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Paneer in everyday diet: Health impacts, risks, and best consumption practices

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Abstract

Paneer, a traditional Indian dairy product, has gained immense popularity due to its high protein content and versatility in vegetarian diets. This article explores the nutritional benefits, potential health risks, and best practices for the safe consumption of paneer. Paneer is rich in proteins, fats, and essential micronutrients like calcium, making it an important food in many diets. However, challenges such as its short shelf life, potential contamination during production, and the presence of saturated fats raise concerns about its health and safety when consumed in excess or under improper conditions. This paper reviews the key health benefits of paneer, including its role in supporting muscle growth and bone health, while also addressing the risks posed by adulteration, microbial contamination, and improper storage.

Through an analysis of traditional and commercial production methods, this study identifies critical control points in the processing and handling of paneer that can reduce risks and enhance its safety. Best practices for safe consumption include proper refrigeration, adherence to hygienic production standards, and limiting consumption of full-fat paneer to avoid excessive saturated fat intake. The article also highlights risk in consuming paneer which are adulterated, causing health threat to general public. Recommendations for future research focus on improving processing techniques and public awareness around safe paneer consumption to ensure its benefits outweigh potential risks.

Keywords: Paneer; Analysis; Vegetable oil adulteration; Microbial contamination; Control; Preservation.

1. Introduction

Paneer, a popular fresh cheese in South Asian cuisine, especially in India, is traditionally prepared by coagulating milk with an acidic agent like lemon juice or vinegar. Unlike most cheeses, paneer is a non-melting variety, which makes it versatile in culinary applications ranging from curries to grilled dishes. It has been a significant part of Indian dietary culture for centuries, providing a vital source of protein, particularly in vegetarian diets. The growing global popularity of Indian cuisine has further spurred interest in paneer as a nutritious dairy product.

Paneer, also known as Indian cottage cheese, is one of the most widely consumed dairy products in India and neighboring countries. It holds a special place in the culinary traditions of the Indian subcontinent due to its mild flavor, versatile texture, and high nutritional value. Unlike most cheeses produced globally, paneer is a fresh, non-fermented, and non-renneted cheese, making it unique in both its preparation method and functional properties. Historically, paneer has been used for centuries in Indian kitchens, with references dating back to the Vedic period, where milk-based foods were integral to the diet (Gandhi, 2019).

The nutritional composition of paneer is rich in proteins, fats, calcium, and essential vitamins, contributing to its increasing demand in health-conscious markets. According to Khamrui and Rajorhia (1998), paneer contains

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approximately 20-25% fat and 15-20% protein, depending on the type of milk used. Its high protein content, coupled with ease of preparation, makes it an important component of both traditional and modern diets (APHA. 2015).

The production of paneer is influenced by factors such as the quality of milk, processing techniques, and coagulation conditions. As explored by Sachdeva and Singh (1988), variations in these factors lead to changes in texture, flavor, and shelf life, making paneer production a subject of research interest in dairy technology. Moreover, the increasing trend toward value-added dairy products has opened avenues for innovative processing and packaging solutions that enhance the shelf stability and consumer appeal of paneer (Goyal, G. K., & Gandhi, D. N., 2009).

The production of paneer involves a simple acid-heat coagulation process, wherein milk is boiled and then curdled using an acidic agent like lemon juice, vinegar, or citric acid. The curd is then drained, pressed, and cooled, resulting in a firm block of paneer that is ready for culinary use. Paneer's non-melting characteristic distinguishes it from many Western cheeses, allowing it to maintain its structure when heated, making it a popular ingredient in a variety of cooked dishes such as curries (e.g., paneer butter masala) or grilled snacks (e.g., paneer tikka).

Paneer is majorly available in supermarkets, grocery stores, and specialty Indian food stores. Some are also available on online grocery platforms. It is very important to have labeling that includes information such as the product's name, ingredients, nutritional information, weight, manufacturing, or expiry date. FSSAI is a regulatory body that governs the food industries in terms of rules and regulations for its sale of products. FSSAI has strict regulations when it comes to milk and milk-based products thus controlling adulteration in labeled brands (Sharma, H., & Sindhu, J. S., 2018).

