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RESEARCH ARTICLE

Assessment of Raw Milk Quality at Selected Chilling Centers in the North Central Province of Sri Lanka

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ABSTRACT

Cow's milk is a vital and highly nutritious food for consumers, and its quality significantly influences dairy production practices. The quality of raw milk depends on its chemical composition, serving as the basis for evaluation. While standardized testing processes are commonly used to assess milk quality in industrialized nations, Sri Lanka lacks comprehensive regional databases for monitoring milk quality. This research aimed to identify key quality parameters of raw milk from selected milk chilling centers in selected areas such as Kahatagasdigiliya, Galenbidunawewa, Thambuththegama, Siwalakulama, Kekirawa, Padaviya, Medawachchiya, Welikanda, Nochchiyagama, Srawasthipura, Saliyapura, Rabawa, and Higurakgoda of the North Central Province of Sri Lanka. The analyzed parameters included fat, solid non-fat, lactose, protein, added water, freezing point, corrected lactometer reading, pH, keeping quality , solubility index and milk stability, all of which help assess the quality of raw milk in compliance with established standards. Milk samples were analysed using ultrasonic milk analysers, pH meters, alcohol precipitation tests, and resazurin dye reduction tests. The quality status was determined using mean comparisons and process control charts. The results revealed the mean quality values of milk from selected areas of North Central Province as follows: pH (6.19±0.14), fat (3.95±0.08%), solid non-fat (8.46±0.16%), protein (3.27±0.06%), lactose (4.87±0.11%), corrected lactometer reading (27.48±0.08), added water (0.13±0.01%), freezing point (0.57±0.03°C), solubility index (0.69±0.01 mg/L), and keeping quality (2±0.03). Additionally, 96% of the samples yielded negative results in the alcohol precipitation test. Based on the findings, none of the regions studied consistently produced raw milk that met the established SLS quality standards. Common deficiencies were observed in parameters such as fat content, solids-not-fat (SNF), pH, and keeping quality. These widespread quality issues highlighted the need for targeted interventions at the grassroots level. Educating dairy farmers on proper milking practices, hygiene, feeding, and milk handling is essential for improving milk quality and ensuring compliance with national standards.

***Keywords**: Comparative study, Milk collection, North Central Province, Quality parameters, SLS standards*

INTRODUCTION

Milk is a nutrient rich natural food that provides essential macronutrients such as proteins, fats, and carbohydrates, alongside vital micronutrients such as copper, zinc, manganese, and iron. These components are essential to human health and development (Murphy *et al.*, 2016; Gupta and Devesh, 2014). Among the various types of milk, cow's milk is globally recognized and widely consumed in different forms, including fresh, powdered, and fermented products, serving as a dietary need for millions of people worldwide (Perera *et al.*, 2019). In Sri Lanka, the consumption of dairy products has risen in recent years, reflecting growing demand. However, maintaining milk quality remains a difficult challenge to overcome. Due to its perishable nature and susceptibility to microbial contamination, milk quality can rapidly deteriorate, compromising both safety and nutritional stability (Srairi *et al.*, 2009; Perera *et al.*, 2019). Quality assurance typically includes analyzing physicochemical properties such as fat content, protein concentration, lactose levels, and solids, along with hygienic indicators such as microbial content, pH, and overall stability (Srairi *et al.*, 2009). While many developed countries have established well established systems to monitor and ensure milk quality from farm to consumer, Sri Lanka currently lacks a tailor-made database to systematically track these quality parameters. This deficiency hinders the efforts to uplift raw milk standards and limits the implementation of systems for farmers to improve milk quality (Valeeva *et al.*, 2007; Srairi *et al.*, 2009). To address this gap, our study focused on evaluating key quality indicators in raw milk samples collected from chilling centers across Sri Lanka's North Central Province. The research team measured parameters including fat, protein, lactose, pH, freezing point, lactometer readings, detection of added water, solubility index, and microbial keeping quality through resazurin dye reduction tests. By establishing benchmarks and investigating the interrelatedness among these factors, this research aimed to provide practical recommendations to enhance the dairy supply chain. Ultimately, these improvements will benefit both producers and consumers by ensuring safer, higher quality milk.

