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Processing and Evaluation of Paneer from Coconut Milk and Cow Milk Blends

Sivakumar, K.P.[a++*], B.Nallakurumban [b#], A.Vijayakumar [c++], A.Kalaiselvan [d#] and T.Balaji [e++]

[a] Department of Family Resource Management and Consumer Science, Community Science College and Research Institute, TNAU, Madurai, Tamil Nadu, India.
[b] ICAR-Krishi Vigyan Kendra, TNAU, Virudhunagar, Tamil Nadu, India.
[c] ICAR-Krishi Vigyan Kendra, TNAU, Ramnad, Tamil Nadu, India.
[d] Department of Extension Education and Communication Management, Community Science College and Research Institute, TNAU, Madurai,Tamil Nadu, India.
[e] Department of Soil Science and Agricultural Chemistry, Agricultural College and Research Institute, TNAU, Thiruvanamalai, Tamil Nadu, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Paneer is an Indian traditional milk product which occupies an important place as a base product for the production of various culinary preparations. Paneer is a nutritious and wholesome food. It provides one of the methods of conserving, preserving and prolonging shelf life of milk solids in a

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[++]Assistant Professor;
[#] Associate Professor;
**Corresponding author: E-mail: sivakumar.kp@tnau.ac.in;*

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highly concentrated form.For coagulation of milk 1% of lime juice, which contains citric acid. The shelf life of the developed product during room temperature (3 days) and refrigerated condition. The present study was under taken with different levels (90:10, 80:20, 70:30) of cow milk and coconut milk. Chemical quality (moisture, fat, protein, and yield) and microbial quality (TPC, yeast and mould, coliform) were also analyzed. The coconut *paneer* with 90:10 ratio of cow milk and coconut milk was found to be best among others. Thus as far as product acceptability judged by organoleptic evaluation the treatment can be rated as P0 > P1> P2> P3. The fresh cow milk *paneer* (P0) chemical constituents were 50.78 g of moisture, 0.22% of acidity, 5.3 of pH, 20.39 g of protein, 22.8 g of fat, 0 g of fibre, 198 mg /100 g of calcium, 2.2 mg /100 g of iron respectively. The coconut *paneer* prepared by 10% coconut milk blending with 90% cow milk, the P1 sample chemical constituents were 52.05 g of moisture, 0.20% of acidity, 5.6 of pH, 20.55 g of protein, 23.75 g of fat, 0 g of fibre, 192mg /100 g of calcium, 3.12 mg of iron respectively. The overall acceptability score was observed as highly acceptable with score point of 8.4±0.70in P1 when compared to control P0 was 8.1±0.73. The unit cost production of 100 g of the functional coconut *paneer* was Rs.25/100gwhereas control was Rs.22/100 g of packets respectively.

Keywords: Paneer; cow milk; coconut milk; composition; sensory quality; microbial count.

1. INTRODUCTION

"Coconuts (*Cocos nucifera* L.) is commonly called tree of life because of its nutrients and myriad uses. It is classed as a fruit and frequently confused for being a nut, the coconut is actually a one seeded drupe. It provides a good potential source of proteins (protein content in coconut milk is quite low; about 2.3% or so – to be claimed a potential source) with good nutritional value and a relatively well-balanced amino acid profile. World production of coconut averaged about 51.01 billion nuts. It is a highly valued ingredient in our eating practice for its enormous medicinal benefits" (Ganguly, 2014).

"Coconut production and processing have been the predominant economic activities in rural communities in many tropical regions of South-east Asia, the South Pacific and to a lesser extent in the west coast of Africa. Traditionally, production of coconut oil from copra (dehydrated coconut meat) has been the largest economic sector of the coconut industry" (Hagenmaier, 1977). "The new products developed from coconut could potentially be of desirable nutritional composition especially in relation to cholesterol reducing fat levels, being as it is that the saturated fat content in coconut milk" (Timmen&Patton, 1989).

"Coconut also has important anti-carcinogenic and anti-pathogenic properties and is less likely to cause weight gain than poly unsaturated oils" (Coconut Research Centre, 2004). "Coconut fat helps to maintain a healthy ratio of omega-6 (w-6) and omega-3 (w-3) fatty acids, when consumed as a part of a diet. Coconut milk, a white opaque liquid, is an emulsion of natural oil in water, extracted from shredded coconut endosperm either with or without the addition of water" (Simuang *et al*., 2004).