Adulteration in paneer seems to be of major concern in today's market. Cost reduction, meeting demands, and competitive pressure are the most common criteria that push producers to resort to such methods. Adulteration can either be incidental or intentional. Incidental adulteration includes pesticide residues, metals, and droppings of rodents. Intentionally added adulteration includes, Urea, Palm oil, Detergents, and hydrogenated vegetable oils (HVO). Several tests can be performed to detect the presence of these adulterants (Tamime, 2009).

A recent article published in the national newspaper stated about adulterated paneer being sold in Bangalore and other states. This captured our attention and instigated us to perform the necessary tests to check whether the paneer was pure or adulterated. As we can find many kinds of adulteration in a wide variety of foods, there must be an awareness created to reach the consumers. If this awareness is not provided, then it could lead to various health hazards resulting in fatality. People in general dine out in restaurants and trust the restaurants to serve authentic paneer but need help understanding the severity of the issue.

1.1. Nutritional value and dietary importance

Paneer serves as a vital source of protein, especially in vegetarian diets common in India. It is also rich in fats, calcium, and essential vitamins like vitamin D and B-complex vitamins. According to research by Khamrui and Rajorhia (1998), paneer derived from buffalo milk contains about 20-25% fat and 15-20% protein, whereas paneer made from cow's milk tends to have a lower fat content. The high biological value of its protein makes paneer a suitable alternative to animal-based proteins like meat, particularly for those following vegetarian or vegan diets (Tamime, 2009).

Recent studies have highlighted the growing role of paneer in health-conscious diets due to its high protein and calcium content, essential for muscle building and bone health, respectively (Singh *et al.*, 2020). Additionally, paneer has a low carbohydrate content, making it suitable for individuals following low-carb or ketogenic diets. Given the rise in lifestyle diseases such as obesity and diabetes, paneer offers a nutritionally dense food option with substantial health benefits.

1.2. Production process and technological advancements

Paneer production is largely artisanal, with regional variations in preparation and texture. However, in recent decades, the demand for commercially produced paneer has increased significantly due to urbanization and the expanding middle class in India and abroad. According to Sachdeva and Singh (1988), the quality of paneer is highly dependent on factors such as the type of milk used, the acidity of the coagulating agent, and the time and temperature of coagulation. The firmness, cohesiveness, and overall quality of paneer can be affected by slight changes in these variables.

In the commercial production of paneer, several technological innovations have been introduced to improve its shelf life and quality consistency. For instance, vacuum packaging and modified atmosphere packaging (MAP) have been explored as methods to extend the shelf stability of paneer, which traditionally has a short shelf life due to its high moisture content (Sharma *et al.,* 2016). Additionally, research into fortification techniques, such as adding probiotics or

enriching paneer with micronutrients like omega-3 fatty acids, has opened new avenues for creating functional and value-added dairy products (Kumar *et al.,* 2017).

1.3. Market trends and global expansion

In recent years, the consumption of paneer has expanded beyond South Asia, driven by the global popularity of Indian cuisine and the rising demand for plant-based and vegetarian protein sources. The global dairy industry has recognized paneer as a potential value-added product, with multinational companies exploring its commercialization in new markets (Gupta, 2018). This shift has led to innovations in both small-scale production, aimed at retaining traditional flavors and textures, and large-scale industrial production, where efficiency and longer shelf life are key priorities, and also caused (Gupta, 2018).

The rise in adulterated paneer in the market is concerning, as it poses serious health risks to consumers and undermines trust in the industry. Adulteration often involves adding starch, synthetic milk, or other harmful chemicals to increase yield or reduce costs. These practices not only compromise the nutritional quality but can lead to foodborne illnesses and other health issues due to contamination (Varnam, A. H., & Sutherland, J. P., 2001).

In this research, we will examine different market samples of paneer on its sensory properties, chemical, microbiological properties and legal compliance. By exploring the science behind paneer production and quality of product available, this study aims to contribute to the understanding of this essential dairy product.

1.4. Adulteration in paneer available in the market

The issue of adulterated paneer made with unsaturated vegetable fats is an emerging concern in food safety and public health. Paneer, a popular dairy product, is usually made from cow or buffalo milk, which is rich in essential nutrients. However, to cut costs and increase shelf life, some producers have resorted to using cheaper and potentially harmful substitutes, such as unsaturated vegetable fats or synthetic oils. These fats help keep the paneer soft and extend its shelf life, but at a significant health cost. The consumption of such adulterated products can have both immediate and long-term health consequences (Chawla, R., & Balachandran, R., 2021).

