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Incorporation of beetroot and pineapple peel extracts as natural antioxidants to improve quality and shelf life of paneer

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Abstract
Paneer, a protein-rich and widely consumed Indian cheese, is highly perishable due to its high moisture and nutrient content. This study investigated the use of beetroot (*Beta vulgaris*) and pineapple (*Ananas comosus*) peel extracts as natural additives to enhance the nutritional, functional, and sensory properties of paneer. Phytochemical screening revealed flavonoids, terpenoids, steroids, and phenolics in the extracts, contributing to antioxidant and antimicrobial effects. Beetroot peel extract exhibited higher total phenolic (840 mg/100 g), flavonoid (1036 mg/100 g), and DPPH radical scavenging activity (79.18%) than pineapple peel extract. Paneer fortified with these extracts showed increased protein, vitamin C, and ash content, with reduced fat and carbohydrate levels. Sensory evaluation indicated that pineapple peel fortified paneer scored higher for colour, taste, texture, appearance, and overall acceptability, while beetroot peel enhanced nutritional quality. The incorporation of fruit peel extracts effectively improved paneer quality, extended shelf life, and offered a sustainable approach to utilizing fruit processing waste.

Keywords: Paneer, natural antioxidants, antimicrobial activity, nutritional enhancement, fruit waste utilization

1. Introduction
Paneer, a soft Indian cheese, is an important protein-rich food but has a very short shelf life due to its high moisture content, near-neutral pH, and nutrient-rich composition. These characteristics make it highly susceptible to microbial spoilage, lipid oxidation, and quality deterioration during refrigerated storage. Conventionally, chemical preservatives and cold storage are employed to delay spoilage, but consumer preference is shifting toward safe, natural, and functional preservation methods.

Paneer, a traditional South Asian cheese, is prepared using coagulating agents such as acid and heat. It is characterized as a non-melting, non-fermenting, unripen, and rennet-free cheese. Widely consumed both raw and in various culinary dishes, paneer has become increasingly popular in today's fast-paced lifestyle. Among its many forms, deep-fried paneer is especially well-liked and extensively used in snacks such as pakoras and paneer chunks [1]. An excellence source of protein, paneer is accessible at very cheap price and is a major animal protein consumed by vegetarians. Paneer is rich in protein, with a content ranging from 80-86% and high digestibility [4]. In addition to protein, it serves as a valuable source of vitamins, minerals, calcium, fat, and phosphorus. Its shelf life can be extended through refrigeration. Owing to its exceptional protein content, paneer holds a prominent position among dairy products. It is only possible to sustain or conserve milk solid in form of paneer. Paneer consists of total milk casein; some amount of denatured whey protein and all fats present in the milk. Paneer has the property of sticking together and forming a closed structure spongy body with mild taste and smooth texture [2]. Due to these micro-organisms the formation of greenish yellow sledge takes place over the surface of paneer and results in unpleasant flavour which contributes to the product's unsuitability [3].

Few research reports describe that increase in shelf life is a very big difficulty for industrial production of paneer at a wider scale. When some food additives like brine solution, H_2O_2 solution, ascorbic acid and potassium sorbate are added to the paneer, shelf life gets extended. Along with this, some chemicals like niacin and delvocid were also added and were observed to enhance the usable time period of paneer.

Use of chemical preservatives in large amount develops chances of disease in the consumer and toxicity takes place in the food product. Natural ingredients and herbs are used in terms of food safety of the food product. Herbs are utilized in food products and act as flavouring agents. They also contribute to the flavour, colour and taste of the product. Herbs also help in extending the product's shelf-life and are used like a preservative as they have antioxidant, medicinal and preservative properties.
This study supports the use of fruit peel extracts as antioxidants and antimicrobials, because active biomolecules in all the extracts exhibit antimicrobial activity to a considerable extent and results in increasing the shelf life of home-made paneer up to 6 days of storage.

