Extension of Paneer Shelf Life using Natural Herbal Preservatives

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Abstract
This research was conducted with aims to increase the shelf life of paneer using addition of herbal extract in the paneer preparations. Paneer samples was prepared by adding cloves (Syzygium aromaticum) and pakhanbedh (Bergenia ciliata) extract mixture each to the extent of 0 to 0.6% of the anticipated yield of paneer in two different stages of paneer preparation i.e, on milk immediately after heat treatment and on curd after draining off 90% of whey and the samples were stored at 7±1°C. Alterations in sensory properties and chemical nature of treated paneer sample as against control paneer samples made without incorporation of herbal extracts were examined during the storage periods. Sensory scores of the control paneer decreased at a fast rate during the storage days and proved to be unacceptable after 5th storage day. The reduction in sensory scores of the herb extract treated samples exhibited reduced rate against control samples. The acidity (% lactic acid), FFA (% oleic acid), tyrosine content (mg/100 g) and plate counts (cfu/g) of herb treated samples rose more slowly compared to control samples. The stored paneer samples collected in case of herb extract added after heating of milk scored better. All paneer samples treated with herbal extract on milk were within acceptable limits for 15 days when stored at 7±1°C. The 0.45% clove and 0.15% pakhanbedh extracts were found to slow down the decline in sensory and chemical parameters compared to the other treatments.

Key words: Herbal, panner , clove, Pakhanbedh, Shelf life.

Introduction
Paneer is a soft, non-fermentative, non-meltingcheeseobtained by acid coagulation of milk, entrapping fat, casein, and whey proteins (Khatkar et al., 2017b). Its high moisture and nutrient content make it highly perishable. While several preservation methods exist, consumer preference is shifting toward **natural, minimally processed foods** (Chauhan et al., 2012). Herbs and spices, rich in antioxidants and antimicrobial compounds, have potential as natural preservatives (Shan et al., 2011; Delesa, 2018). Clove and pakhanbedh possess strong antioxidant and antimicrobial activities (Ishaq et al., 2019; Zafar et al., 2019), prompting their use to extend paneer shelf life.

Statement of the Problem
Despite its nutritional value, paneer has a short shelf life of 3–6 days due to high moisture and microbial spoilage (Bhattacharya et al., 1971; Arora and Gupta, 1980). The study investigates clove

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and pakhanbedh extracts as natural preservatives to improve shelf life.

Objectives

General: To evaluate the effect of clove and pakhanbedh extracts on paneer shelf life.

Specific: Assess sensory, chemical, and microbial changes; test different extract formulations; estimate shelf life.

Significance

Using locally available herbs offers a **cost-effective, natural preservation method**, enhancing food safety, shelf life, and consumer appeal in Nepal.

Limitations

- Commercialmilkusedwithout standardization.
- Sensory and chemical analyses not daily.
- Only two herbs studied; proximate composition not determined.

Literature Review

History and Status of Dairy Development in India

Organized dairy development in India began in 1955 with pilot milk schemes in cities like Mumbai, Kolkata, and Chennai. A major milestone was Operation Flood (1970), led by the National Dairy Development Board under Dr. Verghese Kurien, which established a nationwide milk grid, improved rural incomes, and ensured stable milk supply. Before this, milk production was largely unorganized, relying on household cattle or local milkmen. Today, India's dairy sector is a major agro-industry, supporting rural development, employment, and nutritional security (NDDB, 2020).

India is the largest milk producer globally, with output rising from 106 million tons in 2007–08 to over 230 million tons in 2022–23. Only 20–25% of milk is processed by organized cooperatives or private dairies, while the rest flows through unorganized channels. About 50% of milk comes from buffaloes, 47% from cows, and the remainder from goats and other animals.

Paneer

Paneer is a traditional Indian milk product made by heating and acidifying milk using lactic or citric acid, followed by filtration and pressing. As per PFA (1983), it should contain ≤70% moisture and ≥50% milk fat on a dry matter basis. BIS (1983) and DFTQC (2018) specify that paneer must be free from rancid milk, microbial contamination, and added colors or preservatives.

Standards for paneer

Parameters	Requirements	
	As per BIS	As per DFTQC
Moisture % by mass (max)	60.00	70.00
Milk fat % by mass on dry matter basis (min)	50.00	50.00
Titratable acidity % lactic acid, (max)	0.50	-
Standard plate count per g (max)	5×10^5	-
Coliform per g (max)	90	-

Methodology

Experimental Design

Extracts of two herbs—clove (*Syzygium aromaticum*) and pakhanbedh (*Bergenia ciliata*)—were incorporated into paneer at varying concentrations to study their effects on physicochemical and sensory

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attributes during storage. Previous studies have reported the acceptability of clove extract in paneer up to 0.6% concentration (Eresam et al., 2015; Jagannath, 2012), which was therefore selected as the upper threshold level.

For pakhanbedh, since no prior studies were available, preliminary trials were conducted with extract concentrations of 0.3%, 0.6%, and 0.9% based on paneer yield. Samples containing up to 0.6% extract were found organoleptically acceptable, while those with 0.9% developed a pronounced astringent flavor. Hence, 0.6% was established as the upper threshold for pakhanbedh extract incorporation.

