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A participant – Led programme for field veterinary training to identify bacteriological quality of milk from the farmer to the retail outlet

R. Kalupahana [a], A. Silva-Fletcher [b, *]

[a] *Department of Veterinary Public Health and Pharmacology, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Sri Lanka*
[b] *Lifelong and Independent Veterinary Education, Clinical Sciences and Services, The Royal Veterinary College, London, UK*

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ABSTRACT

The training of field veterinarians in veterinary public health needs an in-depth understanding of the *in-situ* problems, social and economic barriers that prevent problem solving and a relevant pedagogical approach to suit the mature learner. A participatory approach is necessary to develop such training. A course designed on the principles of adult learning theory and utilizing the experience of the field veterinarian's local knowledge combined with the expertise of the training provider can be very effective. Forty-eight field veterinarians were trained using a collaborative, participatory approach to understand the issues in clean milk production in Sri Lanka. The veterinarians developed a Hazard Analysis Critical Control Point-based decision framework to identify and evaluate the evidence of bacterial contamination points in the milk chain from the farm to the processing plant. Samples and swabs were collected for bacterial culture and results showed high bacterial counts that showed contamination of milk starting from the farm, through milk collection and chilling centers ending with 2×10^6–3×10^7 bacteria per ml of milk. Chemical and physical hazards were also identified. Lack of appropriate hygienic procedures, chilling at the farm and at the collection center, together with the delays at the chilling center was identified as main contributing factors for high bacterial counts. This problem-based training approach facilitated collaborative inquiry, experiential learning and critical analytical skills. The training enabled the veterinarians to understand the scale of the problem and how they can intervene directly and indirectly to ensure clean milk production in Sri Lanka.

1. Introduction

With the advent of continuous professional development (CPD) of veterinarians in food safety and public health, new questions about training approaches have arisen. What are good pedagogical approaches to train field veterinarians in public health? A field veterinarian may have an understanding of the local context in public health and what the issues are. But they may lack the skills, knowledge and confidence in developing an effective problem-solving pathway to address the issues. The trainers who develop CPD for field veterinarians are often university based educators and researchers and they often lack the same in-depth understanding of *in-situ* issues. They are, however, well placed to develop the confidence and skills in field veterinarians to construct their own knowledge that can influence practice (Scales et al. 2011).

Constructing own knowledge is considered an effective approach to learning (Vygotsky, 1978). Learning is considered to be an active process, where what the student does is more important than what the teacher does (Biggs, 1999). The field veterinarian therefore must process information actively, building on experience and existing knowledge to develop outcomes that are relevant. The trainer's, or the facilitator's, task is to guide the field veterinarian by providing a relevant framework and the environment to achieve this. However it should also be acknowledged that veterinarians, teachers and researchers could learn from each other based on knowledge developed from previous experiences. In the trainer and trainee relationship, the field veterinarians should have a participatory role in the *in-situ* identification of the problem, developing a problem solving pathway, collecting evidence and using the data to indicate how the problem can be solved (Baum, MacDougall, & Smith, 2006).

In tropical countries, food safety is an area that is beset with problems: particularly in the supply of dairy products to the consumer within the dairy sector (Aaku, Collison, Gashe, & Mpuchane,

* Corresponding author.
E-mail address: asilvafletcher@rvc.ac.uk (A. Silva-Fletcher).

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2004; Kurwijila et al. 2006; Uddin, 2013). The inherent problem of warmer climates, lack of good infrastructure for transport, issues related to refrigeration and unhygienic practices of stakeholders in the milk chain are all contributing to this massive problem. The milk chain starting from cow's udder to the milk processing plant is inundated with many contamination points. Among the plethora of factors in addition to mastitis, lack of hygienic practices during milking, poorly disinfected milking utensils and use of low quality water, are key factors in determining the microbiological quality of bulk milk at the farm-level (Bonfoh et al., 2003, Gran, Mutukumira, Wetlesen, & Narvhus, 2002). Milk, as the starting point in the dairy production chain is a nutritious food commodity: not only for humans and animals but also to a vast array of bacteria that can rapidly multiply in milk at high ambient temperatures and a neutral pH.

The microbiological quality of milk (in terms of the presence of bacteria) has direct influences on consumer safety and shelf life of milk products. On the one hand the presence of pathogenic bacteria in milk transfers milk borne zoonotic diseases (Arimi, Koroti, Kang'ethe, Omore, & McDermott, 2005; Ayele, Neill, Zinsstag, Weiss, & Pavlik, 2004; Evans, Roberts, Ribeiro, Gardner, & Kembrey, 1996) and on the other hand high bacterial counts affect the physical and chemical quality of milk, in turn affecting milk products (Barbano, Ma, & Santos, 2006; Deshapriya & Silva, 2006; Muir, 1996). Considering these facts, safety standards for raw milk have been imposed in some countries. The basic hygienic requirement for raw milk in the European Union (EU) is $\leq 1 \times 10^5$ cfu/ml bacteria (Hillerton & Berry, 2004). However, as illustrated in Table 1, in tropical countries, the bacterial counts identified in raw milk are far above this EU standard.

