCs (Figure 2). Poor cleanliness contributes to false results of the testing, which mislead. About 71% of CCs practiced calibration of testing equipment, mostly with assistance from the processors. There was a lack of adequate and accessible service system for testing equipment calibrated. About 42% of CCs displayed standard milk sampling procedure. All CCs conducted tests for fat, over 75% for SNF, over 25% for acidity and over 15% CCs were practicing different tests as per need, including alcohol, and lactose and Clot-on-Boiling (COB) tests. Only 68.4% of CCs kept records of milk testing results. Only half of CCs reported coding of milk samples. No practice of taking duplicate samples existed.
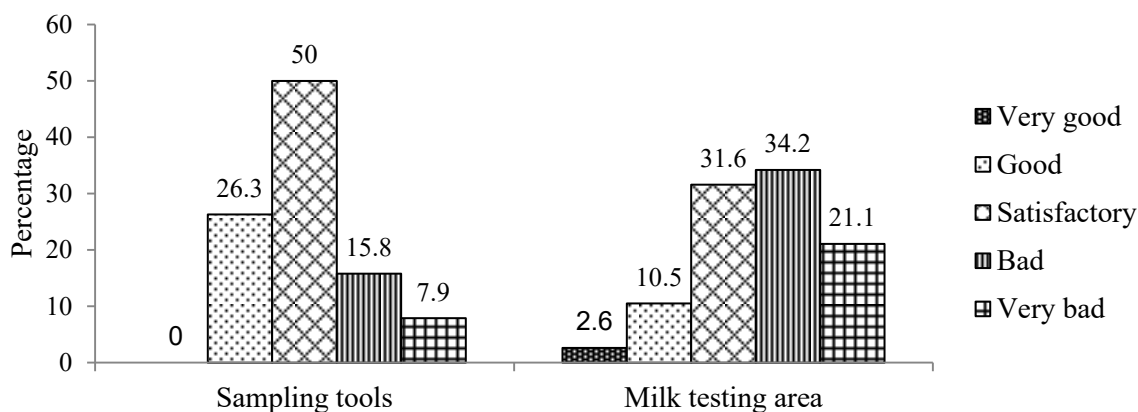
Figure 2. Cleanliness of sampling tools and testing area at the collection center (n=231)

Milk filtering at the collection center

Large variation was found in the use of filter types at CCs. About 34.2% CCs were using cloth and plastic filter, while 10.5% CCs were using more than one filter. The steel filters (2.7% CCs), cloth filters (34.2% CCs), general filters (7.9% CCs), tea filters (2.6% CCs) and locally available materials were also used for filtering milk. Only 28.9% of CCs reported application of guidelines for filter cleaning.

Milk storage in churns and vats at collection center

The CCs were using different types of vessels for storing milk as aluminum cans (34.2%), stainless steel cans (2.7%), plastic containers (26.3%), and other types (2.6%). About 34.2% CCs were using more than one type of storage vessels. Average milk storage or holding time in CCs was found 2.8 hours (hrs.), with maximum of 16 hrs. About 71% of CCs reported storage of milk in shady places while 29% reported storage in open spaces. Dirty milk containers stored in the open area are reservoirs for bacteria that would damage milk.

Cleaning of surfaces and equipment at collection center

About 95% CCs cleaned the milk cans and other equipment that directly come in contact with milk immediately after use. About 58% CCs reported adequacy of water; however, the testing for water quality was not a routine practice. Water quality used for cleaning purpose at CCs was observed satisfactory (36.8%) to very bad (23.7%). Over 70% CCs reported satisfactory to good facilities for cleaning of milk cans. About 40% CCs used surf and 32% used liquid detergent for cleaning purposes, while use of soap (3%), only water (6%) and use of more than one chemical (19%) also existed at CCs. The absence of fat deposition on storage vessels was observed good (24%), satisfactory (40%), bad (21%), and very bad (16%) at CCs. Milk residues are reservoirs for bacteria and can contaminate subsequent batches of milk causing decreased quality and spoilage.

Half of CCs reported cleaning of surfaces and equipment that do not come in direct contact of milk by water while 21.1% CCs reported dry cleaning (sweeping), 21.1% CCs reported cleaning by liquid detergent, and 7.8% CCs used more than one method. Dirty walls, floors, etc. harbor insects, yeasts and molds that can contaminate milk and reduce its quality. The majority of CCs reported cleaning of floors daily (84.2%), cleaning of walls weekly (55.6%) or monthly (33.3%), to even at yearly intervals for cleaning ceiling (22.3%). Internal checking/inspection on sanitation by supervisors is not a routine practice.

