Global Research journal of Natural Science and Technology (Grjnst)
Volume: 03 - Issue 3 (2025)
p.ISSN: 2790-7643 e.ISSN: 2790-7651

Detection of Dairy Products Adulterants sold in District Hyderabad

Ghulam Muhammad Bhutto
Department of Animal Products Technology, Sindh Agriculture University, Tandojam, Pakistan
Livestock and Fisheries Department, Government of Sindh, Pakistan
bhuttorohri@gmail.com
Atta Hussain Shah
Department of Animal Products Technology, Sindh Agriculture University, Tandojam, Pakistan
vetdr_atta@sau.edu.pk
Ghulam Shabir Barham
Department of Animal Products Technology, Sindh Agriculture University, Tandojam, Pakistan
gsbarham@sau.edu.pk
Gul Bahar Khaskheli
Department of Animal Products Technology, Sindh Agriculture University, Tandojam, Pakistan
gbkhaskheli@sau.edu.pk
Muhammad Bilawal
Department of Veterinary Pharmacology, Sindh Agriculture University, Tandojam, Pakistan
Livestock and Fisheries Department, Government of Sindh, Pakistan
dr_bilalarain@yahoo.com
Shakeel Ahmed Tunio
Department of Livestock Management, Sindh Agriculture University, Tandojam, Pakistan
satunio@sau.edu.pk

*** Correspondence author email: vetdr_atta@sau.edu.pk**

Abstract: *This study detects the adulteration in dairy products milk i-e, cream, yogurt, and khoya, sourced from various milk outlets in Hyderabad city, Latifabad, Qasimabad, and Tandojam district, Hyderabad. A total of 180 samples, comprising 60 each of cream, yogurt, and khoya, with 15 samples from each area, were examined. The detection of various adulterants (formalin, hydrogen peroxide, boric acid, Sodium chloride, carbonate, hypochlorite, urea, Quaternary ammonium compounds, cane sugar, starch, sorbitol, detergent) was performed through standard methods by using the Milk Adulteration Testing*

(MAT) Kit. The findings reveal a high incidence of adulteration in the tested dairy products. Cream samples from Hyderabad city exhibited the highest adulteration rate, with all samples (100%) containing adulterants, primarily quaternary ammonium compounds QAC (20%), followed by starch (12%), urea (10%), detergent (8%), boric acid (12%), carbonate (12%), cane sugar (10%), and formalin (7%). Chlorides of hydrogen peroxide, sorbitol, sodium chloride and hypochlorite were detected. Yogurt samples also showed significant adulteration, particularly in Hyderabad city (80%), with QAC (18.33%) being the most prevalent adulterant, followed by boric acid (10%), starch (8.33%), urea (6.66%), and formalin (1.66%). Similarly, khoya samples from all areas demonstrated substantial adulteration, with QAC (20%) being the most common contaminant, followed by starch (10%), boric acid (8.33%), cane sugar (8.33%), detergent (5%), and urea (0.33%).

This study highlights the higher extent of adulteration in dairy products in different areas of Hyderabad district, emphasizing the need for rigorous quality control measures to protect the health of consumers. The regulatory bodies must enforce strict regulations and conduct regular monitoring to reduce the adulteration risk in dairy products and ensure public health and safety.

Keywords: *Adulterants, cream, dairy products, Hyderabad, yogurt, khoya*

Introduction

Milk is highly regarded as a nutritious food and is a rich source of lactose, fat, calcium, minerals, and the building blocks of the body (proteins), as well as health-stimulating vitamins that are required at any age (Hoppe et al., 2006; FAO, 2013). As an important food source for infants, supplying the essential amino acids required for growth, it is easily digested and absorbed in both infants and adults (Afzal et al., 2011). Milk serves as the primary source of nourishment for young mammals until they can digest other foods. Fresh milk, when hygienically produced, is often seen as a complete diet because it contains essential nutrients like lactose, fat, protein, minerals, and vitamins in a balanced ratio,

unlike many other foods. This attraction makes it prone to fraud (Moore et al., 2012). Adulteration of milk results in economic losses, has negative impacts on the quality of milk, compromises the quality of finished products, and is cautious to consumers' safety. It is a perishable commodity, readily spoiled during the hot season, especially in the summer. Quality of milk is scarcely maintained due to a non-regulated and unorganized system of marketing (Javaid et al., 2009). Milk adulteration, lack of hygiene, unethical practices, improper chilling, cooling, and preserving technology, and poor hygienic conditions are considered as main causes of poor quality and quantity of milk and milk products (Haasnoot et al., 2004).

Adulterants are added to milk to keep it wholesome, fresh, and to maintain financial value. This practice results in harmful effects on the consumers upon consumption of not only liquid milk but also milk products produced from such adulterated milk, without leaving any clue/sign that shows what negative effects adulterants can cause. Water (ground, pond, commercial ice, and river water), depending upon the nearest and easiest source, is commonly and readily used adulterant in milk (Barham, 2018); to increase the volume of milk, it reduces the nutritive value of milk and, if contaminated, results in health risks, especially to infants and children. This unethical practice is later masked by the addition of various adulterants like thickening agents, i.e., whey powder, flour, skimmed milk powder, starch and other ingredients such as urea, sugarcane, vegetable oil, refined oil, animal fat, and cheap local cream to compensate for protein, fat and carbohydrate content of diluted milk (Fakhar et al., 2006). In summer, milk production is reduced by around 55% which results in a decrease in milk supply. To cover up this reduction in production, water is added to increase milk volume (Butt, 2011; Afzal et al., 2011). Adulterants and preservatives can pose significant health risks to consumers, especially infants (Javaid et al., 2009).

