Integrated Assessment of the Presence and Levels of Contaminants (Aflatoxins, Antibiotics and Acaricides) in Raw Milk in the North Rift Region- Kenya

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Practice Brief
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FORQLAB = Food Waste Reduction and Food Quality Living Lab in Kenya

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Introduction

Kenya is one of the prominent milk producers in Sub-Saharan Africa, with a dairy sector that contributes a substantial 4-8% to the Gross Domestic Product (Creemers and Aranguiz, 2019). This sector is an economic driver, providing income and employment to over 1.0 million households across the dairy value chain (Creemers and Aranguiz, 2019). The annual average per capita milk consumption is high, equivalent to 115 litres (International Livestock Research Institute, 2023).

Currently, 80% of the milk in Kenya is produced by smallholder farmers (Creemers and Aranguiz, 2019) and sold in the informal market, which makes up about 80% of all milk sales in the country. The informal dairy market typically lacks infrastructure and reliable access to clean water, electricity, sanitation, and refrigeration facilities and does not follow safety regulations. Additionally, it operates without a license, receives little support from the government, and is excluded from the formal market. Most milk in this market is sold raw (unpasteurized) and unpackaged. This sector depends on the spot market. In contrast, the formal market is managed by licensed dairy enterprises that operate within a clear legal framework, have established facilities, and undergo regular inspections. Key participants in this market include processing companies and cooperatives such as Brookside Dairy Limited, Kenya Co-operative Creameries LTD, Githunguri Dairy Farmers Cooperative Society, and Bio Foods Products Ltd, among other processors.

The high share of milk commercialized through informal channels poses a challenge to quality control and minimizing losses in the Kenyan dairy sector (Blackmore et al., 2021). Various contaminants seriously threaten milk's safety and quality.

Bio Foods Products Ltd. (Bio Foods), a privately-owned milk processing company recognized for producing high-quality dairy products, is experiencing a high demand for its premium products. However, the company is currently dealing with the problem of inconsistent supply of high milk volumes due to milk contamination. There is an opportunity to source milk from the informal market. However, the company must ensure that this milk meets its quality requirements and is free from contaminants (antibiotics, aflatoxins and acaricides). The challenge at hand is the lack of effective strategies to keep these three contaminants below threshold levels to enable Bio Foods to channel this milk into their supply chain.

Study Objective

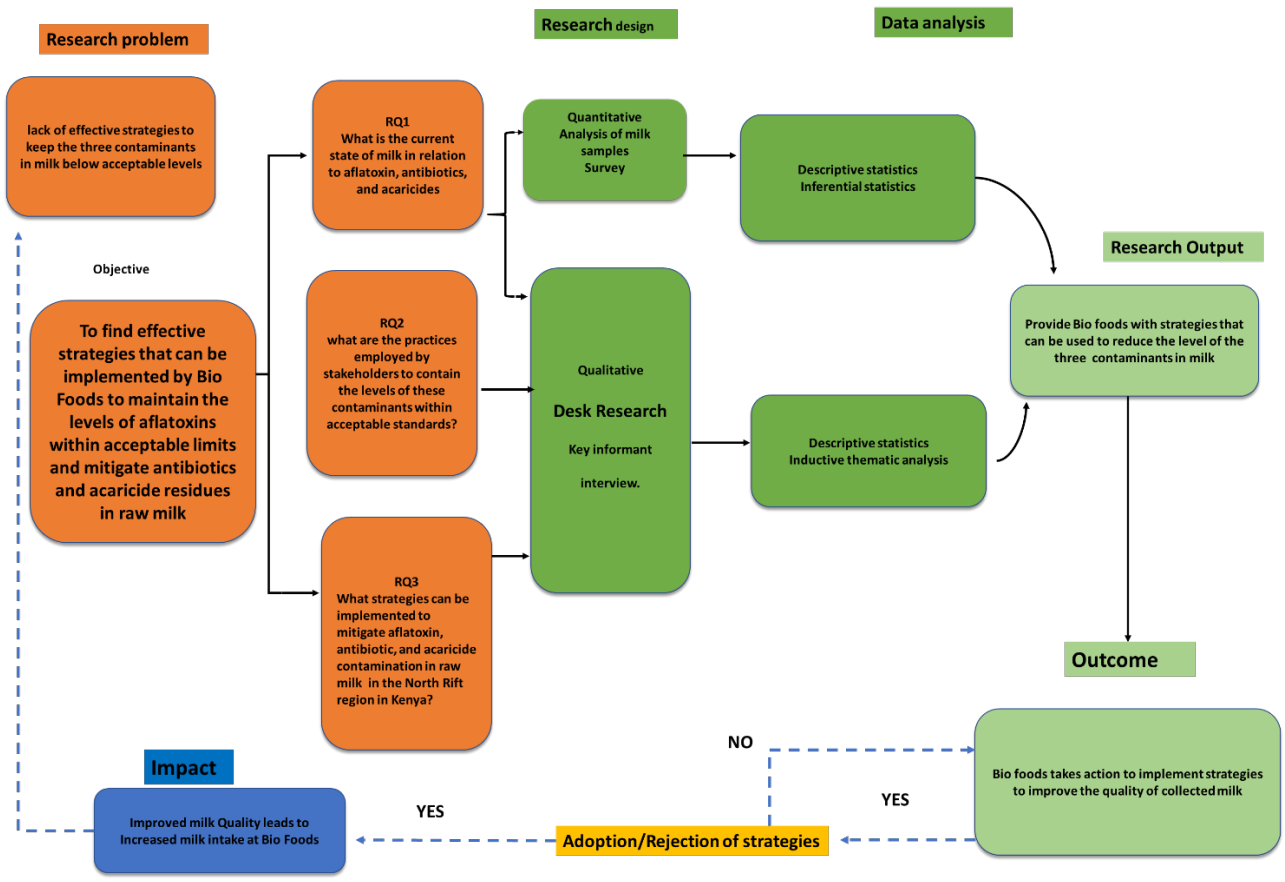
The overall objective of this study was to find effective strategies that Bio Foods can implement to maintain the levels of aflatoxins within acceptable limits, mitigate antibiotics and acaricide residues in raw milk, and enable them to uptake milk from the informal market**.** The research was done by carrying out a comparative analysis of the milk quality from the current Bio Foods suppliers and non-Bio Foods suppliers, different practices carried out by the two groups in relation to contaminants and suggested recommendations to the non-Bio Foods suppliers to ensure their milk conforms and onboard with Bio Foods.