Personal hygiene of milk handlers at collection center

Personal hygiene of milk handlers (personal cleanliness, toilet facilities, and hand washing facilities) was observed satisfactory in the majority of CCs (Figure 3). However, the majority of CCs did not apply/follow the hygiene policies such as sickness policy, visitor policy, jewelry policy, and glass policy (Figure 4). Proper applications of these policies reduce the possible contamination of milk by jewelries, unwanted visitors' bangles, and glass pieces.

Figure 3. Observation on personal hygiene and facilities at collection centers (n=38)
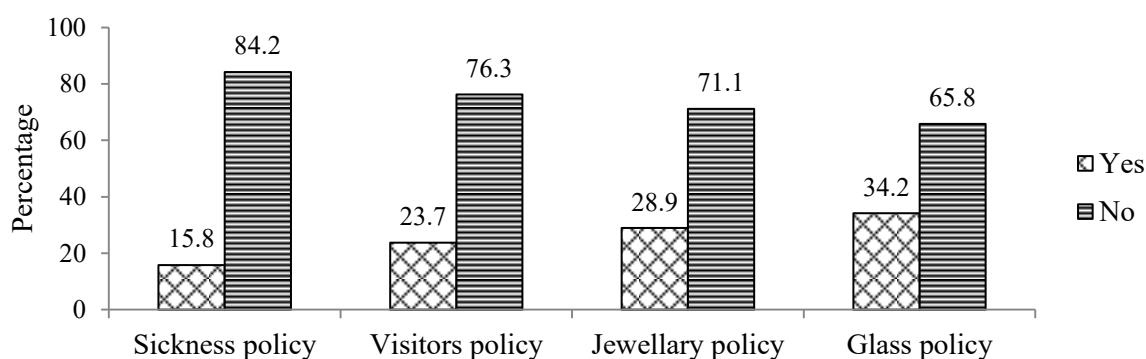

Figure 4. Application of policies at collection centers (n=38)

Pest control at collection center

About one in four CCs (24%) had some measures to control pest in their premises. It was observed that movement of several insects, including flies could contribute to contamination of raw milk in most of the CCs. The vermin carry dirt and diseases, which increases risk to milk contamination and also to human health.

Infrastructure in collection center and premises

Safety measures to check pollutants from surrounding areas was observed satisfactory (53.6%), bad (26.3%), and very bad (10.5%) at the CCs, and only 10.5% CCs were observed in good conditions. Over 75% of CCs had adequacy of physical infrastructure. Inadequate physical infrastructure hinders maintaining cleanliness and hygiene. Poor handling practices at the collection centers, milk-carrying tools and means of milk transport are considered as major factors of milk quality deterioration (Amentae et al., 2015).

Personnel management at collection centers

In majority of the CCs, no defined job descriptions were assigned to personnel working there. Only 34.2% of CCs reported clear description of roles and responsibilities of its staff. About 68.4% of CCs reported at least a worker/staff of the CC received some kind of training related to management of CC and milk production/handling. Insufficient training creates gaps in awareness and knowledge transfer mechanisms.

Routine checking and inspection of collection centers and farmers

About 78.9% CCs reported self-inspection, 52.6% CCs reported third party inspection, and 73.7% CCs reported inspection by milk chilling centers (MCCs) for cleanliness and records at CCs. Likewise, only 44.7% CCs practiced inspection of member dairy farmers. Checking through internal auditing from milk supply chain actors is the main control mechanism for ensuring the quality control systems and procedures are followed.

Practices and behavior of milk transporters
Bulking of milk into large vessels
        All the transporters reported easy access for cleaning of milk carrying vessels and utensils. About 92% of transporters were found cleaning of vessels immediately after use. About 85% of transporters reported adequacy of water for cleaning. However, only 24% reported testing the water quality that was used to clean the vessels. Water is considered as the most common adulterant used, which reduces the nutritional value of milk; the contaminated water poses a serious health risk for consumers (Salih & Yang, 2017).
        Cleanliness of loading pumps and pipes was observed satisfactory (64%), bad (20%), and very bad (8%) at the CCs, while only 8% CCs were observed good. Poorly cleaned pumps are of considerable risk to milk quality. They increase the bacterial load of milk and potentially contaminate the milk with oil, and metal fragments. Absence of fat deposition in the transport vessels was observed good (12%), satisfactory (36%), bad (40%), and very bad (12%) in CCs selected for study. The transporters used various types of transport cans as aluminum cans (52%), stainless steel can (4%), plastic drum (28%), and tank (16%). The containers made of a plastic are of low density and can be easily scratched. These scratches harbor bacteria and decrease milk quality.