The practice of milk adulteration is often carried out to increase its volume. To achieve this, substances like starch and reconstituted milk powders are added to enhance its thickness. To extend the shelf life of milk, various substances such as ice, hydrogen peroxide, carbonates, bicarbonates, antibiotics, caustic soda, starch, rice flour, wheat flour,

and arrowroot are frequently added, and even the highly dangerous chemical formalin is being employed. Milk adulterated with urea poses significant health risks, particularly for young girls, as it accelerates the onset of puberty (Gwin et al., 2009). Additionally, milk adulteration compromises the quality of milk and can lead to severe health issues, including gastroenteritis, nausea, vomiting, diarrhea, kidney damage and failure, acute circulatory system failure, asthma, urticaria, metabolic acidosis, and convulsions in sensitive individuals (Awan et al., 2014; Barham et al., 2024).

Cream is a vital dairy product characterized by its fat content or heat treatment. In rural areas, it is often consumed directly, either spread on bread or added to meals. Additionally, cream serves as a key ingredient in the production of table butter and the preparation of ghee (Shinawy et al., 2018). Fat-concentrated dairy products are often regarded as the major source of fats, especially when sourced from dairy milk animals. It is a rich source of vitamins A, D, E, and K, which are essential for overall body and brain health. Butter also contains lecithin, which aids in the proper assimilation and metabolism of cholesterol and other fats. However, butter can be adulterated through the addition of animal fat, hydrogenated oils, and even non-edible mineral oils (Tanmay et al., 2017).

In Pakistan, cream, butter, yogurt, and khoya are routinely prepared from fresh milk of buffalo, cow, sheep, or goat through traditional methods without any regard to the raw material used; many factors may affect the quality of these end products. This malpractice not only leads to significant economic losses for the processing but also sedates consumers with serious health issues. Considering these concerns, the present study has been designed to achieve the following targeted objectives: to detect the chemical preservatives and assess the thickening and neutralizing agents in milk products sold in the district of Hyderabad.

Materials and Methods

Milk products sampling

Samples of milk products (one hundred grams each), i.e., cream (n=60), yoghurt (n=60) and khoya (n=60) were procured in the evening from various areas (Latifabad, Qasimabad, Hyderabad city, and Tandojam) of district Hyderabad and kept under 4^0C±2 in the refrigerator. The next morning, all samples were kept in the ice box and transported to the Department of Animal Products Technology, Sindh Agriculture University, Tandojam, under hygienic conditions at 40 °C ± 2 °C. After arrival in the laboratory, the samples were subjected to the detection of adulterants using the Milk Adulteration Testing (MAT) Kit (UVAS, Lahore).

Adulterants

All the samples of cream, yoghurt and khoya were screened out for the following adulterants.

1. Formalin
2. Hydrogen peroxide
3. Boric acid
4. Sodium Chloride
5. Carbonate (Neutralizers)
6. Detergent / Soap
7. Urea
8. Quaternary Ammonium Compounds
9. Cane Sugar
10. Starch
11. Sorbitol
12. Hypochlorite

Preparation of Samples

For the preparation of cream samples, approximately 10 grams of cream was accurately weighed and mixed thoroughly with 20 milliliters of warm distilled water at about 40°C. The mixture was stirred well until a uniform emulsion was formed, which was then used for subsequent adulterant testing. In the case of khoya, around 10 to 20 grams of the

sample was taken, finely grated or crushed to break down the solid mass, and then mixed with 25 milliliters of warm distilled water. The mixture was stirred vigorously to dissolve as much of the khoya as possible. After mixing, the solution was filtered through a Whatman filter paper to obtain a clear filtrate free from large particles, which serves as the sample for testing. For yogurt or curd samples, 10 grams of the sample was taken and blended with 20 milliliters of lukewarm distilled water. The suspension was stirred thoroughly until a uniform consistency was achieved. If needed, the suspension was filtered to remove any coagulated particles or impurities. These preparation steps help in obtaining homogeneous and test-ready samples of cream, khoya, and yoghurt, making them suitable for accurate chemical detection of various common adulterants.

Detection of adulterants

Several simple chemical tests can be used to detect common adulterants in cream, khoya, and yoghurt. To detect starch**,** a few drops of iodine solution were added to the prepared sample; a blue-black coloration confirms its presence. Urea can be detected by adding urease solution and phenol red indicator; if the solution turns pink or red, urea is present. For detergents**,** mix equal parts of the sample and water and shake vigorously; the formation of persistent foam indicates adulteration. To check for glucose or added sugar, Benedict's reagent was added to the sample and boiled; the appearance of green, yellow, or brick-red precipitate suggests the presence of glucose. Hydrogen peroxide was detected by adding a few drops of paraphenylene diamine reagent, which produces a blue color in positive cases (Kamthania et al., 2014; Singh and Gandhi, 2015).

Statistical analysis

The data obtained was tabulated and processed through the MS-Excel 2013 program with descriptive statistics.

Results

Occurrence of various adulterants in market cream in different areas of Hyderabad

It has been observed that out of fifteen (n=15) cream samples from each area maximum number of the samples were adulterated with quaternary ammonium

compounds (20%) followed by starch (12%), urea (10%), detergent (8%), boric acid (12%), carbonate (12%), cane sugar (10%) and formalin (7%), respectively, while not a single cream sample collected from Hyderabad city, Latifabad, Qasimabad and Tandojam was found positive for hydrogen peroxide, sorbitol, sodium chloride and hypochlorite. Moreover, the higher number and extent of adulteration in market cream was recorded at Hyderabad city (100%) next by Qasimabad (73.33%), while minimum was recorded at Latifabad (46.66%) and Tandojam (40.00%) areas of Hyderabad district (Table 1).