This study was conducted in the North Rift region, in Uasin-Gishu, Trans-Nzoia and Baringo counties. These areas were chosen because most Bio Foods farmers were concentrated in these areas, and the area was a major milk catchment, therefore considered a potential source of milk for Bio Foods.
A mixed approach of qualitative and quantitative techniques was used. Survey, chemical analysis of milk samples and analysis of feed samples were done for the quantitative aspects. Key informants from Bio Foods, cooperatives and Kenya Dairy Board were interviewed for the qualitative part. Comparative analysis was then done for the Bio Foods suppliers and non-Bio Foods suppliers from the informal channels.
Purposive sampling was used to select farmers and key informants. A total of 16 farms were selected to participate in the survey, eight Bio Foods suppliers and eight non-Bio Foods suppliers.

Conceptual Framework

The study was modelled on a conceptual framework of a theory of change (Figure 1). Originating from the research problem and focusing on the outcome of the study where, Bio Foods would be provided with strategies to manage the three contaminants.

Figure 1. Conceptual framework used for the study. RQ=research question.



MAIN FINDINGS

Table 1. Levels of contaminants in milk of Bio Foods farmers and non-Bio Foods farmers. ppt=parts per trillion; µg=microgram per kg; ppb=parts per billion.

Contaminants	Bio Food suppliers (N=8)	non-Bio Food suppliers (N=8)	Average	Bio Food supplying coop (N=1)	non-Bio Foods Supplying coop (N=2)	Average
Aflatoxins in milk (ppt)	116.5[a]±102.4	326[b]±224	221±163.2	360	164±92.9	262±46.5
Acaricide (Cypermethrin µg/kg)	85.6±50.4	104.7±43.1	95.2±43.5	34.8	83.0±46.4	58.9±23.2
Acaricide (Organophosphate µg/kg)	14.7[a]±27.2	0.0[b]	7.3±13.6	42.2	62.1±36	52.2±18
Antibiotics	0.0[a]±0	1.4[b]±0.7	0.7±0.4	0	0	0
Aflatoxins in feeds (ppb)	2.8±2.8	4.3±3.4	3.6±3.1	0.0	0.3	0

AFLATOXIN

A t-test analysis revealed a significant difference in the average aflatoxin levels between milk samples from Bio Foods and non-Bio Foods farmers ($p<0.05$). This indicated that Bio Foods farmers had distinct lower aflatoxin levels with a mean average of 116 ppt compared to non-Bio Foods farmers with a higher mean of 326 ppt. However, the aflatoxin level in Bio Foods supplying cooperatives was high at 360 ppt compared to the non-Bio Foods supplying cooperatives, averaging at 164 ppt.

The primary source of aflatoxin was confirmed to be feeds. The results revealed that 13 out of 19 samples had aflatoxin B1. A t-test ($p>0.05$) indicated no significant difference between the levels of aflatoxin B1 in the Bio Foods-supplying farms and those from non-Bio Foods-supplying farms. However, it was noted that some farm practices led to the contamination of the feeds at the farm level. Table 2 shows different practices by Bio Foods and non-Bio Foods farmers.

Table 2. Practices of Bio Foods and non-Bio Foods suppliers in relation to aflatoxin.