Accordingly, six formulations were finalized using different combinations of clove and pakhanbedh extracts, each with 0% (control) and 0.6% (upper limit) concentration levels based on paneer yield.

Different formulations of herb extracts added to paneer

Samples	Formulation
Control	**0% cloves + 0% *pakhanbedh***
A, F	**0% cloves + 0.6% *pakhanbedh***
B, G	**0.15% cloves + 0.45% *pakhanbedh***
C, H	**0.3% cloves + 0.3% *pakhanbedh***
D, I	**0.45% cloves + 0.15% *pakhanbedh***
E, J	**0.6% cloves + 0% *pakhanbedh***

Control represents the paneer sample where no herbs extracts were added. Samples A, B, C, D, E represent the paneer samples where herbs extracts are directly treated on milk and samples F, G, H, I, J represent the samples where herb extract are treated on curd after coagulation and drainage of whey.

Preparation of Herb Extracts

20 g grounded powder

↓

200 ml of ethanol (96%) in conical flask

↓

Plugged with cotton wool

↓

Kept in magnetic stirrer at 120 rpm for 24 h

↓

Filtration through Whatman no-42 filter paper

↓

Concentration using rotary vacuum evaporator at 40°C

↓

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Extract stored at 4°C

The final extract concentration was determined assuming only the solvent evaporated while active components remained unchanged.

Preparation of paneer

Paneer was prepared in the laboratory using method described by De (1983) with slight modifications and the procedure

Filtration of milk

↓

Heating to 95°C for 5 min

↓

Cooling to70°C

↓

Addition of Coagulant– Citric acid (1 %) at 70°C

↓

Holding 5 min

↓

Drainage of whey

↓

Pressing

↓

Removal of paneer from block

↓

Chilling (4°C)

↓

Removal of paneer cubes from chilling water

↓

Allow to drain water (15 min)

↓ **packagig**

Refrigerated storage (5-7 °C)

Analysis of Paneer Samples

Proximate Composition

Paneer samples were analyzed for moisture, fat, and protein content to assess their nutritional quality.

Chemical Characteristics During Storage

Chemical parameters including acidity, free fatty acids, and total plate count were measured to monitor changes in quality and microbial stability over the storage period.

Sensory Evaluation

Control and herb-extract-incorporated paneer were evaluated by five semi-trained panelists using a 9-point hedonic scale. Samples were cut into cubes and assessed at room temperature for color and appearance, body and texture, flavor, and overall acceptance on the 0th, 5th, 10th, and 15th day of storage.

Results and Discussion

The study assessed the impact of clove (*Syzygium aromaticum*) and pakhanbedh (*Bergenia ciliata*) extracts on paneer's shelf life, sensory, chemical, and microbial stability. Control paneer deteriorated by the 5th day, showing mold, off-flavors, and textural loss. Herbal-treated samples exhibited extended shelf life, remaining acceptable up to 15 days when extracts were added to milk and up to 10 days when added to curd. Sensory scores for color, flavor, texture, and overall acceptability were consistently higher in treated samples, with 0.45% clove + 0.15% pakhanbedh in milk performing best. Addition at the milk stage proved more effective in preserving organoleptic properties. Chemical analyses

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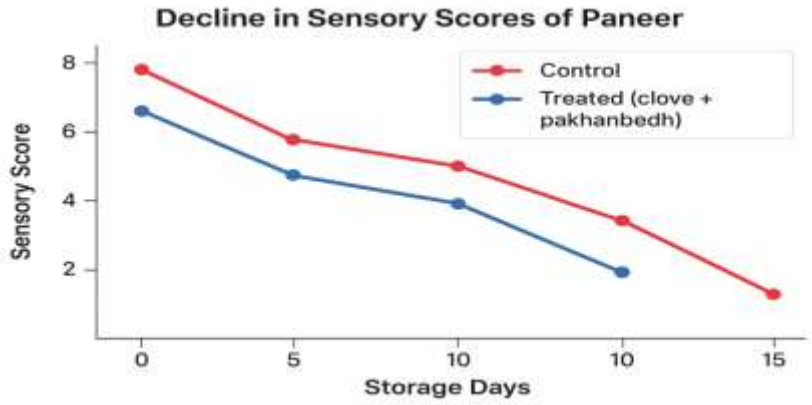
showed slower increases in acidity, free fatty acids, and tyrosine content, while microbial counts remained lower in treated samples. The combination of extracts demonstrated a synergistic preservative effect, inhibiting microbial growth and delaying spoilage. These results indicate that natural herbal extracts can serve as safe, plant-based preservatives, maintaining both quality and safety of paneer while meeting consumer demand for minimally processed, chemical-free dairy products.

Observation:

- Control paneer spoiled fastest.
- Herbal extracts added to **milk stage** extended shelf life the most.
- **0.45% clove + 0.15% pakhanbedh** combination gave the best sensory quality.