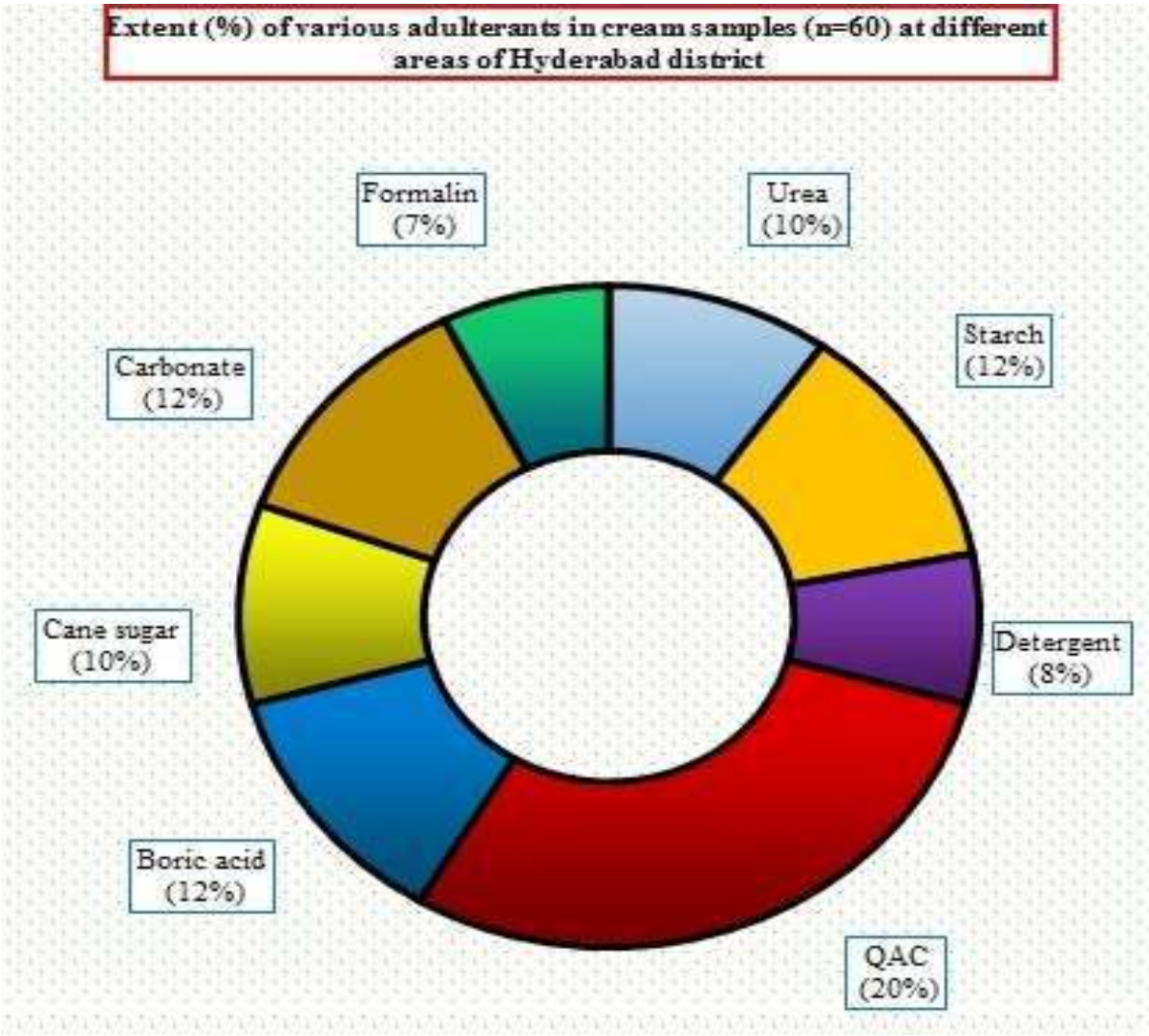
Table 1: Occurrence of various adulterants in the cream retailed at different areas of Hyderabad district

Adulterants	Different areas of Hyderabad district			
	Hyderabad city (n=15 samples)	Latifabad (n=15 samples)	Qasimabad (n=15 samples)	Tandojam (n=15 samples)
Urea	6.66%	6.66%	13.33%	0
Starch	20.00%	6.66%	6.66%	6.66%
Hydrogen peroxide (H2O2)	0	0	0	0
Detergent	6.66%	0	0	0
Sorbitol	0	0	0	0
Cane sugar	6.66%	6.66%	6.66%	0
Boric acid	13.33%	6.66%	13.33%	6.66%
Sodium chloride	0	0	0	0
Carbonate	13.33%	6.66%	13.33%	0
Formalin	6.66%	6.66%	6.66%	0
Hypochlorite	0	0	0	0
Quaternary ammonium compounds (QAC)	26.66%	6.66%	13.33%	26.66%
Total Positive (%)	100%	46.66%	73.33%	40.00%

Overall extent of various adulterants in market cream in Hyderabad district

It has been observed that out of total sixty (n=60) samples of market cream maximum number of samples were adulterated with from each area maximum number of the samples were adulterated with quaternary ammonium compounds 12/60 (20%) followed by each of starch 5/60 (12%), boric acid 5/60 (12%), carbonate 5/60 (12%), each of cane sugar 4/60 (10%) and urea 4/60 (10%), whereas minimum number of positive

samples and extent each of formalin and detergent 3/60 (8%) was noted in market cream samples at Hyderabad district, respectively (Figure 1).