Inspection of vessels and utensils
        About 72% of transporters reported self-inspection in place, and only 24% transporters reported third party inspection of transport vessels and utensils for cleanliness. In the absence of training and with the difficult roles transporters do play, checking on their standards of performance is essential to minimize the risk of contaminations of all kinds.

Transfer of milk
        About 60% of transporters reported records and traceability of milk batch applicable to CCs. The tracing of individual farmers was beyond the scope. About 84% of transporters reported back up transport in case of any problem. Above 96% of transporters reported preventive maintenance of vehicles used in milk transportation. Cleanliness of milk transporting vehicle was observed satisfactory (52%) to bad (36%) in the majority of transporters, while 12% transporters were observed good. Poor cleanliness causes the bacterial load of milk that can increase rapidly via dirty equipment, which comes into contact with milk. Milk carriers are important milk contaminating factors (Ranjit et al., 2008).

Personal hygiene of the milk transporters
        Personal cleanliness and clothing was observed satisfactory to good of the majority of transporters. Transporters reported variation in the application of the policies as the sickness policy applied by most transporters (72%) followed by glass policy (44%) and jewelry policy (32%).

Management of personnel engaged in milk transport
        About 48% of transporters reported clear description of roles and responsibilities of staffs. Only 8% transporters reported at least a worker/staff at CC attaining some sort of training on proper transportation of milk. Without proper training to transporters, there would be little/no awareness of the impact of their current practices on poor standards of milk.

Practices and behavior of Milk Chilling Centers (MCCs)
Milk sampling and testing at MCC
        Cleanliness of sampling tools and testing area at the MCCs was observed satisfactory (45%) to good (30%), while cleanliness of sampling tools and testing areas of about one fourth MCCs was observed bad. About 68.4% of MCCs practiced calibration of testing equipment, while 31.6% reported otherwise. Only 31.6% of MCCs reported displaying of standard milk sampling procedure. All MCCs reported fat test, 78.9% reported SNF test, 31.2% MCCs reported acidity test, and 26.3% MCCs reported lactose test. While boil test and temperature test was carried out by only 5.2% MCCs. Only 36.8% of MCCs reported coding of milk samples. About 80% of MCCs reported recording of testing results.

Milk unloading and filtering at MCC

Permission to unload milk at MCCs was granted by MCC Head/Manager. About 52.6% of MCCs reported verbal grant from the MCC head. About 68.4% of MCCs reported cleaning of unloading pumps and pipes, while 31.6% MCCs reported otherwise. About 63.2% of MCCs reported of provision of filtration guidelines.

Chilling process and cleanliness of chillers at MCC

About 84% MCCs were using chill vat, 5% were using plate chillers and 11% were using both types of chillers for chilling milk. About 52.6% MCCs were using acid reagents, while 47.4% were using alkali reagents for cleaning of chillers. The majority of MCCs reported using surf (36.8%) as cleaning agent, followed by liquid detergent (15.8%) and soap (10.5%). About 31.6% MCCs used more than one material for cleaning the chillers, whereas 5.3% of MCCs used water only for cleaning the chillers. About 31.6% MCCs were using more than one cleaning agent. About 42.1% MCCs were using hot water for cleaning purposes. About 36.8% MCCs reported self-inspection of effectiveness of cleaning, followed by Consumer Committees (21.1%) and Dairy Development Corporation (DDC) (21%). About 15.8% MCCs reported no such checking.