While paneer can be a healthy, nutrient-rich food when made from fresh, natural ingredients, the use of unsaturated vegetable fats and other harmful additives in its production poses significant health risks. These risks are not limited to immediate digestive issues like nausea, vomiting, and diarrhoea but extend to long-term consequences such as liver and kidney damage, cardiovascular diseases, weakened immunity, and developmental delays in children (Kumari, A., & Thakur, M., 2020).

For these reasons, it is crucial to prioritize food safety and quality when consuming paneer. Opting for fresh, hygienic, and unadulterated paneer—preferably made at home or sourced from trusted producers—can help avoid these health risks. Public awareness campaigns and stricter food safety regulations are essential to mitigate the widespread consumption of adulterated dairy products and protect the health of consumers, especially vulnerable populations like children, the elderly, and individuals with pre-existing health conditions. The purpose of this study is to identify these gaps.

2. Materials and methods

The Paneer which are taken for study as follows

- Nandhini paneer
- Milky Mist Paneer
- Arna Paneer
- Rathirams Paneer

These paneer are sourced from Supermarket.

2.1. Physical and chemical analysis (Kumari, A., &Thakur, M., 2020)

2.1.1. Sensory Analysis

Sensory analysis with the parameters such as Colour, Flavour, texture, taste and overall appearance were studied using 5 point hedonic scale.

2.1.2. Moisture Content

- Weigh approximately 5 g of paneer in a crucible.
- Dry in a hot air oven at 105 °C for 5–6 hours until a constant weight is achieved.
- Calculate moisture content as:
- Moisture Content (%) = (Initial weight – Final weight) / Initial weight x 100

2.1.3. Fat content

- Dissolve paneer in sulfuric acid in a butyrometer.
- Centrifuge and measure the fat layer in the butyrometer.

2.1.4. Total Solids

- Dry paneer at 105 °C to determine the residue, which represents total solids.

2.1.5. Vegetable fat

- Perform the Reichert-Meissl test to differentiate between milk fat and vegetable oils.

2.1.6. Starch test

- Add a few drops of tincture of iodine or iodine solution.
- The formation of blue color indicates the presence of starch.
- If the test for starch is positive, quantitative estimation of starch is to be carried out for determination of SNF in paneer samples.

2.1.7. Detergent test

- Pipette 1 ml of suspected paneer sample into a 15 ml test tube.
- Add 1 ml of dye solution followed by the addition of 2 ml chloroform.
- Vortex the contents for about 15 sec and centrifuge at about 1100 rpm for 3 min.
- Note the intensity of the blue colour in the lower and upper layer.
- Relatively, the more intense blue colour in the lower layer indicates the presence of detergent in the paneer.
- The relatively more intense blue colour in the upper layer indicates the absence of detergent in the paneer.
- The method can detect the presence of a 0.15% level of laboratory-grade detergent (e.g. labolene) in paneer.

2.2. Microbial analysis (Aneja *et al.,* 2002)

2.2.1. Total Plate Count

- Conduct a 10-fold serial dilution of the given sample and label the tubes according to the dilution.
- Autoclave Nutrient agar and petri plates, once autoclaved, pour the molten agar into the Petri plates and allow it to solidify.
- Use 10^{-2},10^{-4} and 10^{-5} for inoculating on the plate. Perform a spread plate for all the dilutions.
- Incubate the plates for 24 hours at 37^{o}c and observe the plates.
- Tabulate the results.

2.2.2. Total Yeast And Mold

- Prepare potato dextrose agar and autoclave at 120 ^{o}C for 20 mins.
- Pour into petri plates and let it solidify.
- Take 1 ml of sample dissolved in 0.8% saline and put the drops all over the agar.
- Spread the sample all over the plate.
- Incubate at Room temperature for 24 hours or more and observe for growth.

2.2.3. E. coli test

- LB broth of 100 ml was prepared in a 250 ml conical flask and autoclaved at 121°C for 15 min.
- After autoclaving, the LB broth media is transferred to the test tubes under aseptic conditions in laminar airflow.
- Serially diluted paneer sample was added to the test tubes.

- These test tubes were incubated at 37 °C for 24hrs.
- After the incubation time, the tubes were checked for turbidity formation.