Legend: QAC =Quaternary ammonium compounds

Figure 1: Extent of different adulterants in the cream samples retailed at different areas of Hyderabad district

Occurrence of various adulterants in the yogurt market in different areas of Hyderabad

It has been observed that out of fifteen (n=15) samples of yogurt from each area maximum number of samples were adulterated with quaternary ammonium compounds (18.33%) followed by starch (8.33), boric acid (10%), urea (6.66%) and formalin (1.66%) collected from Hyderabad city, Latifabad, Qasimabad and Tandojam, however all the collected samples of yogurt from different areas of Hyderabad district were found free from for hydrogen peroxide, detergent, sorbitol, cane sugar, sodium chloride, carbonate and hypochlorite, respectively. Whereas a higher number and extent of adulteration in market yogurt was noted at Hyderabad city (80%) contrast to Qasimabad (46.66%), Latifabad (40.00%) and Tandojam (40.00%) areas of Hyderabad district, respectively (Table 2)

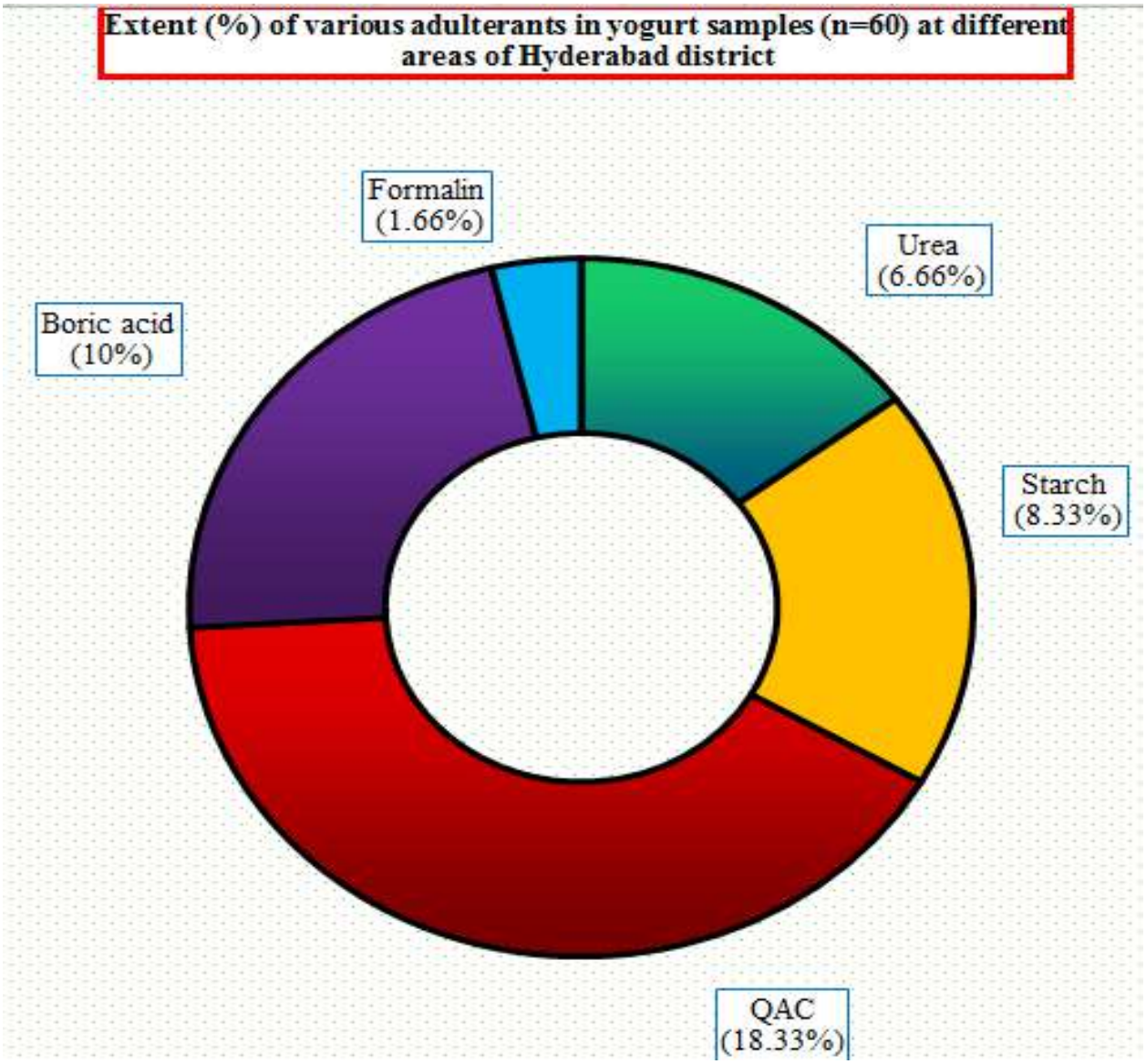
Table 2: Occurrence of various adulterants in the yogurt retailed at different areas of Hyderabad district

Adulterants	Different areas of the Hyderabad district			
	Hyderabad city (n=15 samples)	Latifabad (n=15 samples)	Qasimabad (n=15 samples)	Tandojam (n=15 samples)
Urea	13.33%	6.66%	13.33	0
Starch	20.00%	13.33	13.33%	6.66%
Hydrogen peroxide (H2O2)	0	0	0	0
Detergent	0	0	0	0
Sorbitol	0	0	0	0
Cane sugar	0	0	0	0
Boric acid	20.00%	6.66%	6.66%	6.66%
Sodium chloride	0	0	0	0
Carbonate	0	0	0	0
Formalin	6.66%	0	0	0

Hypochlorite	0	0	0	0
Quaternary ammonium compounds (QAC)	20.00%	13.33%	13.33%	26.66%
Total Positive (%)	(80.00%)	(40.00%)	(46.66%)	(40.00%)

Overall extent of various adulterants in market yogurt in the Hyderabad district

Overall number of positive samples and extent of various adulterants was recorded in the market yogurt was recorded and results are presented in figure 4.2. It has been noted that over a total of sixty (n=60) yogurt samples highest number of samples were adulterated with higher extent of quaternary ammonium compounds 11/60 (18.33%) followed by boric acid 6/60 (10%), starch 5/60 (8.33%) and urea 4/60 (6.66%), whereas single sample and minimum extent of formalin 1/60 (1.66%) was noted in market yogurt



samples at Hyderabad district, respectively.