2. Materials and Methods

2.1 Collection of samples

Beetroot and pineapple waste peels were collected from Jaipur local fruit shops, thoroughly washed and shade dried at room temperature (35-37 °C) until get completely dried. The dried peels were blended in an electric blender and powder was stored in close containers until further use.

2.2 Preparation of plant extract

1 g of dried peel powder was taken in a beaker and 10 ml of distilled water was added. The mixture was heated for 30 min in water bath. Then extract was filtered through Whatman filter paper no.1 and the filtrate were used for the further analysis. The filtrate was kept in refrigerator for further use.

2.3 Phytochemical screening

Phytochemical screening was performed for preliminary detection of specific compounds, present in the given fruit peel extract.

2.3.1 Alkaloids

1ml of peel extract and 1ml of Wagner's reagent (dilute iodine solution) were added and mixed. Formation of reddish-brown precipitates indicates the presence of alkaloids.

2.3.2 Carbohydrates

1 mL of peel extract was treated with Benedict's reagent and heated gently. Reddish precipitate indicates the presence of reducing sugars.

2.3.3 Glycosides

5ml of peel extract was treated with 2ml of glacial acetic acid containing one drop of ferric chloride solution and 1ml of concentrated sulphuric acid. A brown ring at the interface indicates the presence of glycosides.

2.3.4 Saponins

1ml of peel extract was mixed with 5 ml of distilled water and shake vigorously for a stable persistent forth. stable froth indicates the presence of saponins.

2.3.5 Flavonoid

1ml peel extract was treated with a few drops of sodium hydroxide solution. Formation of intense yellow color, which becomes colorless on addition of dilute acid, indicates the presence of flavonoids.

2.3.6 Steroids

1ml peel extract is dissolved in chloroform and equal volume of concentrated sulphuric acid was added. Greenish-yellow colour in chloroform layer indicates the presence of steroids

2.3.7 Tannin

1ml of the aqueous peel extract was stirred with 3ml of distilled water and few drops of FeCl3 solution were added. The formation of green color precipitate was indication of presence of Tannins.

2.3.8 Terpenoids

1ml of peel extract was added in 2 ml of chloroform and 3 ml of sulphuric acid. Formation of reddish-brown colour indicates the presence of terpenoids.

2.3.9 Quinones

To 1ml of the peel extract,1 ml of concentrated sulphuric acid was added. Formation of red colour indicates the presence of quinones.

2.4 Determination of total phenolic content

The total phenol content was determined according to folin-ciocalteu's method [7]. 0.5 ml of extract and 0.1 ml folin-ciocalteu's reagent was mixed and incubated at room temperature for 15 min. Then 2.5 ml of 20% sodium carbonate solution was added and further incubated for 30 min at room temperature and the absorbance was measured at 760 nm. Gallic acid was used as a standard. Total phenol values are expressed in terms of gallic acid equivalent for pomegranate and beetroot peel (mg/100 gm).

2.5 Determination of total flavonoid content

The flavonoid content was determined according to aluminium chloride colorimetric method [8]. The reaction mixture consisting in a final volume of 3 ml, 1.0 ml of sample (1 mg/ml), 1.0 ml methanol and 0.5 ml of (1.2%) aluminium chloride and 0.5 ml (120 mm) potassium acetate was incubated at room temperature for 30 min. The absorbance of the samples was measured at 415 nm. Quercetin was used as standard [9]. Flavonoid content is expressed in terms of quercetin equivalent (mg/100 gm)

2.6 Determination of DPPH radical scavenging activity of antioxidant extract

The free radical of the peel extract was tested using a 1,1-diphenyl-2-picryl hydrazyl (DPPH) technique [10]. In a test tube, 3 ml DPPH solution were combined with 100 µl of peel extract. 3ml of solution containing DPPH in 100 µl of methanol was used as control. After that, the tubes were incubated in dark for 30 minutes. Therefore, the absorbance was determined at 517 nm. The following formula was used to calculate the percentage of antioxidants

$$\% \text{ of antioxidant activity} = [(Ac - As) \div Ac] \times 100$$

Where, Ac = absorbance of control and As = absorbance of sample

2.7 Preparation of paneer with fruit peel extract

Paneer was prepared with 25 ml of antioxidant fruit peel extract in 500 ml of milk, 1-2 table spoon of vinegar was used to split the milk for paneer to be formed and without

the addition of fruit peel extract was kept as control. The milk was brought to a temperature just below boiling and vinegar was added to milk. It was allowed to curdle and cool. After cooling whey was separated by filtering through muslin cloth. Whey was drained from the paneer and paneer was cut it into rectangular block. It was kept at cold temperature to form soft and firmer texture.