2.2.4. Total Coliforms

- The samples for this test were serially diluted and dilution 10^{-1} was taken for experimenting.
- Eosin Methylene Blue agar and EMB broth 10 ml in test tubes was prepared and autoclaved at 120 ^{o}C for 20 mins.
- The agar was then poured into petri plates and allowed to solidify.
- 1 ml of 10^{-1} diluted samples were taken added to EMB broth test tubes and also same quantity is spread on the agar.
- Incubation was done at 37 ^{o}C for 24-48 hours.
- The samples were observed for growth

2.2.5. Staphylococcus aureus

- The samples for this test were serially diluted and dilution 10^{-1} was taken for experimenting.
- Mannitol salt agar was prepared and autoclaved at 120 ^{o}C for 20 mins.
- The agar was then poured into petri plates and allowed to solidify.
- 1 ml of 10^{-1} diluted samples were taken and spread on the agar.
- Incubation was done at 37 ^{o}C for 24-48 hours.

2.2.6. Listeria monocytogenes

- The samples for this test were serially diluted and dilution 10^{-1} was taken for experimenting.
- Listeria Oxford agar was prepared and autoclaved.
- The molten agar was poured aseptically into sterile petri plates and allowed to solidify.
- 1 ml of 10^{-1} diluted samples were taken and spread on the agar.
- Incubation was done at 37 ^{o}C for 24-48 hours.

3. Result and discussion

The results suggested that Arna, Milky mist and Nandhini paneer had the characteristic attributes such as off white colour, soft texture and milk flavour whereas Rathirams Paneer was found to have deviated characters such as white colour, soft texture and no milk flavour.

Physiochemical analysis was performed based on parameters such as Moisture, Fat, Total solids and presence of vegetable oil for the different brands of panner as shown in the table 1. The results showed that all brands except Rathirams were within the maximum prescribed limits (Codex Alimentarius Commission, 2020).

Table 1 The parameters of the different paneer samples

Parameters	Max	Arna Paneer	Milky Mist	Nandhini	Rathirams
Moiture (%)	60%	58.2%	55.2%	53 %	65.2%
Fat	23 %	23.1%	22.1%	22.7%	20.5%
Total Solids	44%	42%	44.8%	47%	35%
Vegetable Fat	Absent	Absent	Absent	Absent	Present

The average moisture percentage should be 45–55%. High moisture enhances softness but reduces shelf life. Compare values to regulatory standards (e.g., FSSAI/USFDA). Fat content percentage (20–25%) contributes to taste and texture, deviations may impact mouthfeel. Normally the total solids measured (45–50%), the High solids indicate richer quality, important for shelf stability (Food Safety and Standards Authority of India, 2023).

In starch test all the sample shows negative result. Starch addition lowers nutritional quality and violates regulations.

Table 2 The starch test

Sample	Starch test
Nandini Paneer	Negative
Arna Malai Paneer	Negative
Milky Mist Paneer	Negative
Rathirams	Negative

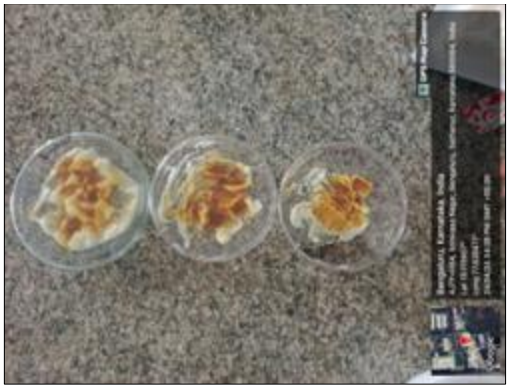

Figure 1 The starch test

The presences of detergents indicate contamination and pose severe health risks.

Table 3 The detergent test

Sample	Intense blue colour in the lower layer
Nandini Paneer	Absence
Arna Malai Paneer	Absence
Milky Mist Paneer	Absence
Rathirams	Presence

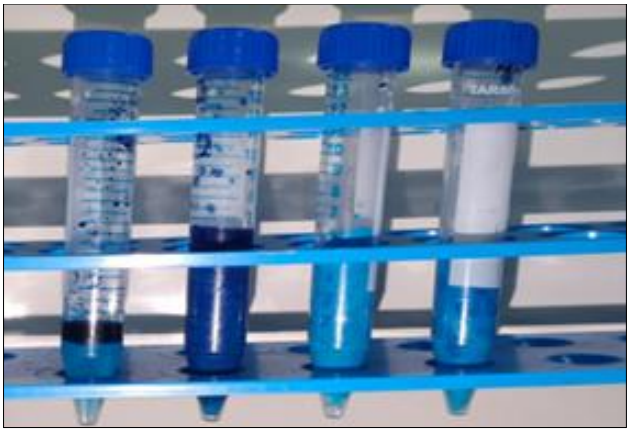

Figure 2 The detergent test

Total plate count indicates the overall microbial load and hygienic practices during production.