Legend: QAC =Quaternary ammonium compounds

Figure 2: Extent of different adulterants in the yogurt samples retailed at different areas of Hyderabad district

Occurrence of various adulterants in market khoya in different areas of Hyderabad

It has been observed that out of fifteen (n=15) khoya samples from each area maximum number of Khoya samples were adulterated with quaternary ammonium compounds (20%) followed by starch (10%), cane sugar (8.33%), boric acid (8.33), detergent (5%) and urea (0.33%) at Hyderabad city, Latifabad, Qasimabad and Tandojam areas, all the collected Khoya samples from different areas of Hyderabad district were found free from hydrogen peroxide, formalin, sorbitol, sodium chloride, carbonate and hypochlorite. Moreover, a similar higher number and extent of adulteration in market khoya was recorded at Hyderabad city (66.66%), next by Qasimabad (66.66%) and Latifabad (66.66%), whereas a lower number and extent was noted at Tandojam (60.00%) areas of Hyderabad district (Table 3).

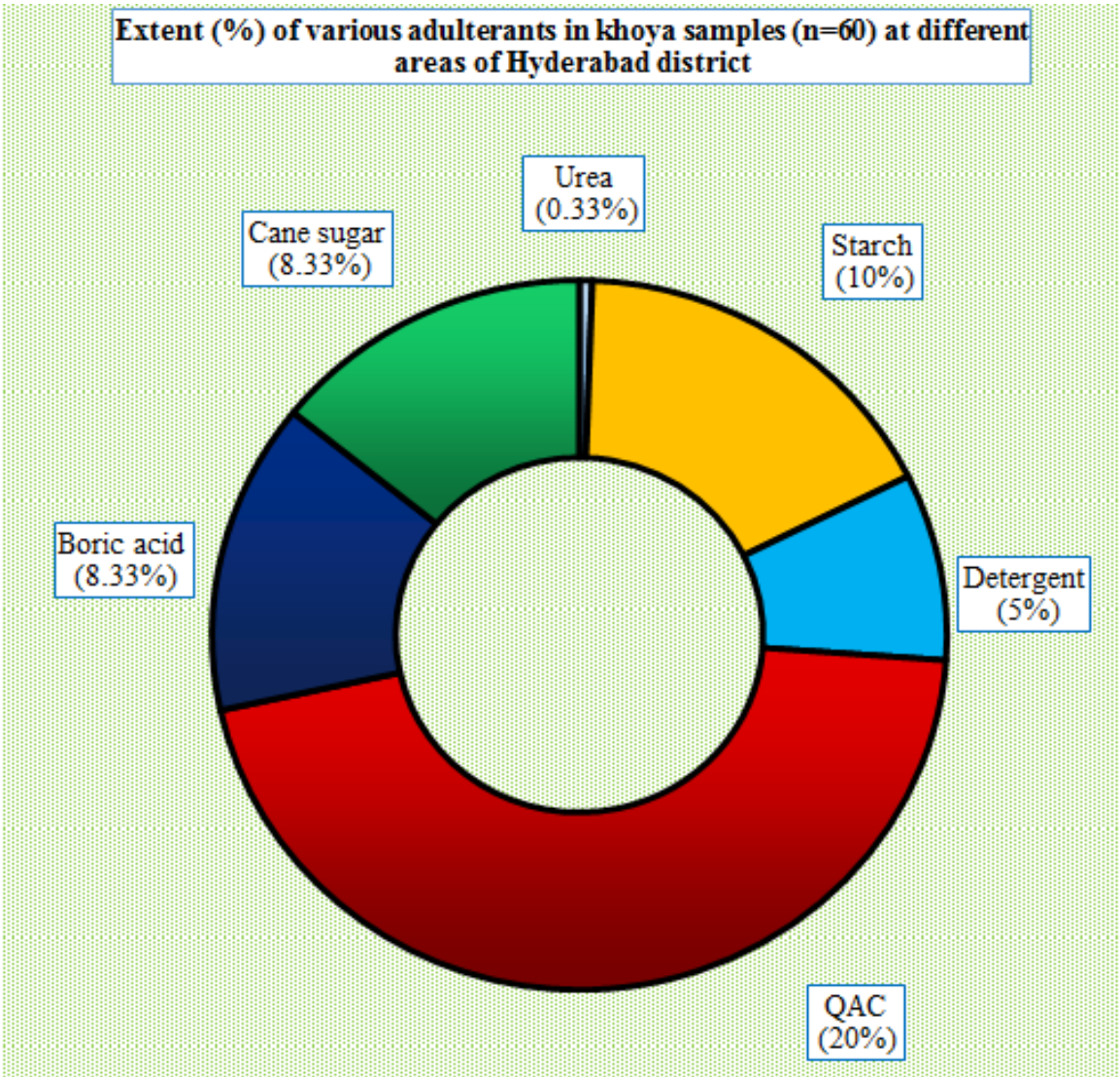
Table 3: Occurrence of various adulterants in the khoya retailed at different areas of Hyderabad district.