"While cow's milk has nearly equal amounts of oil and proteins, coconut milk has ten times more oil than proteins Coconut milk is considered as a valuable food for people having nutritional deficiencies since it has significant amount of Vitamin C, adequate natural minerals (viz., Mg, K, P, Fe), and a highquality protein. Very little are still known about the coconut proteins as studies are focused on its high oil content which has also showed many health benefits" (Carandang, 2008). Coconut milk is lactose free, unlike cow milk, and can be used as a milk substitute by those ailing from lactose intolerance. Paneer is popular indigenous variety of soft cheese (David, 2009). It is highly popular traditional Indian Dairy product which is obtained by acid and heat coagulation of milk. FSSAI imposed maximum of 60.0% moisture and minimum of 50% fat in dry matter.

"Paneershould preferably be marble white in appearance but spongy body, possessing sweetish-acidic, nutty flavor" (Vera and Mathur, 1986; Bandyopadhyay and Mathur, 1987). Paneer is highly nutritious since it retains about 90 % fat and protein, 50 % minerals and 10 % lactose of the original milk. About 5 % of the total milk produced in India is converted to paneer.8% of calcium and 68.3% of magnesium of the original milk got retained in *paneer* (Mathur,1995). Production of *paner* provides one of the methods of conserving, preserving and prolonging theshelf-life of milk solids in ahighly concentrated form.

Therefore, this research was aimed at increasing the utilization of coconut milkthrough its use in *paneer* making and in improving the nutrient content of paneer.The objective of this study was to investigate the influence of incorporating coconut milk in its blend with cow milk on the proximate composition, sensory quality, microbial countof *paneer* and monitor the products shelf life.

2. MATERIALS AND METHODS

2.1 Standardization of the Method of *Paneer* Making

The coconut *paneer* was prepared from milk blend comprising of the following proportions of cow milk with coconut milk viz., 90:10, 80:20 and 70:30 utilizing 1% lime juice as an acidulant (i.e. paneer samples P1, P2 and P3respectively). Control paneer was prepared exclusively from cow milk (i.e. sample P0).

The standardization process schedule used for trial

Table 1. Details of treatments utilizing blend of cow milk with coconut milk in the preparation of *Paneer*

Proportion of the two types of milk	Paneer made using treatment			
	P0	P1	P2	P3
Coconut milk	-	10	20	30
Cow milk	100	90	80	70

Table 2. Preparation of *paneer* from cow milk (Po)

S.No	Ingredients	Quantity
1.	Cow milk	1000 ml
2.	Lime juice	10 ml

Table 3. Preparation of *paneer* from blend of cow milk and coconut milk (P1)

S.No	Ingredients	Quantity
1.	Cow milk	900 ml
2.	Coconut milk	100 ml
3.	Lime juice	10 ml

2.2 Chemical Analyses

2.2.1 Moisture

The moisture content of the paneer samples was estimated by Gravimetric method employing hot air oven as per the procedure given by AOAC (1995). Weigh accurately 2 g of pre-shredded paneersample into the previously dried and weighed dish. Add 4 ml of hot distilled water and mix. Add 1 ml of hot distilled water to dislodge the particles adhering to the sides of the dish. Place the dish in the oven maintained at 102°C for 4 h. Oven drying was continued till we obtain concordant values. Dried samples were cooled in a desiccator and subsequently weighed.

Calculation:

$$\text{Moisture (\%)} = \frac{\text{Loss in weight}}{\text{Weight of the sample}} \times 100 = \frac{(W_2 - W_3)}{(W_2 - W_1)} \times 100$$

W1 = Initial weight of empty plate
W2 = Weight of empty plate plus sample before drying
W3 = Final weight of empty plate plus sample after drying

