An Exploration of Milking Practices on North Wales Dairy Farms: Potential Impact of Behaviour upon Microbiological Quality of Unpasteurised Milk.

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Introduction

Consumption of raw milk has become popular in recent years among UK consumers and therefore, its regulation is important to ensure food safety[1]. The increased popularity is demonstrated by a 5-fold increase in the production volume from 610,000 litres in 2012 to 3.2 million litres in 2017[2]. Raw milk can be purchase in England, Wales and Northern Ireland directly through farmers markets', farm shops, online or through vending machines at farms[3].

Raw milk must comply with the standards set in The Food Hygiene (Wales) Regulations 2005, Schedule 6 – Regulation 32, Restrictions on the Sale of Raw Milk intended for Direct Human Consumption. In accordance with the regulation, raw milk must meet specific microbiological standards[3].

Due to its nutritional availability raw milk can be a vehicle for spoilage and pathogenic organisms[4]. When harvested from the mammary gland of a healthy cow, milk is sterile however, many factors can impact upon the microbiological content of milk. Contamination can occur during milking or as a result of on-farm practices[5, 6]. Potential routes of contamination include the milking parlour, housing, bovine faeces, milking equipment, humans and from the cow[7].

Currently, there is no standardised milking procedure for farmers in the UK, therefore the milking method is decided by the farmers, resulting in a large variation in practices[8, 9]. On-farm practices can be habitual, influenced by resource, or differ due to equipment availability[8, 10].

Although research has assessed the microbiological quality and safety of raw drinking milk on retail sale in England[11], given the lack of a standardised milking procedure, there is a need to explore the potential impact of different on-farm practices and milking procedures on the microbiological quality of raw milk.

Purpose

To explore the potential impact of on-farm milking practices upon the microbiological quality of unpasteurised cow's milk.

Methods

An observational and microbiological survey was conducted in the milking-parlours of dairy farms in North Wales (*n*=15), involving:

- An observational survey which included a hygiene index and captured data detailing the maintenance of machinery; cleanliness of the surrounding environment; milking system; and milking techniques.
- Microbiological sampling of unpasteurised milk samples were analysed for *Enterobacteriaceae*, *Escherichia coli*, *Staphylococci*, *Salmonella* spp., *Listeria* spp. and *Campylobacter* spp. following standard procedure at an UKAS and ISO/IEC 17025:2017 certified microbiology testing laboratory.
- Statistical analysis was undertaken to identify potential association between microbiological quality of milk and on-farm observations that were undertaken.

Results

As part of this study, fifteen dairy farms in the counties of Conwy and Denbighshire in north Wales were visited to undertake the observational and microbiological survey. As indicated in Table 1:

- The herd sizes ranged from 60 – 324 cows, which included purebred and crossbred Holstein, Friesian and Jersey cows.
- The majority (87%) of farms had herringbone milling parlours, which are commonly used on dairy farms with smaller herds, where by the milking machines are positioned in the middle, between two aisles where the cattle stand at a 45-degree angle. The other style of parlour observed were a rotary parlour and a tandem parlour that operated 24 hours a day.
- The majority of farms milked twice a day.
- All farms visited had automated washing of the parlour and tank at the end of each milking.
- The majority (55%) of farms only pastured their cows, 36% housed the herd indoors only, the remainder were both.

Table 1: Demographic characteristics of dairy farms (*n*=15)

Farm ID	Herd size	Cow breed	Daily milking frequency	Parlour type
Farm A	188	Holstein, Friesian, Jersey	2	Herringbone
Farm B	182	Holsteins	2	Herringbone
Farm C	180	Holstein Friesians	3	Herringbone
Farm D	160	British Friesians	2	Herringbone
Farm E	128	Friesians	2	Herringbone
Farm F	60	British Friesians	2	Herringbone
Farm G	130	Holstein Friesians	2	Herringbone
Farm H	105	Holstein	2	Herringbone
Farm I	324	Friesians, Holsteins, Jerseys, Friesian cross	2	Herringbone
Farm J	120	Holstein Friesians	2	Herringbone
Farm K	248	Jersey X Friesian	2	Herringbone
Farm L	210	Jersey Crosses and Friesians	2	Herringbone
Farm M	230	Holstein Friesians	Continual	Tandem
Farm N	140	Friesian	2	Herringbone
Farm O	212	Holstein, Jersey X Friesian, Norwegian Red	2	Rotary