Adulterants	Different areas of Hyderabad district			
	Hyderabad city (n=15 samples)	Latifabad (n=15 samples)	Qasimabad (n=15 samples)	Tandojam (n=15 samples)
Urea	0	0	6.66%	6.66%
Starch	13.33%	13.33%	13.33%	0
Hydrogen peroxide (H2O2)	0	0	0	0
Detergent	0	6.66%	6.66%	6.66%
Sorbitol	0	0	0	0
Cane sugar	6.66%	13.33%	6.66%	6.66%

Boric acid	6.66%	6.66%	13.33%	6.66%
Sodium chloride	0	0	0	0
Carbonate	0	0	0	0
Formalin	0	0	0	0
Hypochlorite	0	0	0	0
Quaternary ammonium compounds (QAC)	26.66%	26.66%	20.00%	33.33%
Total Positive (/%)	66.66%	66.66%	66.66%	60.00%

Overall extent of various adulterants in market khoya at Hyderabad district

It has been observed that over total of sixty (n=60) Khoya samples maximum number of sample were adulterated with higher extent of quaternary ammonium compounds 12/60 (20%) followed by starch 06/60 (10%), each of cane sugar and boric acid 5/60 (8.33%) and detergent 03/60 (5%) whereas minimum extent of urea 2/60 (0.33%) was noted in market Khoya samples at Hyderabad district, respectively (Figure 3).



Legend: QAC =Quaternary ammonium compounds

Figure 3: Extent of different adulterants in the khoya samples retailed at different areas of Hyderabad district

DISCUSSION

The results of this investigation into the identification of common adulterants in dairy products sold in District Hyderabad offer important new information about the widespread adulteration practices in the area. Widely eaten dairy products, such as cream, khoya, and yogurt, were found to be significantly adulterated with a variety of adulterants, including cane sugar, starch, boric acid, and quaternary ammonium compounds. To address the health and financial consequences of these activities, these findings highlight the necessity of strict quality control procedures and regulatory supervision (Memon et al., 2013; Barros et al., 2022)

Quaternary ammonium compounds were the most often discovered adulterants in all three goods, according to the study. 20% of the samples in cream tested positive for these substances, compared to 18.33% and 20% in yogurt and khoya, respectively. This is consistent with research by Gale and Hu (2009) and Yadav et al. (2023), who documented comparable patterns of adulteration to extend the shelf life of products. The identification of starch and boric acid as secondary adulterants supports previous research showing their extensive use to enhance texture and preserve goods (Debnath et al., 2015). However, potential regional differences in adulteration techniques are highlighted by the absence of certain adulterants such as sorbitol and hydrogen peroxide in the studied products (Shaikh et al., 2013).

Hyderabad city has the greatest rates of adulteration across all dairy products, according to a geographical analysis; 66.66% of khoya samples, 80% of yogurt samples, and 100% of cream samples tested positive for adulterants. Tandojam had the lowest amounts of adulteration in comparison. These results are more likely to occur in metropolitan areas, which are defined by high demand and competitive markets. Studies carried out in Karachi

and Faisalabad's urban areas have found similar patterns (Awan et al., 2014; Tanmay et al., 2017). According to Fakhar et al. (2006), the discovery of starch in 12% of cream samples and 10% of yogurt samples, along with the presence of boric acid in khoya samples, indicates a continuance of long-standing adulteration problems (Soomro et al., 2014). Furthermore, the extensive use of quaternary ammonium compounds to adulterate cream emphasizes how poor market practices are regulated in metropolitan areas (Lateef et al., 2009; Khan et al., 2022).

There are major public health issues when adulterants like boric acid and quaternary ammonium compounds are found. Despite being used to stabilize and preserve dairy products, some chemicals may have negative health impacts. For example, when ingested in large amounts, quaternary ammonium compounds are known to cause respiratory and gastrointestinal problems (Mota et al., 2003). Similarly, boric acid, which was found in 12% of samples of cream and yogurt, is linked to reproductive problems, kidney toxicity, and other systemic consequences (McGwin et al., 2010). The addition of starch and cane sugar, which undermines the nutritional value of dairy products while concealing the dilution of milk with water, increases the dangers. Research by Zia (2007), and Barham et al. (2018) emphasizes how contaminated water can introduce harmful germs, increasing the hazards to the public's health. Furthermore, according to earlier research, using artificial milk powders may change the biochemical makeup of milk, which could have long-term health effects (Manish et al., 2001; Habib et al., 2021).

In addition to posing a risk to public health, the adulteration of dairy products erodes customer confidence in the dairy sector. Because tainted products lower the market value of authentic dairy products and deter producers from acting ethically, the economic ramifications are significant. To stay competitive, even respectable producers may turn to adulteration because of this immoral behavior. These results are consistent with those of Mabrook and Petty (2003), who highlighted the financial consequences of adulteration on the dairy sector. Additionally, research in Pakistan and India has shown that adding glucose and cane sugar to milk to cover up water dilution impairs the authenticity of the product

(Debnath et al., 2015). The decline in consumer confidence adds to the financial expenses and may have long-term effects on regional and local dairy markets (Memon et al., 2018).

The frequency of adulteration suggests shortcomings in regulatory frameworks and enforcement systems, even in the face of acknowledged concerns. Adulterants can enter the market because of the absence of routine inspections and standardized testing procedures. The Milk Adulteration Testing (MAT) Kit used in the study, for example, shows how effective contemporary testing methods are, although industry acceptance of them is still quite low. To lessen these difficulties, more regulatory measures are necessary, as recommended by Afzal et al. (2011) and Soomro et al. (2014). In line with suggestions made by Shaikh et al. (2013), the results further emphasize the necessity of improved infrastructure and assistance for dairy farmers to guarantee the quality of raw milk. Furthermore, a culture of impunity that sustains unethical behavior is fostered by the lack of severe punishments for violators (Awan and Naseer, 2014).