METHODOLOGY

The research study was conducted at Pelwatte Dairy Industries (Pvt.) Ltd. Raw milk samples were collected into labelled separated plastic bottles from the milk chilling centers. Random milk samples (200 mL) were collected from selected chilling centers in the North Central Province, then transported into the laboratory in strigiform boxes with gel ice (30–40°C) and subjected to laboratory quality analysis. All laboratory experiments were conducted in accordance with ISO and AOAC standards, as well as to the guidelines provided in the equipment manuals. Around 400 milk samples were collected from each centre weekly for a 2-month period.

Fat, solid non-fat, protein, lactose, corrected lactometer reading, added water, freezing point, and solubility index of raw milk samples were recorded using an ultrasonic milk analyser (AMA40, Shree Kamdhenu Electronics Pvt. Ltd, Gujarat, India) (Sulaiman and Silva, 2023). A pH meter (PH600, Milwaukee Instruments, North Carolina, USA) was used to measure the pH of the samples. The alcohol precipitation test was used to detect the stability of the raw milk samples. The keeping quality of the samples was determined using the Resazurin dye reduction test (Murphy *et al.*, 2016; Gupta and Devesh, 2014). The results were recorded and analysed to assess the quality status of raw milk samples through mean comparisons and process control charts.

RESULTS AND DISCUSSION

pH value of milk samples

According to the results of the pH analysis of milk samples from chilling centers in selected areas of the North Central Province, the mean pH level was 6.19±0.14 (Figure 1). According to SLS standards, the pH level of raw milk should range between 6.5 and 6.7. According to the data analysis, only the chilling center at Galenbidunawewa met the SLS standard for raw milk pH (6.5–6.7). Poor hygiene during milking and subsequent handling can lead to bacterial contamination, which increases acidity and lowers pH. Delays in transporting milk to chilling centers allow microbial activity to rise, further affecting pH (Teoh, 2020). Inadequate refrigeration or malfunctioning cooling systems at the chilling centers can also promote bacterial growth. Additionally, the health condition of the cows, including mastitis or dietary issues, can influence the natural pH of milk. Collectively, these factors contribute to the failure of some chilling centers to meet the required standard.

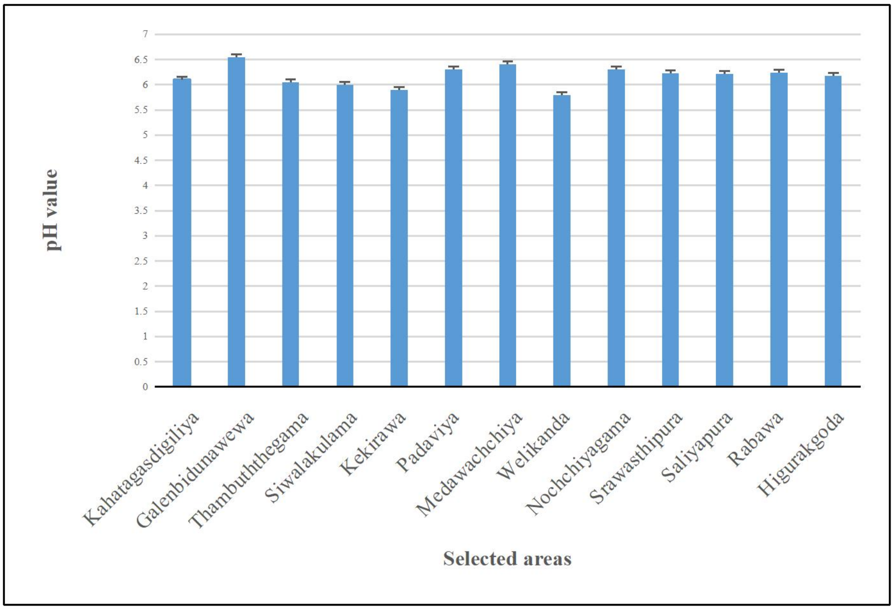

Figure 1: pH value of milk samples from chilling centers in selected areas of the North Central Province