2.8 Total Carbohydrate content
Carbohydrate estimation was done to determine the concentration of reducing sugar in paneer by DNS method [11]. Standard graphs have been plotted by using glucose standard solution. To the standard glucose solution of different concentration 0.5 ml of DNS reagent and volume make up to 2 ml with distilled water. For sample analysis, 0.5 ml of the paneer sample extract was taken in a test tube, 0.5 ml of DNS reagent was added, and the volume was made up to 2ml with distilled water. The mixture was boiled at 90 °C for 5 minutes until the red brown colour develops. After cooling it to room temperature, absorbance was measured with a spectrophotometer at 540 nm.

2.9 Total protein content
Estimation of protein content by the Folin lowry's method. 1mg/ml of bovine serum albumin was used as standard [12]. To this, 2 ml of a mixture was added, prepared by combining 100 µl of 0.5% (w/v) copper sulphate solution, 100 µl of 1% (w/v) potassium-sodium tartrate solution, and 10 ml of 2% (w/v) sodium carbonate solution. The resulting mixture was incubated in the dark for 15 minutes at room temperature. Afterward, 100 µl of folin-ciocalteu's reagent was added. The mixture was shaken again and allowed to stand in the dark for 30 minutes to develop colour. For sample analysis, 100 µl of paneer sample extract was taken and treated in the same manner as the standard. The absorbance was measured at 660 nm using a spectrophotometer. The protein concentration of the sample was determined from the BSA standard calibration curve.

2.10 Total titratable acidity
2 grams of paneer was taken and a paste was made in a mortar with 20 ml distilled water. Few drops of the phenolphthalein indicator was added. The content of the flask was titrated against standard 0.1N sodium hydroxide solution till the appearance of a permanent pink colour [13].

Titratable acidity as% lactic acid per 100 g paneer = 0.9 x V1 x N/V2

Where
V1 = volume in ml of standard solution used for titration
N = normality of standard NaOH solution
V2 = volume in gram of sample taken for the titration.

2.11 Total Vitamin-C content
The Vitamin-C content in the paneer sample was determined according to the method by alam [14]. In a 250 ml conical flask, 10 ml of sample solution was added first, followed by 75 ml distilled water and 0.5 ml of the 0.5% starch indicator solution, the sample was then titrated using a 0.005 mol/l iodine solution. The endpoint was recognized by the formation of a starch-iodine complex, indicated by the first appearance of a characteristic dark blue-black coloration.

Vitamin c (mg/100 gm) = (total titre volume x 0.44 x dilution factor/amount of sample) x 100

2.12 Determination of moisture content
Moisture content was determined following the oven-drying method recommended by the association of official analytical chemists (AOAC) [15, 16].

Moisture content (%) = total amount of moisture/weight of sample X 100

2.13 Ash content
Ash content was determined following the method recommended by BIS (1981) [17]. A clean, dried crucible was weighed, and 5 g of paneer sample was placed in it. The sample-containing crucible was first dried in a hot air oven and then incinerated in a muffle furnace at 550-600 °C for 4 hours until all organic matter was completely burnt, leaving a white ash residue. The crucible was then transferred to a desiccator, cooled, and weighed.