Cleaning of surfaces and equipment at MCC

About 84.2% MCCs reported immediate cleaning of cans and equipment that directly come in contact with milk. More than 70% MCCs had satisfactory to good facilities for cleaning milk cans. Only 15.8% MCCs were found displaying methods of cleanliness. Written and displayed procedures have a positive contribution to maintain good practices. Only 15.8% MCCs had good provision of cleaning water quality testing. Water quality testing was observed satisfactory (21.1%) to very bad (36.8%) in the majority of MCCs. Poor quality water used in testing negates the results of testing and misleads. The level of absence of fat deposition in vat covers and storage vessels was observed satisfactory to good in the majority of MCCs. The satisfactory to good level of no fat deposit inside the vat lid, inside of pipe and tap, and inside storage vessels were observed in 78.9%, 36.9% and 84.2% MCCs respectively. Poor removal of fat, protein and bacterial deposits cause a build-up in pipelines, taps, plate exchanges, and tanks those compromise the quality of milk. A study conducted by Dahal et al. (2010) in the eastern Terai of Nepal found that the total bacterial counts (TBC) in milk at the processing level significantly higher than the TBC in milk at the farm level.

Cleanliness of non-food contact areas was observed satisfactory (42%) to bad (47%). Only 10.5% of MCCs were observed good. Repeated touching of walls, doors, etc. transports the dirt to operators' hands and then to equipment.

Personal hygiene of MCC personnel

Personal cleanliness at MCCs was observed satisfactory (73.7%) to good (15.8%), however, 10.5% MCCs reported bad condition. Hand washing and toilet facilities were observed in satisfactory (52.6%) to good (28.9%) conditions. Sickness policy was adopted by about 90% of MCCs while visitor policy, jewelry policy and glass policy were followed by 31.6% and 31.6% and 42.1% of MCCs, respectively.

Pest control measures at MCC

Only just over one-fourth of MCCs were applying pest control activities to prevent contamination in milk. There is a high risk of deteriorating quality of milk due to pests at MCCs. For example, rats harbor Wyle's disease. The presence of Coliforms especially E. coli in milk may pose health risk through infection to people, especially if not well pasteurized (Adesinaet et al., 2011; Kivaria et al., 2006). The study conducted by Arjyal et al. (2004) found that the raw milk available in Kathmandu valley was contaminated with several types of microorganisms (mostly E. coli).

Facilities and cleanliness of MCC premises

Cleanliness of MCC premises becomes very important to minimize the entry of dirt and contaminants into milk plants, pipe systems, floors, equipment, and even for the hygiene of the personnel. About half of the MCC had muddy, earthen premises with likelihood of entering the dust/dirt from premises to milk chilling facilities. Safety and pollution conations at MCCs were observed satisfactory (53% MCCs) to good (21% MCCs). However, it was observed bad in 26% of MCCs. About 70% of MCCs were found having energy backup in case of load shedding or power shortage situations.

MCC personnel management

About 68.4% of MCCs reported clear description of roles and responsibilities of its staff. About 63.2% of MCCs reported at least a worker/staff attaining some of trainings related to management of MCC and clean milk production.

Internal checking, inspection and auditing by MCCs

All MCCs reported self-inspection of records and cleanliness. About 78.9% reported public body inspection, and 73.7% MCCs reported inspection by processors for cleanliness and records at MCCs. Likewise, 84.2% of MCCs were inspecting CCs for records and cleanliness, and 57.9% of MCCs were also inspecting of dairy farmers. The depth of inspection in terms of milk quality appears shallow.

CONCLUSION

Good-quality raw milk is required to make good-quality dairy products. Degraded raw milk cannot be improved during processing, and defects often become more pronounced at the processor level. Therefore, it is important that raw milk be produced and handled from farm to chilling centers under conditions that do not reduce its quality.

There is a lack of consistency of milk quality across different points in the raw milk supply chain. The evidences of the behaviors and the negligence of the actors lead to milk quality deterioration in different points in the supply chain. Good herd management practices help ensure low bacteria count at source that reduces the risk of the presence of pathogens in raw milk. Chilling milk at the earliest possible time can check the further microbial growth.

In Nepal, management of CCs is poor in all aspects of quality requirements. There is inadequate awareness and lack of specific knowledge and skills in handling milk among the CC personnel. The infrastructure, utensils, equipment and facilities at CCs are of primitive state, many of them of non-food grade that are likely to further add contaminants to collected milk. Time management at collection center is inefficient. All the CCs and MCCs must improve their facilities, inculcate knowledge and skills to bring good practices while handling milk and recognize the importance of time in their collection schedule so that milk reaches MCCs within a stipulated time of about three hours of milking at the farm. Such milk can be subjected to chilling before it is spoiled. If the timing of collection and delivery to MCCs is managed appropriately, actors will minimize adulteration in milk to correct the compromised milk quality.

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