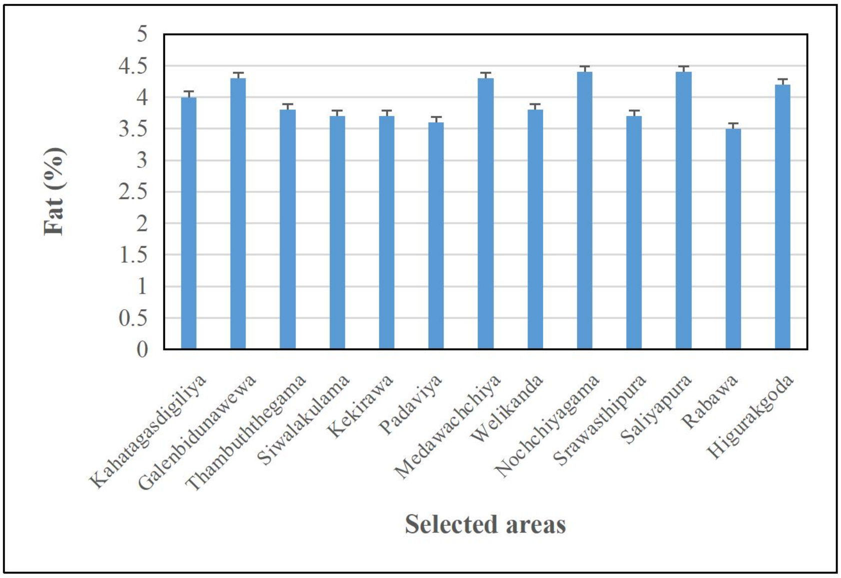

Figure 2: Fat content of milk samples from chilling centers in selected areas of the North Central Province

Fat content of milk samples

In the chilling centers of selected areas in the North Central Province, the mean fat percentage of milk samples was 3.95±0.08. According to SLS standards, the acceptable fat content in raw milk ranges from 3 to 5%. Based on the data analysis, all sampled areas complied with this standard (Figure 2).

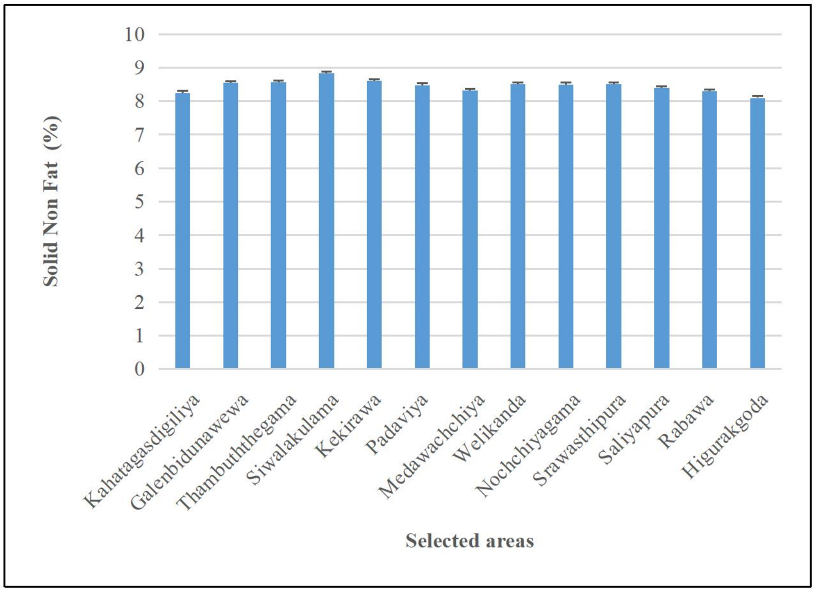

Figure 3: Solid non-fat content of milk samples from chilling centers in selected areas of the North Central Province

Soild-non-fat content of milk samples

According to the analysis of solid non-fat (SNF) content in milk samples collected from chilling centers in selected areas of the North Central Province, the mean SNF percentage was 8.46±0.16% (Figure 3). According to the SLS standards, the SNF content of raw milk should be at least 9%. However, according to the data analysis, none of the sampled areas met this standard. It may be attributed to the dilution of milk with water, either intentionally, in order to increase volume, or unintentionally due to poor handling practices. Additionally, poor nutrition and inadequate feeding of dairy cows can lead to reduced SNF content in milk.