Protein

Reagents

i. Folin –Ciocalteau reagent (reagent D)- reflux gently for 10 hours a mixture consisting of 100g Sodium tungstate (Na2WoO4.2H2O), 25g Sodium molybdate (Na2WoO4.2H2O), 700ml water, 50ml of 80% phosphoric acid, and 100ml of concentrated hydrochloric acid in a 1.5L flask. Add 150g lithium sulfate, 50ml water and a few drops of bromine water. Boil the mixture for 15 min without condenser to remove excess bromine. Cool, dilute to 1L and filter. (Reagent A).
ii. 0.5% Copper Sulphate (CuSO4.5H2O) IN 1% potassium sodium tartrate (Reagent B)
iii. Alkaline copper solution.: Mix 50ml of reagent A and 1ml of reagent B prior to use (Reagent C)
iv. Protein Solution (Stock Standard)

Weigh accurately 50mg of bovine serum albumin (fraction V) and dissolve in distilled water and make up to 50ml in a volumetric flask.

v. Working Standard Solution

Dilute 10ml of the stock solution to 50ml with distilled water in a standard flask. 1.0 ml of this solution contains 200µg protein.

Procedure:

Extraction of protein from Sample

Extraction is usually carried out with buffers used for the enzyme assay. Weigh 500mg of the

sample and grind well with a pestle and mortar in 5-10mL of the buffer. Centrifuge and use the supernatant for protein estimation.

Estimation of Protein

1. Pipette out 0.2, 0.4, 0.6, 0.8 and 1.0ml of the working standard into a series of test tubes.
2. Pipette out 0.1 ml and 0.2 ml of the sample extract in two other test tubes.
3. Make up the volume to 1.0 ml in all the test tubes. A tube with 1.0ml of water serves as the blank.
4. Add 5.0 ml of reagent C to each tube including the blank. Mix well and allowed to standing for 10mins.
5. Then add 0.5 ml of reagent D, Mix well and incubate at room temperature in the dark for 30min, blue colour is developed.

Take the reading at 660nm. Draw a standard graph and calculate the amount of protein in the sample.

Fat

The lipid in the sample was extracted with petroleum ether (60-80°C) in Soxplus apparatus for two hours. Then the solvent was evaporated and the remaining residue was weighed. The fat content was expressed as percentage.

Calculation

$$\text{Fat (\%)} = \frac{(W_3 - W_2)}{W_1} \times 100$$

W1= Weight of sample used
W2 = Weight of flask W3 = Weight of flask with fat residue

2.3 Minerals

2.3.1 Preparation of ash solution for estimation of minerals

One gram of samples were acid digested using triple acid (nitric, sulphuric, perchloric acids in the ratio 9:2:1) by keeping in sand bath until getting a clear solution and filtered through Whatman No. 41 ash less filter paper. The filtrate was made up to 100 ml and the obtained triple acid extract (ash solution) was used for the estimation of calcium, magnesium, phosphorus and other micro nutrients such as iron, zinc, manganese and copper.

2.3.2 Iron

The clear extract of prepared triple acid extracts was fed into the Atomic Absorption Spectrophotometer (AAS). The absorption of light by the atoms of the element in the vaporized sample was related to the concentration of the desired metal (iron) in it. The concentration was measured by using the wavelength of 248.33 nm. The concentration of the iron in the solution was measured by comparison with absorbance measurements on standards of known composition.

2.3.3 Calcium

Estimation is carried out by the versenate method. A 10ml of triple acid extracted sample added 10% NaoH drop by drop and 5 ml added to maintain the pH at 12. Added pinch muroxide indicator. Titrated against 0.02N ETDA (colour changed from pinkish red to purple or violet.

Calcium content = 0.0004×titre value / Volume of extract (ml) 100×1000

2.3.4 Estimation of pH

The pH of the sample was determined by the method of Hart and fisher (1971). An aliquot of 10 g of sample was mixed well by stirring with 50 ml of distilled water using glass rod and the pH of the suspension was determined in the pH meter.

2.4 Microbial Analysis

The microbial count of the *paneer* was enumerated by the method described by Istavankiss (1984). The microbial load such as total plate count (bacteria, yeast and mould count, coliform count for freshly prepared product (i.e. 0 day) and those stored under refrigeration/room temperature for 3 days were analyzed based on the procedure given below.

2.4.1 Preparation of medium

Plate count agar was used for enumeration of total aerobic bacteria, Malt Extract agar medium was used for enumeration of yeast and mould, coliforms were enumerated using Violet Red Bile Agar.