Ash content % = total amount of ash/weight of sample X 100

2.14 Fat content
Estimation of fat content was done by Soxhlet's method (AOAC, 1995) [18]. Take 5 gm sample into a thimble and then thimble was dropped into siphon tube of the Soxhlet apparatus. Approximately 60 mL of petroleum ether was poured through the sample into the flask and Soxhlet was run for 3 hours. Fat was estimated with petroleum ether and then petroleum ether was evaporated by using hot air oven. Dry at 100 °C for 1 hour. Cool it and weigh.

Calculate the percentage of fat by using this formula: fat% = total amount of fat/weight of sample X 100

2.15 Sensory analysis
The sensory evaluation of paneer was carried out by a 10-member semi-trained panel comprised of students and academic staff members of the faculty who had some previous experience in sensory evaluation of food products. The panel members were requested in measuring the terms identifying sensory characteristics and in use of the score. Participants rated the products using a 9-point hedonic scale, where 9 indicated "like extremely" and 1 indicated "dislike extremely."

3. Results and Discussion

Table 1: Preliminary phytochemical analysis of the plant extract

Serial No.	Phytochemical	Beetroot peel extract	Pineapple peel extract
1	Alkaloids	Negative	Negative
2	Carbohydrates	Negative	Positive
3	Glycosides	Negative	Positive
4	Saponins	Negative	Negative
5	Flavonoids	Positive	Negative
6	Steroids	Positive	Positive
7	Tannins	Negative	Negative
8	Terpenoids	Positive	Positive
9	Quinones	Negative	Positive

Table 2: Proximate analysis of beetroot and pineapple peel extracts.

Proximate analysis	Beetroot peel extract	Pineapple peel extract
Phenolic content (mg/100 gm)	840	680
Flavonoid content (mg/100 gm)	1036	700
FRAP (uM Fe/gm)	190	26
DPPH (%)	79.18	70.02

The results show that beetroot peel extract possesses higher levels of phenolics and flavonoids compared to pineapple peel, which is reflected in its stronger antioxidant activity. Beetroot peel exhibited greater FRAP values and higher DPPH radical scavenging activity, indicating superior reducing power and free-radical neutralization ability. Overall, beetroot peel demonstrated a more potent antioxidant profile than pineapple peel, suggesting its better potential for use in functional or nutraceutical applications.

Table 3: Proximate analysis of control, beetroot peel fortified panner and pineapple peel fortified panner.

Proximate analysis	Control paneer	Paneer fortified with beetroot peel extract	Paneer fortified with pineapple peel extract
Titrable acidity (%)	0.414	0.468	0.585
Vitamin-C (mg/100 gm)	33	55	22
Moisture (%)	67.78	67.92	68.46
Ash (%)	2.58	9.42	6.14
Carbohydrate (%)	4.5	2.38	1.67
Protein (%)	0.23	2.18	0.29
Fat (%)	31.004	18.57	20.49

Fortification of paneer with fruit peel extracts resulted in measurable improvements in its nutritional profile. Both beetroot and pineapple peel extracts increased titratable acidity and moisture, likely due to added organic acids and fiber-related water retention. Beetroot-fortified paneer showed markedly higher vitamin C, ash, and protein levels, indicating superior mineral and bioactive compound enrichment. In contrast, both fortified samples showed reduced carbohydrate and fat content due to dilution of milk solids. Overall, beetroot peel extract demonstrated greater nutritive enhancement than pineapple peel, suggesting its stronger potential as a functional fortifying agent in dairy products.

Table 4: Sensory analysis of beetroot peel fortified panner and pineapple peel fortified panner.

Parameters	Beetroot peel fortified panner	Pineapple peel fortified panner.
Colour	6	8.33
Taste	7.25	8
Texture	6.5	8
Flavour	6.8	6.8
Appearance	6.5	7.8
Overall acceptability	6.5	7.8

4. Conclusion

The study found that beetroot and pineapple peel extracts significantly improved the nutritional quality and shelf life of paneer. Beetroot peel extract showed higher phenolic (840 mg/100 g), flavonoid (1036 mg/100 g), and antioxidant (79.18% DPPH) activity than pineapple peel extract. Paneer fortified with beetroot peel extract had increased protein (2.18%), vitamin C (55 mg/100 g), and ash (9.42%) compared to control samples. Moisture and acidity were slightly higher, while fat content decreased. Sensory evaluation revealed that pineapple peel fortified paneer scored higher for colour (8.33), taste (8.0), texture (8.0), appearance (7.8), and overall acceptability (7.8), whereas beetroot peel fortified paneer scored slightly lower but remained acceptable. The fortified paneer-maintained quality for up to six days, indicating effective preservation through natural fruit peel extracts.