Bio Foods farmers	non-Bio Foods farmers
• Outsource feeds from reputable suppliers & request certificate of analysis • Observe trends of aflatoxin in milk • Store feeds in leakproof stores on pallets • Harvest maize at the right stage and ensile properly	• Outsource feeds or feed ingredients depending on availability & proximity to the farm • Feed in stores, sometimes on pallets or floor • Harvest maize at the right stage and ensiled properly • No certificate of analysis during feed procurement

ANTIBIOTICS

The t-test results showed a significant difference in antibiotic residues between milk samples from Bio Foods and non-Bio Foods farmers ($p<0.05$) (Table 1). All the antibiotic-positive samples were from the non-Bio Foods supplying farms. No milk from both cooperatives tested positive for antibiotics. Antibiotics were confirmed to come from the treatment of cows and failure to withdraw milk from the treated cows. Table 3 summarises the practices of both groups in relation to antibiotic residues.

Table 3. Practices of Bio Foods and non-Bio Foods suppliers in relation to antibiotics.

Bio Foods farmers	non-Bio Foods farmers
• Treatment done by either resident or outsourced vets • Records kept & used for withdrawals • Treated cows milked differently • Distinct visual colours used on treated cows • Board on the parlour with names of treated cows	• Treatment done by either a manager, resident or outsourced vets • Treatment records kept but for culling purposes • Treated cows milked last

ACARICIDES

All the samples collected and tested for cypermethrin were found to be positive. The t-test results showed no significance value ($p>0.05$) between samples from Bio Foods-supplying farms and non-Bio Foods-supplying farms, and both types of cooperatives. The maximum cypermethrin residue limit (MRL) is 50 µg/kg. The results revealed that 84% of the samples had cypermethrin levels exceeding this limit, highlighting widespread use across the tested farms.

Nineteen samples were tested for organophosphates, with 26% testing positive for this acaricide. Notably, all the positive samples exceeded the maximum residue limit of 20 µg/kg. The t-test results showed a significance level ($p<0.05$), indicating a significant difference in organophosphate levels between Bio Foods supplying farms and non-Bio Foods supplying farms. Table 4 shows farmers' practices in relation to both of the acaricides.

Table 4. Practices of Bio Foods and non-Bio Foods suppliers in relation to acaricides.

Bio Foods farmers	non-Bio Foods farmers
• Farmers sprayed/dipped the animals weekly or biweekly using the acaricides • Spraying/dipping was done early to have a difference of 8 hrs. before milking • Farmers made the spraying area far from the milking area • Ensured proper cleaning of the udder before milking • Ensured accurate dosing of the acaricides as instructed • Farmers sampled the deep solution for concentration analysis to avoid overdosing	• Sprayed/dipped the animals weekly or Biweekly using the acaricides • Spraying/dipping was done early to have a difference of 5 hours before milking • Ensured accurate dosing of the acaricides as instructed by the manufacturer • Farmers made the spraying area far from the milking area

Conclusion

The study indicated that milk from both Bio Foods suppliers and non-Bio Foods suppliers was contaminated with aflatoxins, antibiotics, and acaricides. However, the contamination levels of milk from Bio Foods suppliers were significantly lower. This reduction in contamination could be attributed to the effective measures implemented by Bio Foods suppliers to control these contaminants. The presence and levels of contaminants were found to be directly related to farming practices.

The study revealed that cooperatives and processors, such as Bio Foods, provide significant support to farmers, such as training farmers and implementing practices that ensure that milk meets the required

standards. However, stakeholders not involved with Bio Foods did not implement these practices. Collaboration between Bio Foods and the Kenya Dairy Board (KDB) was noted to be essential for integrating stakeholders outside the Bio Foods supply chain.

The study identified that a comprehensive range of strategies is necessary to improve milk quality and lower contaminant levels, enabling farmers to integrate into the formal channel. This included implementing broad interventions across the value chain. Effective strategies involve:

Farmers: Adopting good farming practices to ensure milk quality.

Feed suppliers and service providers: Providing high-quality products and services to farmers.

Bio Foods: Actively train farmers to meet required standards and ensure their milk is conform standards, collaborate with other chain actors like KDB and other cooperatives, and link farmers to reputable input suppliers.

Recommendations

Three recommendations were put forward to Bio Foods as areas of intervention.

1. Create partnerships with more cooperative societies like the ones involved in this study. This would involve onboarding the cooperatives as new milk suppliers. These cooperatives were already established with high volumes of milk. But first, Bio Foods has to take them through a training and onboarding process to ensure consistency in the quality of the milk.
2. Create collaborations with private companies in Kenya, especially those in the feed industry working with international standards and link farmers to these companies. This would allow farmers to access quality products with low contaminant levels. When farmers use these products, their milk conforms to Bio Foods' required standards and can be onboard with Bio Foods.
3. Bio Foods to provide farmers with incentives to encourage them to shift from the spot market.

Impact

Implementation of the recommended interventions by Bio Foods will allow Bio Foods farmers for the production of high-quality milk, meeting the required standards, increasing their intake and meeting the market demand.

References

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