Protein content of milk samples

According to the results of the protein content analysis of milk samples from chilling centers in selected areas of the North Central Province, the mean protein percentage was 3.27±0.06% (Figure 4). According to the SLS standards, the protein content of raw milk should be 3.2–3.5%. According to the data analysis, all areas met the required level except Higurakgoda. This deviation may be due to poor nutritional management of dairy cows, particularly inadequate protein intake in their diet, which can lead to lower milk protein content.

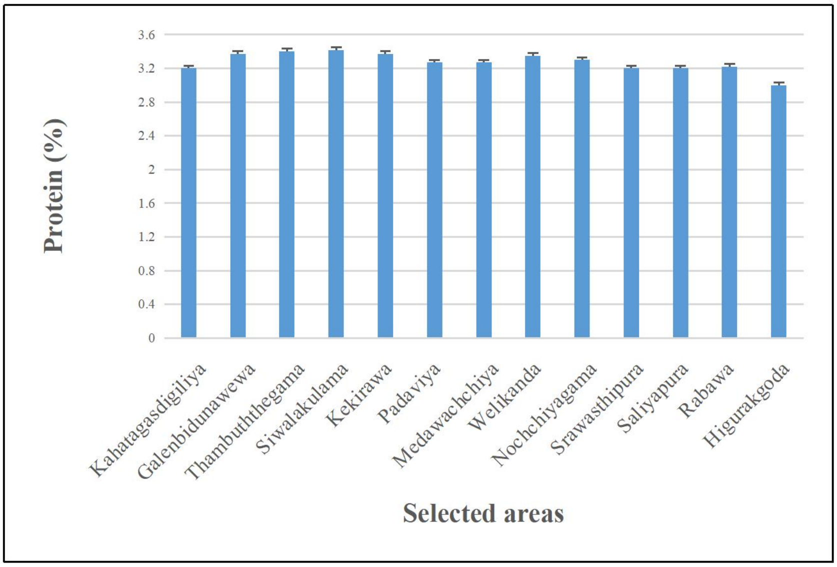

Figure 4: Protein content of milk samples from chilling centers in selected areas of the North Central Province

Additionally, genetic factors such as low-yielding or non-improved cattle breeds, as well as poor animal health, can impact the protein synthesis in milk (Lajnaf *et al.*, 2022). Environmental stress such as heat exposure and improper milking practices may also contribute to the deviation observed in this area (Gao *et al.*, 2021).

Lactose content of milk samples

According to the process control chart of the lactose percentages of milk samples collected from chilling centers in selected areas of the North Central Province, the mean lactose percentage was 4.87±0.11% (Figure 5). According to SLS standards, the lactose percentage of raw milk should to be 4–5%. According to the data analysis, milk from Kahatagasdigiliya, Galenbidunawewa, Padaviya, Medawachchiya, Nochchiyagama, Srawasthipura, Saliyapura, Rabawa, Higurakgoda areas met this standard. Health and nutritional status of the dairy cows, and poor diets lacking in energy can reduce lactose production. Additionally, diseases such as mastitis can disrupt normal milk synthesis, leading to altered lactose levels (Dogra *et al.*, 2021; Nayak, 2023). Improper milking practices or adulteration, such as dilution with water can also lower lactose concentration. These factors, when combined, may result in lactose percentages falling outside the acceptable range in certain chilling centers.