Table 4 The Total plate count

Sample Name	Min	Test Results
Nandini Paneer	3.5x 105 cfu/ml	3.36 x 105 cfu/ml
Arna Malai Paneer	3.5x 105 cfu/ml	1.67 x 105 cfu/ml
Milky mist Paneer	3.5x 105 cfu/ml	2.5 x 105 cfu/ml
Rathirams	3.5x 105 cfu/ml	9.5x 105 cfu/ml

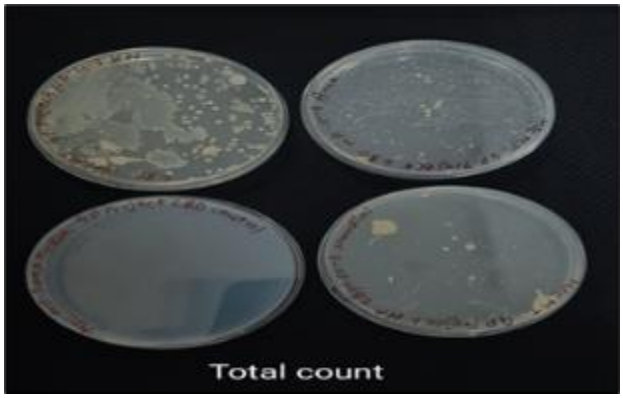

Figure 3 The total plate count

The result indicates the non spoilage or contamination in the production.

Table 5 The Total Yeast And Mold

Sample Name	Min	Test Results
Nandini Paneer	50 cfu/ml	<10 cfu/ml
Arna Malai Paneer	50 cfu/ml	<10 cfu/ml
Milky mist Paneer	50 cfu/ml	<10 cfu/ml
Rathirams	50 cfu/ml	<10 cfu/ml

Figure 5 The Total Yeast and Mold

Table 6 The *E coli* test

Sample	Standard	Test Result
Nandini Paneer	Absent	Absent
Arna Malai Paneer	Absent	Absent
Milky Mist Paneer	Absent	Absent
Rathirams Paneer	Absent	Present

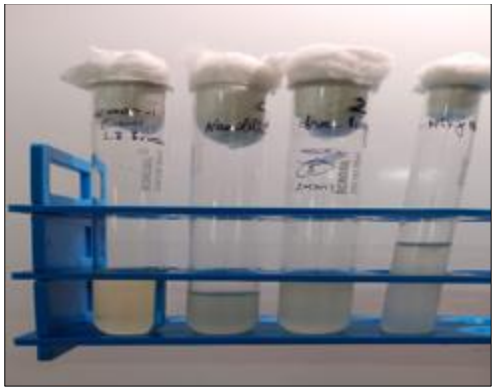

Figure 4 The *E coli* test

Table 7 The Total *Coliforms* test

Sample	Standard	Test results
Nandini Paneer	<10 cfu/g	<10 cfu/g
Arna Malai Paneer	<10 cfu/g	<10 cfu/g
Milky Mist Paneer	<10 cfu/g	<10 cfu/g
Rathirams Paneer	<10 cfu/g	>300 cfu/g

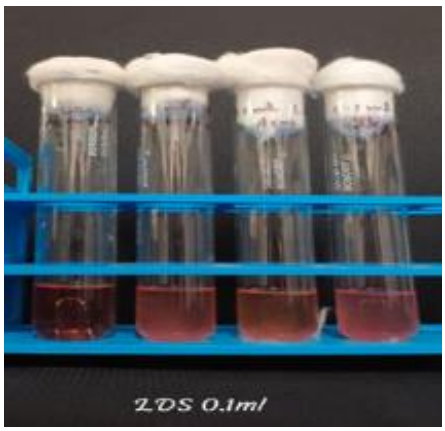

Figure 5 The Total *Coliforms* test

Table 8 The *Staphylococcus aureus* test

Sample	Standard	Test results
Nandini Paneer	<10 cfu/g	<10 cfu/g
Arna Malai Paneer	<10 cfu/g	<10 cfu/g
Milky Mist Paneer	<10 cfu/g	<10 cfu/g
Rathirams Paneer	<10 cfu/g	>300 cfu/g