Policymakers, business stakeholders, and consumers must all take a multifaceted approach to addressing the problem of adulteration. Adulteration techniques can be discouraged by enforcing harsher sanctions for non-compliance and carrying out routine inspections (Awan et al., 2014). For regulations to be effectively enforced, cooperation between industry stakeholders and government officials is essential. Campaigns for public education can educate customers about the dangers of adulteration and the significance of buying dairy products from reputable suppliers. Awareness-raising activities like workshops, seminars, and social media outreach can be quite important (Tipu et al., 2007; Barham et al., 2018). According to Soomro et al. (2014), consumer hotlines for reporting suspected adulteration could also improve accountability and give regulators useful information.

The detection of adulterants at different supply chain stages can be improved by the broad use of fast testing techniques like the MAT Kit. Studies carried out in China and Turkey have shown that this strategy is in line with international best practices (Tasci, 2011; Yildiz et al., 2012). Incentives for producers that follow best practices might encourage moral conduct in the sector. These initiatives can be strengthened even more by certification

programs and quality assurance plans (Fakhar et al., 2006; Afzal et al., 2011). Furthermore, encouraging collaborations between academic institutions and business leaders can result in the creation of cutting-edge testing tools and effective detection techniques (Goswami & Gupta, 2008; H El-Shinawy et al., 2018).

Conclusions

The results of this study highlight the urgent need for tight quality control procedures in the dairy sector, especially regarding the identification of adulterants in dairy products, including yoghurt, cream, and khoya, in the District Hyderabad, Sindh, Pakistan. The report identifies several production and procurement malpractices that seriously jeopardize public health and the dairy industry's reputation. The main issues were found to be contamination, the existence of adulterants, and poor production methods. These include water adulteration, the use of toxic chemicals, and unsanitary manufacturing conditions, all of which reduce the nutritional content and quality of dairy products and put customers' health at risk. This study is important because it has the potential to spur industry reforms, public awareness campaigns, and governmental measures. Protecting consumer interests, maintaining the dairy industry's viability, and maintaining the standing of regional dairy products all depend on addressing these problems.

Conflict of interest:

The authors declare no conflict of interest.

References

Afzal, A., Mahmood, M. S., Hussain, I., & Akhtar, M. (2011). Adulteration and microbiological quality of milk (a review). *Pakistan Journal of Nutrition*, *10* (12), 1195-1202.

Awan, A., & Naseer, M. (2014). Adulteration in milk: A serious public health concern. *Pakistan Journal of Pharmaceutical Sciences, 27*(1), 183-186.

Awan, F. N., Iqbal, M., & Khan, H. A. (2014). Adulteration and its implications on milk quality. *Pakistan Journal of Food Sciences, 24*(2), 123–130.

Barham, G. S., Khaskheli, M., Soomro, A. A., Nizamani, Z. A., & Shah, A. H. (2018). Frequent Supply of Adulterated Milk at Southern Zone of Sindh, Pakistan *Journal Dairy Research Techenology*, *1* (002).

Barham GS, GB Khaskheli, NUN Mari, MB Arain, AH Shah, MA Jamali, Qadeer-ur-Rehman, Qut-bud-Din (2024). Screening of betalactam and oxytetracycline residues in tetra pack milk and their impact on fermentation. Intl J Agric Biol 31:17–22

Barros, M. V., Salvador, R., Maciel, A. M., Ferreira, M. B., de Paula, V. R., de Francisco, A. C., ... & Piekarski, C. M. (2022). An analysis of Brazilian raw cow milk production systems and environmental product declarations of whole milk. *Journal of Cleaner Production*, *367*, 133067.

Butt, T. (2011). Analysis of milk supply chain and impact of seasonal variation on its composition in Punjab, Pakistan. *Pakistan Journal of Agricultural Sciences, 48*(3), 203–208.

Debnath, A. N. A. N. Y. A., Banerjee, S., Rai, C., & Roy, A. (2015). Qualitative detection of adulterants in milk samples from Kolkata and its suburban areas. *International Journal of Research in Applied, Natural and Social Science*, *3*, 81-88.

Fakhar, H., Law, F., & Walker, G. (2006). The white revolution: Dhoodh darya. *Pakistan Dairy Development Company,* 72.

Food and Agriculture Organization of the United Nations. (2013). *Milk and dairy products in human nutrition*. Rome: FAO. Retrieved from https://www.fao.org/newsroom/detail/Milk-and-dairy-hold-potential-for-improving-nutrition-of-world-s-poor/en

Gale Jr, H. F., & Hu, D. (2009). Supply chain issues in China\u2019s milk adulteration incident. *No. 1005-2016-79204, USDA Economic Research Service.*

Goswami, T. K., & Gupta, S. K. (2008). Detection of dilution of milk with the help of glass transition temperature by differential scanning calorimetry (DSC). *African Journal of Food Science*, *2*, 7-10.

Gwin, L. L., Thakur, M., & Lev, L. (2009). The Health Hazards of Adulterated Milk: A Review. *Journal of Dairy Science, 92*(5), 2031–2040.

H El-Shinawy, Saadia, Gamal M Hassan, Fayza A Sdeek, and Dina M Ismaiel. "Risk assessment of some residues in milk and some dairy products." *Journal of Veterinary Medical Research* 25, no. 2 (2018): 305-312.

Haasnoot, W., Smits, N. G., Kemmers-Voncken, A. E., & Bremer, M. G. (2004). Fast biosensor immunoassays for the detection of cows' milk in the milk of ewes and goats. *Journal of Dairy Research*, *71*(3), 322-329.