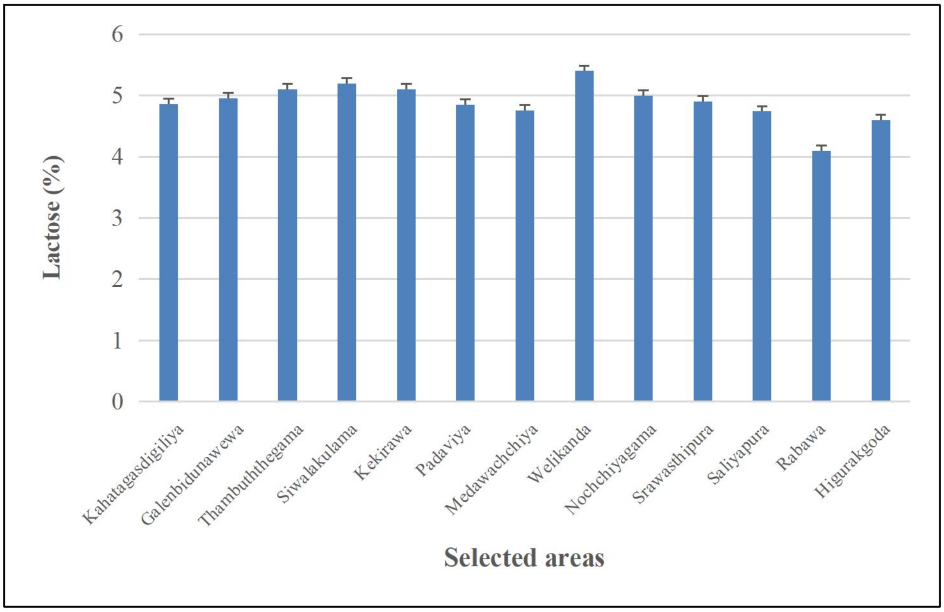

Figure 5: Lactose content of milk samples from chilling centers in selected areas of the North Central Province

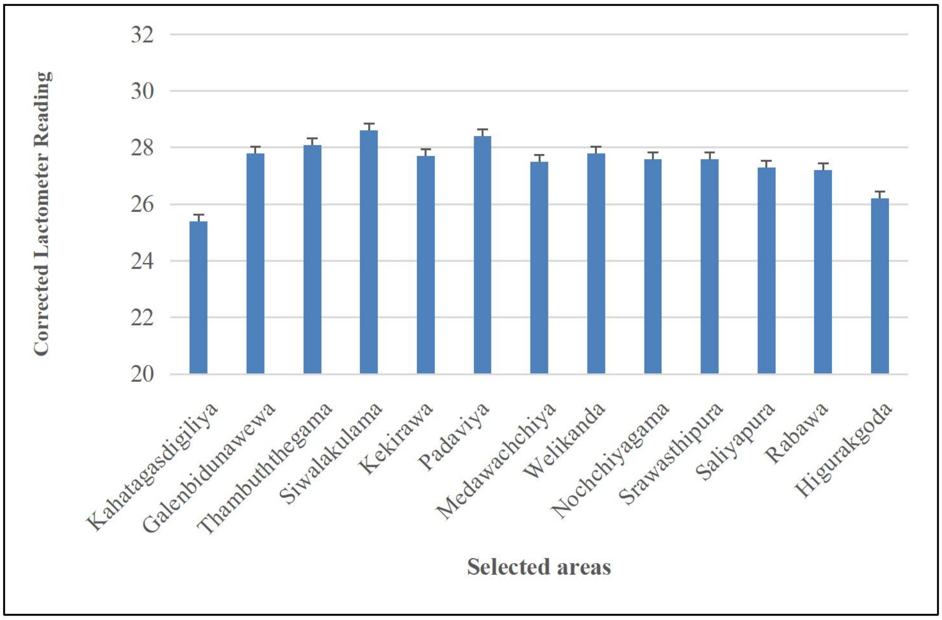

Figure 6: Corrected lactometer reading of milk samples from chilling centers in selected areas of the North Central Province

Corrected lactometer reading of milk samples

According to the results of the corrected lactometer reading analysis of milk samples from chilling centers in selected areas of the North Central Province (Figure 6), the mean corrected lactometer reading value was 27.48±0.08. According to SLS standards, the corrected lactometer reading of raw milk should be 26–32. Based on the data analysis, all areas met this standard except Kahatagasdigiliya. The deviation observed in Kahatagasdigiliya may be due to possible milk adulteration, such as the addition of water, which lowers the milk's density and consequently, the corrected lactometer reading. Additionally, poor feeding practices or cow health issues may affect the natural composition of milk, resulting in lower total solids and altered density.

Added water content of milk samples

Added water was reported only in milk samples from Higurakgoda (1.69%). According to Sri Lanka Standards (SLS), the acceptable level of added water in raw milk, as indicated by the corrected lactometer reading, should be 0%. The deviation in added water percentage in Higurakgoda could be due to unintentional water contamination during milk handling or storage. Additionally, the presence of added water might also indicate attempts to increase milk volume, which leads to a higher water percentage than the standard.