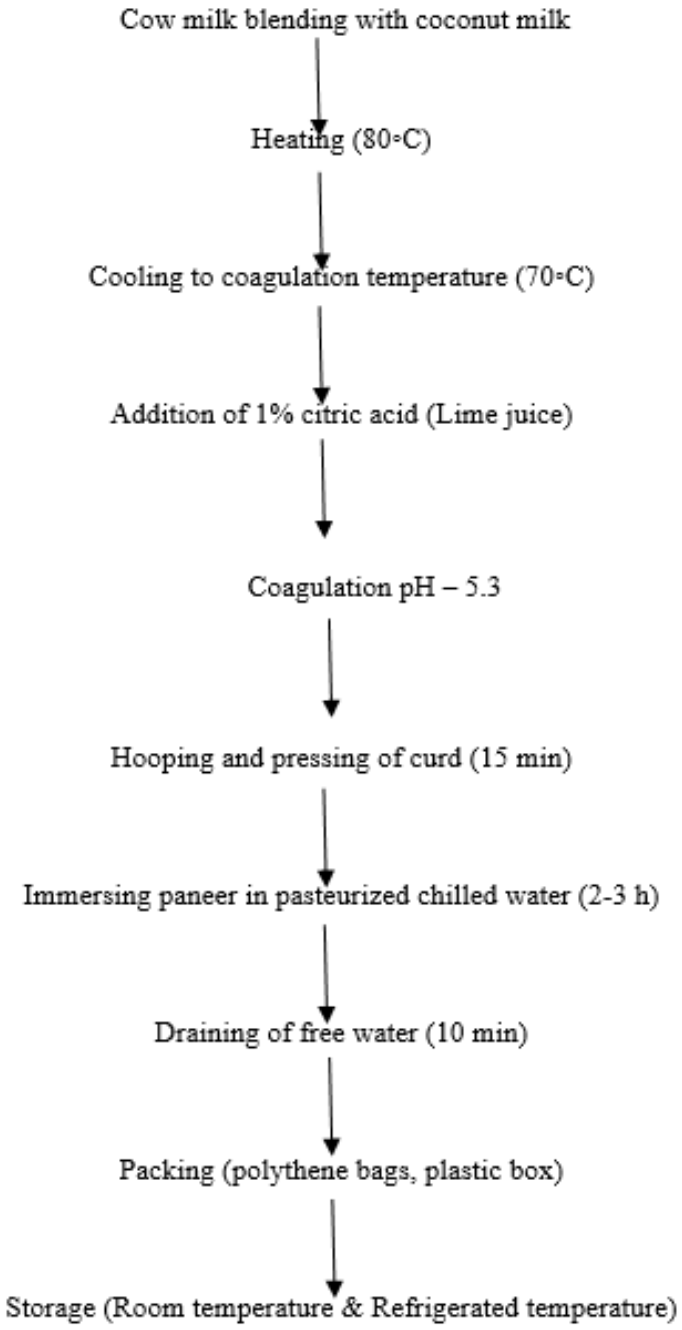
2.4.2 Evaluation of microbial quality of *paneer*

One ml of the sample was taken for microbiological enumeration and serially diluted. Dilution of 10^5 and 10^6, 10^3 and 10^4, and 10^3 and

10^4 was taken for bacteria, yeast and mould count and coliforms respectively. One ml of the serial dilutions of the samples was taken in petriplates and appropriate media was added for the specific organisms. Plates were incubated at room temperature for 24 to 48 h for bacteria, coliforms and 3 days for yeast and mold and the colonies were counted and expressed cfu/g.

2.5 Organoleptic Evaluation

The prepared coconut milk blending with cow milk functional *paneer* was evaluated organoleptically for various quality attributes such as colour, texture, flavour, taste and overall acceptability, by a panel of 10 trained and untrained judges using 9 point hedonic scale as per the procedure given by Watts *et al.* (1989).



Flow Chart 1. The flow chart for the preparation of *paneer* from milk blend

2.6 Cost Analysis

Cost analysis of cow milk *paneer* and 10% of coconut milk blending with 90% of cow milk to produce the product like functional coconut *paneer* were determined systematically.