Sri Lanka, is a tropical country with high environmental temperatures, a lack of immediate cooling facilities for milk at farm level and an already existing high prevalence of clinical and subclinical mastitis in dairy herds (Gunawardana et al. 2014). Sri Lanka therefore faces difficulties in maintaining good hygienic standards of milk. Scant and scattered data available on milk hygiene have indicated poor quality of raw milk with high bacterial counts and its influence for product quality in the Sri Lankan market (Deshapriya & Silva, 2006, Ubeyratne, Jayaweera, & Mangalika, 2014).

The estimated milk production in Sri Lanka for the year 2013 was 320 million liters accounting for 41% of the total milk requirement of the country (Anonymous, 2014). Many small-scale dairy farms contribute to milk production in the country and milk from these farms is collected by a number of different milk collecting networks. Generally, hand milking is practiced and the dairy farmer transports collected milk to a collecting center. The dairy processors transport milk from the collecting centers to the processing plant. Therefore, there are many stakeholders contributing to the hygienic quality of milk in Sri Lanka. Out of these stakeholders, field veterinary officers bear the highest responsibility and authority in improving the quality of milk at farm level. Training them on dairy quality assurance systems is therefore suggested to be a valuable exercise.

Hazard analysis critical control point (HACCP) is a well-developed systematic approach to the identification, evaluation and control of hazards (whether biological, physical or chemical) in a particular food operation system (Van Schothorst, 1998). It is well accepted that quality assurance system such as HACCP can improve microbiological quality of milk and milk products (Lievaart et al. 2005; Nada, Ilija, Igor, Jelena, & Ruzica, 2012; Ruegg, 2003). Developing a HACCP decision tree with key control and critical control points has to be done *in-situ* with detailed consideration and understanding of the local processes (Boccas et al. 2001; Roberto, Brandão, & da Silva, 2006). It is likely that some veterinarians do not have the theoretical knowledge regarding HACCP or have never used this approach in their field practice. It is necessary to identify the physical, chemical (Singh & Gandhi, 2015) and microbiological (Noterman, Zwietering & Mead, 1994) hazards in the milk chain and the field veterinarians with their knowledge and experience of local situation and practices are best situated to develop such a HACCP plan. The CPD training providers on the other hand are competent in delivering the theoretical basis of HACCP and can guide the field veterinarians to develop a HACCP decision tree to enhance quality of milk and milk products to the consumer.

Overall this is anticipated to lead to an active approach to learning, problem solving and a participant-led CPD programme that encourages engagement with longer lasting impact. The aim of the current project was to develop the participant-led CPD for field veterinarians so that they would develop skills in critical thinking and become proficient in evidence collection for decision making to address local public health issues.

2. Materials and methods

2.1. Course participants

A total of 48 field veterinarians working for the Department of animal Production and Health in nine provinces were recruited as participants. They were nominated by their provincial directors and represented a cross section of field veterinarians in Sri Lanka. Two workshops, each of four-day duration, were conducted with 24 participants per group.

2.2. The training programme

The training programme was designed as a face to face short course. To update theoretical knowledge, the course consisted of lectures, practical sessions and field training. The lectures were designed to explore problems associated with clean milk production in Sri Lanka, HACCP principles and application in the farm to the processing plant, milk testing and quality assurance in the UK (for comparison). Laboratory practicals were conducted to ensure that the veterinarians understand the routine milk testing at the collection points in Sri Lanka. Practicals included demonstration of milk sample collection and processing for bacteriology and checking for chemical hazards such as adulterants that are commonly added to milk. The tests included sugar, salt, starch, glucose, neutralizers, urea, formaldehyde and hydrogen peroxide. The practicals were mainly considered as a refresher activity as the participants

Table 1
Total bacterial counts of raw milk at the farm level in some tropical countries.

Country	Standard plate count number (CFU/ml)	Reference
Burkino Faso	1×10^7	Millogo, Sjaunja, Ouédraogo, & Agenäs, 2010
India (Odisha)	5×10^8	Minj & Behera, 2012
India (Madurai)	6×10^5	Lingathurai, Vellathurai, Ezil Vendan, & Alwin Prem Anand, 2009
Malaysia	12×10^6	Chye, Abdullah, & Ayobet, 2004
Mali	5×10^6	Bonfoh et al. 2003