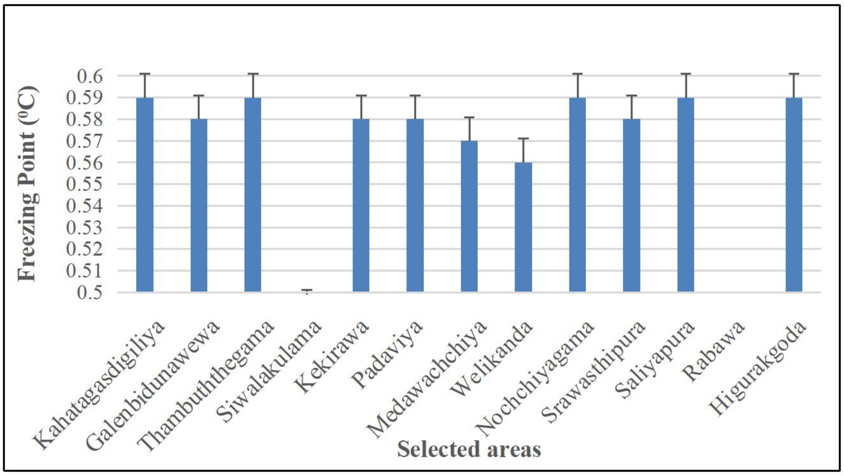

Figure 7: Freezing point of milk samples from chilling centers in selected areas of the North Central Province

Freezing point of milk samples

According to the freezing point analysis of milk samples from chilling centers in selected areas of the North Central Province (Figure 7), the mean freezing point was 0.57±0.03℃. As per SLS standards, the acceptable freezing point range for raw milk is 0.505–0.525. However, the data analysis represents that no sampled area met this standard (0.505–0.525). The deviation in freezing point may be due to the presence of added water or milk adulteration, which lowers the freezing point (Guetouache *et al.*, 2014). Additionally, poor milking and handling practices, such as improper storage temperatures or delayed cooling, can further affect the freezing point of milk.

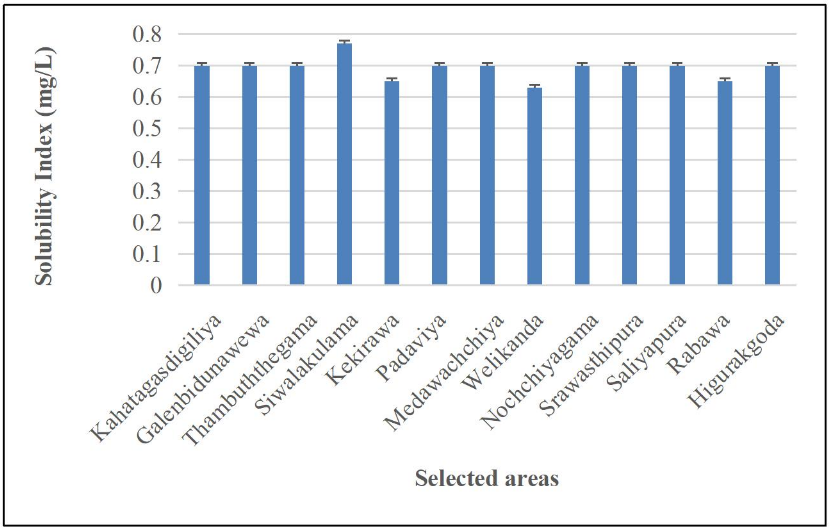

Figure 8: Solubility index of milk samples from chilling centers in selected areas of the North Central Province