References

1. Aneja RP. Traditional dairy delicacies. In: Dairy India. 6th ed. New Delhi: Dairy India Yearbook; 2007. p. 235-240.
2. Kanawjia SK, Rajorhia GS, Singh S. Paneer technology and its diversification. Indian Dairyman. 1990;42(9):390-393.
3. Sachdeva S, Singh S. Technology of paneer from buffalo milk and its physicochemical properties. Indian J Dairy Sci. 1990;43(3):371-376.
4. Shrivastava S, Goyal GK. A review on the preparation of paneer. Indian J Dairy Sci. 2007;60(6):377-388.
5. Lei K, Kumar P, Singh R. Paneer—An Indian soft cheese variant: A review. J Food Sci Technol. 2013;50(4):615-623.
6. McDonald LM, Johns T. Antioxidant activity in medicinal plants associated with the symptoms of diabetes mellitus used by the Indigenous peoples of the North American boreal forest. J Ethnopharmacol. 2002;82(2-3):197-205.
7. Sengul M, Ercisli S, Yildiz H, Gungor N, Kavaz A, Cetin B. Total phenolic content, antioxidant and antimicrobial activities of some medicinal plants. Pak J Pharm Sci. 2009;22(1):102-106.
8. Kaneria M, Baravalia Y, Vaghasiya Y, Chanda S. Determination of antibacterial and antioxidant potential of some medicinal plants from Saurashtra region, India. Indian J Pharm Sci. 2009;71(4):406-412.
9. Chang CC, Yang MH, Wen HM, Chern JC. Estimation of total flavonoid content in propolis by two complementary colorimetric methods. J Food Drug Anal. 2002;10(3):178-182.
10. Valko M, Leibfritz D, Moncol J, Cronin MTD, Mazur M, Telser J. Free radicals and antioxidants in normal physiological functions and human disease. Int J Biochem Cell Biol. 2007;39(1):44-84. doi:10.1016/j.biocel.2006.07.001.
11. Lam HH, Dinh TH, Dang-Bao T. Quantification of total sugars and reducing sugars of dragon fruit-derived sugar samples by UV-Vis spectrophotometric method. IOP Conf Ser Earth Environ Sci. 2021;947(1):012023.
12. Niamke S, Kouadio YJ, Soro S, Chatigre KO, Kouame LP. Effect of some chemicals on the accuracy of protein estimation by the Lowry method. Biokemistri. 2005;17(2):73-81.
13. Zaouay F, Mena P, García-Viguera C, Mars M. Development and quality assessment of new drinks combining sweet and sour pomegranate juices. Emir J Food Agric. 2014;26(1):1-7.
14. Moradinezhad F, Ansarifar E, Moghaddam MM. Extending the shelf life and maintaining quality of minimally processed pomegranate arils using ascorbic acid coating and modified atmosphere packaging. J

Food Meas Charact. 2020;14(6):3445-3454.
15. Girish V, Kumar KR, Girisha ST. Estimation of sugar and bioethanol from different decaying fruit extracts. Adv Appl Sci Res. 2014;5(1):106-110.
16. Yadav S, Tiwari D, Upadhyay S. Chemical analysis of herbal paneer. Int J Recent Adv Multidiscip Res. 2019;6(5):4911-4915.
17. Bureau of Indian Standards. Handbook of Food Analysis. Part XI: Dairy Products. New Delhi: BIS; 1981. p. 1-18.
18. Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. Washington (DC): AOAC; 1995. p. 1-1200.