Shelf Life and Sensory Scores of Paneer Samples

Sample	Stage of Addition	Shelf Life (Days)	Sensory Score (Overall Acceptability)
Control	–	5	Low
Clove 0.45% + Pakhanbedh 0.15%	Milk	15	Very High
Clove 0.45% + Pakhanbedh 0.15%	Curd	10	High
Other Formulations (0.3–0.6% herbs)	Milk/Curd	10–15	Moderate



Conclusions and Recommendations

Conclusions

The study investigated the preservative effect of cloves (*Syzygium aromaticum*) and pakhanbedh (*Bergenia ciliata*) extracts on paneer. The results demonstrated that both extracts possessed high phenolic content and strong antioxidant activity, contributing to improved stability of the product. Incorporation of the extracts significantly influenced sensory attributes, acidity, free fatty acids, tyrosine content, and microbial counts during storage. Paneer treated at the milk stage showed better preservation than when the extracts were added to curd, likely due to enhanced protein-polyphenol interactions, uniform mixing, and reduced microbial contamination. Milk-treated paneer exhibited an extended shelf life of up to 15 days, whereas curd-treated paneer lasted up to 10 days. Among all formulations, the combination of 0.45% cloves and 0.15% pakhanbedh maintained minimal changes in sensory and chemical characteristics over storage. Overall, all herbal treatments effectively extended the shelf life of paneer compared to control samples, with an estimated production cost of NRs. 572.82/kg.Both extracts exhibited high

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phenolic content and strong antioxidant activity

Recommendations

The study recommends further research to evaluate the preservative potential of other herbs and spices in paneer to identify additional natural alternatives for extending shelf life. It also suggests exploring the application of cloves and pakhanbedh extracts in other food products as safe, plant-based preservatives. Additionally, investigating the effects of different packaging materials and storage conditions on paneer preservation could provide valuable insights for optimizing shelf life and maintaining product quality.

References

Acharya, P. P., & Katwal, B. K. (2002). Effect of coagulants on paneer quality. *Nepal Journal of Science and Technology, 4*, 1–4.

Ahmad, M., Akram Butt, M., Zhang, G., Sultana, S., Tariq, A., & Zafar, M. (2018). Bergenia ciliata: A comprehensive review of its traditional uses, phytochemistry, pharmacology and safety. *Biomedicine & Pharmacotherapy, 97*, 708–721.

Arora, D. S., & Kaur, J. (1999). Antimicrobial activity of spices. *International Journal of Antimicrobial Agents, 12*(3), 257–262.

Badola, R., Danish, M., Kumar, S., Fahad, M., Kanade, P. P., Upadhayay, S., Kohli, D., & Rautela, I. (2018). Effect of incorporation of black pepper and cardamom on quality characteristics of paneer. *International Journal of Applied Sciences and Engineering, 6*(2), 121–127.

Buch, S., Pinto, S., & Aparnathi, K. D. (2014). Evaluation of efficacy of turmeric as a preservative in paneer. *Journal of Food Science and Technology, 51*(11), 3226–3234.

Chauhan, R., Ruby, K., & Dwivedi, J. (2012). *Bergenia ciliata*: Medicinal properties: A review. *International Journal of Pharmaceutical Sciences Review and Research, 15*(2), 20–23.

Chauhan, R., Ruby, K., & Dwivedi, J. (2016). Antioxidant, lipid peroxidation and astringency study of hydroethanolic root extracts of *Bergenia ligulata*, *Bergenia ciliata*, and *Bergenia stracheyi*. *European Journal of Medicinal Plants, 15*(1), 1–10.

El-Maati, M. F. A., Mahgoub, S. A., Labib, S. M., AlGaby, A. M. A., & Ramadan, M. F. (2016). Phenolic extracts of clove (*Syzygium aromaticum*) with novel antioxidant and antibacterial activities. *European Journal of Integrative Medicine, 8*(4), 494–504.

Goyal, S., & Goyal, G. K. (2016). Maximizing shelf life of paneer: A review. *Critical Reviews in Food Science and Nutrition, 56*, 1253–1261.

Jagannath, D. R. (2012). *Efficacy of herbal preservatives to enhance shelf life of paneer* (Ph.D. Thesis). Mahatma Phule Krishi Vidyapeeth, India.

Khatkar, A. B., Ray, A., & Kaur, A. (2017). Effect of addition of clove essential oil on the storage stability of paneer. *The Pharma Innovation Journal, 6*(9), 39–44.

Kumar, S., Rai, D. C., Niranjan, K., & Bhat, Z. F. (2011). Paneer—An Indian soft cheese variant: A review. *Journal of Food Science and Technology, 51*, 821–831.

Rajkumar, V., Guha, G., Kumar, R. A., & Mathew, L. (2010). Evaluation of antioxidant activities of *Bergenia ciliata* rhizome. *Records of Natural Products, 4*(1), 38–48.

Shan, B., Cai, Y.-Z., Sun, M., & Corke, H. (2005). Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents. *Journal of Agricultural and Food Chemistry, 53*(20), 7749–7759.

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