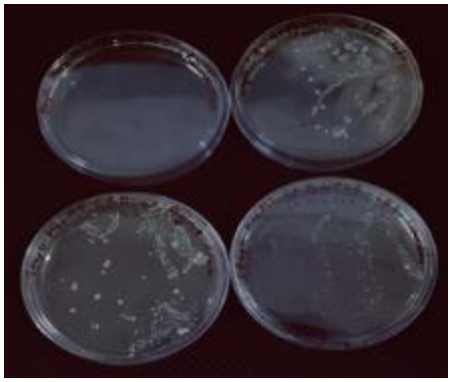

Figure 6 The *Staphylococcus aureus* test

Table 9 The *Listeria monocytogenes* test

Sample	Standard	Test Result
Nandini Paneer	Absent	Absent
Arna Malai Paneer	Absent	Absent
Milky Mist Paneer	Absent	Absent
Rathirams Paneer	Absent	Present

Figure 7 The *Listeria monocytogenes* test

The microbial analysis results highlights the importance of pasteurization and hygienic practices to prevent pathogenic contamination except rathirams paneer.

The samples for the given study were procured from markets and our canteen. Samples (Nandini and Milky Mist) were purchased from a nearby supermarket for experimenting. The sample (Arna Malai Paneer) was procured from the institution's canteen and local Delhi Paneer (Rathiram's) are usually sold wholesale to vendors and are economically cheaper compared to other brands. Hence, vendors resort to buying these paneers. As these paneer brands are cheaper compared to others, they usually decrease the quality of the paneer. The samples were subjected to several physical, chemical, and microbiological analyses. It was observed that several brands, even though established, adulterate their paneer with several adulterants intentionally and incidentally to bring down the Cost of the Paneer.

4. Conclusion

Paneer remains a nutrient-rich, versatile food in the everyday diet, but its safety and quality heavily depend on standardized manufacturing processes and vigilant monitoring for adulteration and contamination. Consumer education and stricter regulations are essential to mitigate risks associated with paneer consumption. This study evaluated the sensory, physicochemical, and microbiological properties of paneer, focusing on its quality, safety, and compliance with regulatory standards. Paneer samples exhibited favorable sensory properties, with high scores for taste, texture, and aroma, indicating consumer acceptability. Variations in sensory quality were linked to differences in production processes.

The results of the study demonstrate that Nandini Paneer, Arna Malai Paneer, and Milky Mist Paneer performed well across all tested parameters, including the starch test, detergent test, microbial safety, and pathogen detection. These brands consistently met safety and quality benchmarks as per the guidelines of FSSAI and Codex Alimentarius standards. Their low microbial counts (total plate count, total yeast, and mold) and absence of pathogens (*E. coli, total coliforms, Staphylococcus aureus, and Listeria monocytogenes*) indicate good manufacturing practices and adherence to hygienic protocols.

Conversely, Rathirams Paneer did not perform satisfactorily, with notable deviations observed in microbial counts and pathogen presence. Specifically, results from total plate count and total coliform tests exceeded acceptable limits, raising concerns about potential contamination and storage inadequacies. These findings highlight the need for stringent quality control measures in the production and distribution processes for this brand.

The presence of microbiological activity, severe adulteration with vegetable oil and lack of proper packaging and essential manufacturing details not only heightenthe risk but make them outright hazardous. While we do not recommend completely eliminating paneer from your diet, we strongly advise against consuming it often from unhygienic brands. While paneer can be a nutritious and delightful part of a vegetarian diet, consuming it in unhygienic conditions poses significant health risks. Understanding the potential clinical side effects of consuming contaminated paneer emphasizes the importance of food safety and hygiene practices. By taking appropriate precautions, consumers can enjoy paneer without compromising their health.

Recommendations:

- Regular monitoring of paneer production facilities to ensure compliance with food safety regulations.
- Development of consumer awareness programs to educate about the risks of adulteration and unsafe products.
- Adoption of advanced processing techniques to enhance quality and extend shelf life without compromising safety.
- Future studies should focus on advanced preservation techniques and exploring consumer preferences for value-added paneer products, ensuring both safety and innovation in the dairy sector.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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