2.7 Storage Study

The shelf life qualities of the developed products were assessed for a period of 7 days. Two sets of all the products (each containing 100g) were kept in a Packaging material (plastic boxes, 80gauge polythene bags) for a period of 7 days under Room temperature and Refrigerator storage respectively.

3. RESULTS AND DISCUSSION

This study deals with the blending of coconut milk with cow milk to improve the nutritional quality of *paneer*. The main purpose for using the coconut milk is due to their nutritive value and to study their acceptability in dairy products. In order to evaluate the quality and acceptability of functional coconut milk *paneer*, the chemical analysis as well as organoleptic evaluation were determined.

Nutritional Compositions of Fresh Cow Milk *Paneer:*

Table 4. Nutritional Composition of Fresh Cow milk *Paneer* (100g)

Chemical Constituents	Value (%)
Moisture (g/100g)	50.78 g
Protein (g/100g)	20.39 g
Fat(g/100g)	22.8 g
Acidity	0.22 %
Carbohydrate	1.4 g
Ash	1.97%
Iron (mg/100g)	2.2 mg
Calcium (mg/100g)	198 mg

The Table 4 showed that the fresh cow milk panernutritional compositions were 50.78 g of moisture, 0.22% of acidity, 5.3 of pH, 20.39 g of protein, 22.8 g of fat, 0 g of fibre, 198 mg /100 g of calcium, 2.2 mg /100 g of iron respectively. The moisture and protein contents increased with decrease in fat content of *paneer*. Similar findings were reported in *paneer* by Ashraf Pal and Yadav (1992).

The Table 5 revealed that the functional coconut *paneer* prepared by 10% coconut milk blending with 90% cow milk, the P1 sample chemical constituents were 52.05 g of moisture, 0.20% of acidity, 5.6 of pH,20.55 g of protein, 23.75 g of fat, 192 mg /100 g of calcium, 3.12 mg of iron respectively.Experimental *paneer* (T3) had highest average protein of 30.58 percent whereas (T1) had lower average protein control of 26.17 percent (AOAC 1980).Control (T0) had highest fat of 14.64 percent and experimental *paneer* (T1) had the lowest average fat of 11.62 percent **(**AOAC 1980).

Table 5. Proximate Composition of *Paneer* P1

Constituents	Value (%)
Moisture (g/100g)	52.05 g
Protein (g/100g)	20.55 g
Fat(g/100g)	23.75 g
Acidity	0.20 %
Carbohydrate	1.8 g
Ash	2.10%
Iron (mg/100g)	3.12 mg
Calcium (mg/100g)	192 mg

3.1 Organoleptic Evaluation of the Standardized Product

A sensory property of this dairy product was assessed as the sensory evaluation and consumer acceptance is a desirable criterion for a product before launching it in the market. Sensorial evaluation of each sample was done in terms of colour and appearance, consistency, flavour, taste and overall acceptability. Nine point hedonic scale was followed for conducting the sensory evaluation of fresh cow milk *paneer* and functional coconut *paneer*. The panel of 10 trained and untrained judges comprising of professors and students of Department of Food Science and Nutrition, Home Science College and Research Institute, TNAU, Madurai were selected to evaluate the products for sensory parameters. The samples were presented to judges and plain water was given to them to rinse their mouth in between the evaluation of the samples. The average score value of each combination was taken (Table 6). The change in the quality attributes directly influenced the organoleptic evaluation scores.

- P1 - 90% of Cow milk + 10%of Coconut milk + 1% Lime juice
- P2 - 80% of Cow milk + 20%of Coconut milk + 1% Lime juice

- P3 - 70% of Cow milk + 30%of Coconut milk + 1% Lime juice

3.2 Shelf Life of Product

The shelf life of the developed products were assessed for a period of 7 days. Two sets of all the products (each containing 100g) were kept in a packaging material (plastic boxes, 80gauge polythene bags) for a period of 7 days under Room temperature and Refrigerator storage respectively. Both the sets of each product were examined visually for microbial infestation and noted down the period in which first infiltration was seen. The period was taken as the shelf life of the product under norma1l room temperature and refrigeration temperature.