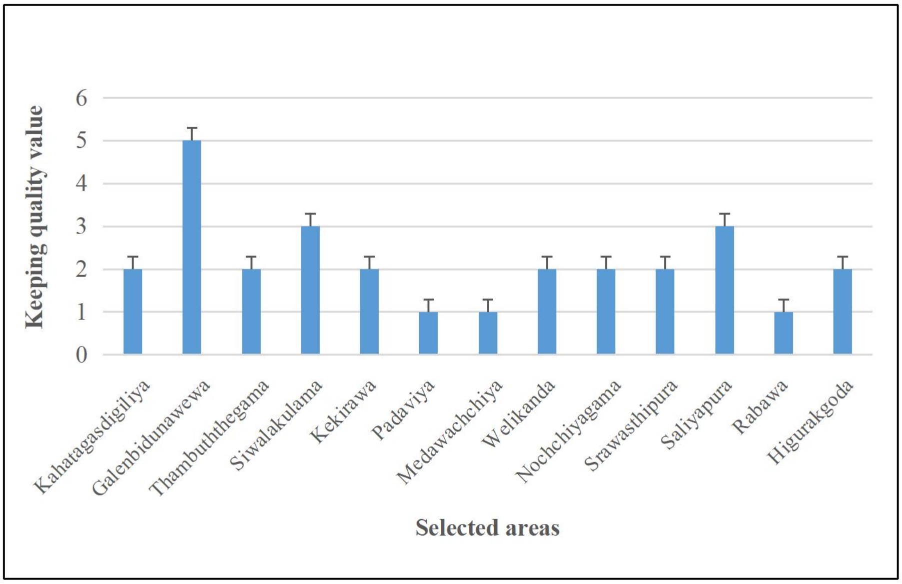

Figure 9: Keeping quality value of milk samples from chilling centers in selected areas of the North Central Province

Solubility index of milk samples

According to the solubility index analysis of milk samples from chilling centers in selected areas of the North Central Province (Figure 8), the mean solubility index was 0.69±0.01 mg/L. Deviations in the solubility index may be attributed to factors such as poor milk quality, improper storage conditions, or bacterial contamination, all of which can negatively affect the solubility of milk solids.

Keeping quality value of milk samples

According to the results of the keeping quality assessment of milk samples from chilling centers in selected areas of the North Central Province (Figure 9), the mean keeping quality was 2±0.03. As per SLS standards, the keeping quality level of raw milk should be greater than 4. Based on the data analysis, only samples from Galenbidunawewa met this requirement. The deviation in keeping quality observed in other areas may be due to factors such as improper milk handling, delays in cooling, and inadequate refrigeration, all of which promote bacterial growth and reduce milk quality. Additionally, poor hygiene during milking and transportation, along with the cow health issues such as mastitis, may further contribute to lower keeping quality (Murphy *et al.*, 2016).

Among all samples, 96% tested negative in the 77% alcohol precipitation test, indicating acceptable milk quality. However, only 4% tested negative at the 72% alcohol precipitation test. No samples tested negative at 68% alcohol test, indicating poor milk quality. Since the recommended standard requires a negative result at the 77% alcohol concentration, the observed results confirmed that the overall milk quality in most areas falls below the required standard.

CONCLUSION

The analysis of raw milk collected from selected chilling centers in the North Central Province revealed significant variability in quality parameters, indicating a pressing need for targeted improvements across several areas. These inconsistencies, if not addressed, can directly affect the overall quality and safety of dairy products manufactured from this raw milk. The results show that certain areas consistently demonstrated substandard composition and poor keeping quality, suggesting underlying issues potentially linked to differences in cattle breeds, farm management practices, or hygiene standards during milking and transportation. In particular, poor keeping quality observed in multiple locations points to the need for better pre-chilling handling and improved hygiene practices at the farm and collection levels.

The study also highlighted the potential abnormal trends and deviations in milk quality across several centers. To address this issue, it is recommended that training programs be developed for relevant personnel, such as quality control officers, extension officers, and chilling centre staff, focusing on the interpretation and application of process control charts. Integrating routine control chart analysis into the milk quality monitoring system can enable early detection of quality issues and support prompt corrective actions. Furthermore, establishing a standard protocol for recording and investigating anomalies observed in control charts will enhance the traceability of quality issues and contribute to continuous improvement in raw milk quality management.

To ensure the quality of raw milk and its derived products, it is essential that extension officers and other stakeholders in the dairy sector focus on improving milk quality at the grassroots level. This can be achieved through farmer education, the introduction of good milking and storage practices, and regular monitoring. Future researches can aim to identify the root causes behind variations in milk quality across different chilling centers and explore the links between quality parameters and specific farm-level practices. Additionally, the data gathered in this study can serve as a valuable secondary data set for further research and long-term quality monitoring efforts in these regions.

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