Attitudes of farmers towards raw milk consumption and hygiene practices

In Wales, raw milk must comply with microbiological standards[7]. During the farm visit, attitudes of farmers regarding hygiene practices and towards raw milk consumption were explored:

- 80% of farmers thought that their bacteria management was somewhat adequate and 20% believed it was extremely adequate.
- None of the farms sold raw milk directly to the consumer from the farm gate, and 87% had no desire to sell raw milk directly in the near future.
- All farms visited reported personally consuming raw milk.
- 67% of farmers reported they would recommend others to consume raw milk, 13% reported that they would not recommend consumption to others and 20% stated that they were unsure of recommendations.

Microbiological quality of milk

As indicated in Table 2, *Salmonella spp., Listeria spp.* and *Campylobacter spp.* were not detected in any samples from the visited farms, this is inline with the microbiological requirements of the pathogens being absent in 25ml[7].

Table 2: Microbiological quality of raw milk from visited farms (*n*=15).

Farm ID	Enterobacteriaceae (CFU/ml)	B-glucuronidase positive *Escherichia coli* (CFU/ml)	Coagulase Positive Staphylococci (CFU/ml)	Aerobic Plate Count (CFU/ml)	*Salmonella* spp. (CFU/ml)	*Listeria* spp. (CFU/ml)	*Campylobacter* spp. (CFU/ml)
Farm A	1	1	24	3,800	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm B	14	1	8	17,000	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm C	47	1	84	16,300	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm D	1	1	156	40,000	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm E	5	1	32	1,200	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm F	4	1	12	1,000	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm G	2	2	26	210,000	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm H	4	1	2	94,000	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm I	37	4	2	100	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm J	29	7	2	4,200	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm K	3	1	2	500	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm L	160	121	15	5,800	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm M	2	1	3	600	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm N	1	1	2	300	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml
Farm O	8	1	6	200	Not detected in 25ml	Not detected in 25ml	Not detected in 25ml

- 80% of farms had were within microbiological specification for aerobic plate count at 30°C ≤ 20,000 CFU/ml[7].
- All farms were within microbiological specification for Coagulase positive staphylococci ≤ 10,000 CFU/ml[7].
- At 53% of farms, raw milk was stored in tanks between 0-5^{o}C, 13% had tank temperatures between 6^{o}C and 10^{o}C and 33% had tanks at temperatures above 10^{o}C. No significant differences in storage temperature and microbiological quality were determined (p>0.05).
- Personal protective equipment (PPE) such as aprons and gloves were worn by farmers and herdsmen during milking, however, when worn, gloves were not changed throughout the duration of milking. No significant differences were determined according to PPE use (p>0.05).
- No significant differences were determined in microbiological quality of milk and self-reported hygiene practices such as reported time since replacing teat cup liners, method of cleaning teats and the frequency of cleaning the milking clusters.
- The majority (55%) pastured their herd, lower *E. coli* counts were significantly associated with farms of 'pastured cows' than 'housed cows' (p<0.005). Indeed, previous research suggests that bedding is considered to be one of the main routes of contamination in milk[8, 9, 12].
- Farms with parlour floors graded as 'excellent condition' according to the hygiene index score, had significantly lower levels of Aerobic Plate Count in raw milk (p<0.005).
- No significant association were determined microbiological content according to herd size, breed, or milking frequency (p>0.05).

Significance of study

- It must be noted that the milk from the farms in this study was not sold as raw milk direct to the consumer. All milk was collected and pasteurised.
- Previous research has focused on the effect of milking practices on the efficiency of milking, however, completion of this study has explore the potential impact of on-farm hygiene practices and milking practices on North Wales farms upon the microbiological quality of unpasteurised cow's milk.
- Findings suggest that there is a need to support farmers with the provision of information regarding the impact of on-farm practices upon the microbiological quality of raw milk.

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