Table 7, revealed that the shelf life of both control (P0) and functional coconut *paneer* (P1) were 3 days under room temperature and 7 days in refrigeration temperature. It shows that there is no significant change in shelf life of both the *paneer.*

Sensory analysis (quantitative and/or descriptive) is often used to assess the flavor, appearance, texture and other attributes of food products as a function of processing parameters (Kwok *et al.,* 2000). Yoghurt manufactured from cow and coconut milk mixtures recorded the highest levels of flavour which may be due to the good coconut flavor.

3.3 Yield of *paneer*

The yield of *paneer* was determined on the basis of weight of coagulated milk product (in grams) collected by means of muslin cloth, cow's milk produced a yield of 134 g/lit which was more than the 162 g/lit yield recorded by 10% coconut milk blending with cow milk.The cheese product was formed by the coagulation of proteins in the cow and coconut milk, thus the greater protein content the greater the yield of cheese product (Adedeji and Nwanekezi, 1987).

3.4 Microbiological Quality of the Product

Microbiological quality of the fresh cow milk *paneer*and functional coconut *paneer*were evaluated and the results are elaborated in Table 8. Total bacterial count ranged between 34.80log 10^6cfu ml^{-1}, whereas yeast and mould count ranged from 12.90log 10^4cfu ml^{-1}, coliform count was absent throughout the storage period.

Kumar and Bector (1991) analyzed the yeast and mould counts of control *paneer* sample and found that initial count increased from 10 per g to 50 per g after 4 days and 250 per g after 7 days of storage at 15 °C. Venkateswarlu et al. (2003) reported that yeast and mould count of *paneer* 2.45 per g. Kumar and Bector (1991) reported the initial level of coliform counts of control increased from 90 per g to 3.5×103 per g after 4 days and 8.0×106 per g after 7 days of storage.

3.5 Cost Analysis

The unit cost production of 100 g of the functional coconut *paneer* was Rs.25 whereas control was Rs.22 of packets respectively.

Table 6. Sensory scores of paneer product

Sensory attributes	Sensory Scores (out of 9.00) of *Paneer*			
	P0	P1	P2	P3
Colour & appearance	8±0.67	8.2±0.79	8.4±0.70	8.3±0.82
Flavour	8±0.47	8.2±0.92	8±1.15	7.8±1.23
Texture	8.2±0.79	8.0±0.57	7±0.94	7.1±0.88
Taste	8.1±0.74	8.4±0.70	7.6±1.17	7.5±1.08
Overall Acceptability	8.1±0.73	8.4±0.70	7.8±1.03	7.7±1.20

Table 7. Shelf life of control anddeveloped paneer at two storage conditions

S.No	Sample	Shelf life	
		Room temperature	Refrigerator
1	Control (P0)	3 days	7 days
2	Experimental *paneer* (P1)	3 days	7 days

Table 8. Microbial count (After storage)

Type of count	Microbial count of P*aneer*	
	P0	**P1**
Total Plate Count -10^6cfu ml^{-1}	42.20	34.80
Yeast &Mould Count-10^4cfu ml^{-1}	14.60	12.90
Coliform Count -10^3cfu ml^{-1}	Nil	Nil

4. CONCLUSION

- Paneer made from a blend of coconut milk and cow milk can have a number of nutritional and quality benefits, including:
- **Cost**: Blending coconut milk and buffalo milk can produce a low-cost paneer.
- **Nutritional value**: Paneer made with coconut milk has a higher nutritional value than milk paneer, with more fat and carbohydrates. It's also rich in crude fiber, which can help reduce the risk of chronic diseases.
- **Quality**: Paneer made from a blend of homogenized and unhomogenized milk can have a higher yield and fat recovery than paneer made from unhomogenized milk alone.
- **Lactose-free**: Coconut milk is naturally lactose-free, making it a good option for people who are lactose intolerant.
- **Sustainable**: Coconut milk is a more sustainable option than cow's milk.

Other findings from studies on paneer made from coconut milk and cow milk blends:

- The moisture content of coconut milk paneer is lower than cow milk paneer.
- The ash content of coconut milk paneer is lower than cow milk paneer.
- Paneer made from a blend of coconut milk and buffalo milk is free of coliform, indicating good quality.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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