Habib, M. R., Khandakar, M. M. H., Islam, M. A., Sarkar, M. M., Alam, M. K., Rahman, M. K., ... & Islam, M. A. (2021). Status of the buffalo milk trade and dairy manufacturing business at Bhola district of Bangladesh, and opportunities for buffalo milk products branding. *Research in Agriculture Livestock and Fisheries*, *8*(3), 301-310.

Hoppe, C., Mølgaard, C., & Michaelsen, K. F. (2006). Cow's milk and linear growth in industrialized and developing countries. *Annual Review of Nutrition, 26*, 131–173.

Javaid, S. B., Gadahi, J. A., Khaskeli, M., Bhutto, M. B., Kumbher, S., & Panhwar, A. H. (2009). Physical and chemical quality of market milk sold at Tandojam, Pakistan. *Pakistan Veterinary Journal*, *29*(1), 27-31.

Javaid, S., Ishfaq, M., & Lodhi, G. M. (2009). Milk marketing and adulteration in Pakistan: A case study. *Pakistan Journal of Nutrition, 8*(9), 1391–1395.

Kamthania, M., Saxena, J., Saxena, K., & Sharma, D. K. (2014). Milk Adulteration: Methods of Detection & Remedial Measures. *International Journal of Engineering and Technical Research*, 1, 15-20.

Khan MA, S Bughio, R Buriro, MB Arain, SA Soomro, GA Mughal, Z Lanjar (2022). Residual potential of dexamethasone and its effect on goat milk. Intl. J. Agric. Biol. Vol. 27, Issue 1, Pp:28–33

Lateef, M., Faraz, A., Mustafa, M. I., Akhtar, P., & Bashir, M. K. (2009). Detection of adulterants and chemical composition of milk supplied to canteens of various hospitals in Faisalabad city. *Pakistan Journal of Zoology*, *9*(1) 139-142.

Mabrook, M. F., & Petty, M. C. (2003). A novel technique for the detection of added water to full-fat milk using single-frequency admittance measurements. *Sensors and Actuators B: Chemical, 96*(1-2), 215-218.

Manish, P., Singhal, R. S., & Kulkarni, P. R. (2001). Detection of synthetic milk in dairy milk. *International Journal of Dairy Technology, 53*(3), 87-91.

McGwin Jr, G., Lienert, J., & Kennedy Jr, J. I. (2010). Formaldehyde exposure and asthma in children: a systematic review. *Environmental Health Perspectives*, *118*(3), 313-317.

Memon, M. A., Khaskheli, M., Kamboh, A. A., Soomro, N. A., Mangsi, A. S., Barham, G. S., & Korejo, N. A. (2018). Surveillance of milk adulteration and its influence on physico-chemical characteristics of milk in Hyderabad, Pakistan. *A Review. Journal Animal. Health Producation*, *6*(1), 5-12.

Moore, J. C., Spink, J., & Lipp, M. (2012). Development and application of a database of food ingredient fraud and economically motivated adulteration from 1980 to 2010. *Journal of Food Science*, *77*(4), 118-126.

Mota, F. J., Ferreira, I. M., Cunha, S. C., & Oliveira, P. P. (2003). Optimisation of extraction procedures for analysis of benzoic and sorbic acids in foodstuffs. *Food Chemistry, 82*(3), 469-473.

Shaikh, N., Soomro, A. H., Sheikh, S. A., & Khaskheli, M. (2013). Extent of water adulteration and its influence on physical characteristics of market milk. *Pakistan Journal of Nutrition*, *12*(2), 178.

Shinawy, M., El-Hofi, M., & El-Kadi, S. (2018). Physico-chemical and organoleptic properties of cream and butter produced from milk treated by different methods. *Egyptian Journal of Dairy Science, 46*(1), 29–36.

Singh, P., & Gandhi, N. (2015). Detection of adulteration in milk fat with vegetable oils using gas chromatography. *International Journal of Dairy Technology*, 68(1), 120–125.

Soomro, A. A., Khaskheli, M., Memon, M. A., Barham, G. S., Haq, I. U., Fazlani, S. N., ... & Soomro, R. N. (2014). Study on adulteration and composition of milk sold at Badin. *International Journal Research Applied Natural Social Sciences*, *2*(9), 57-70.

Tanmay, H., Vivek, S., Priti, S., & Parmar, M. K. P. (2017). Physico-chemical properties analysis of ghee. *International Journal of Science Environmental Technology*, *6*(1), 899.

Tanmay, S. M., Roy, I., & Singh, A. (2017). A study on detection of adulterants in butter and ghee. *International Journal of Chemical Studies, 5*(6), 1937–1940.

Tasci, F. (2011). Microbiological and chemical properties of raw milk consumed in Burdur. *Journal of Animal and Veterinary Advances*, *10*(5), 635-641.

Tipu, M. A., Ashfaq, T., Siddique, M., & Khan, M. I. (2007). Monitoring of chemical adulterants and hygienic status of milk. *Pakistan Journal of Agricultural Sciences, 44*(3), 383–386.

Yadav, A. K., Gattupalli, M., Dashora, K., & Kumar, V. (2023). Key milk adulterants in India and their detection techniques: A review. *Food Analytical Methods*, *16*(3), 499-514.

Yildiz, A., Erdogan, S., Saydut, A., & Hamamci, C. (2012). High-performance liquid chromatography analysis and assessment of benzoic acid in yogurt, ayran, and cheese in Turkey. *Food Analytical Methods*, *5*, 591-595.

Zia, U. (2007). Improved market access and smallholder dairy farmer participation for sustainable dairy development. *Consultancy Report CFC/FIGMDP/16FT. Lessons Learned Study*.