



Chemical Quality of Moringa Paneer Prepared from Buffalo Milk

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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

The current study, "(Technology of preparation of moringa paneer from buffalo milk,)" was conducted at Chandra Shekhar Azad University of Agricultural and Technology in Kanpur at the Department of Animal Husbandry and Dairying. Using buffalo milk, two types of coagulant, three types of temperature, and extracts of 0%, 5%, 10%, 15%, and 20% moringa leaves, moringa paneer was made. The sensory and chemical characteristics of the freshly collected samples were examined. When samples were made with 10% moringa leaf extract, 2% citric acid, and 80°C temperature, the higher sensory quality of moringa paneer was attained. The cost of manufacturing was also determined; for moringa paneer, the maximum average cost of production was Rs. 232 per kg. The highest production cost per kilogram for a sample made with 20% extract from moringa

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leaves was Rs. 236.00. For sample (A3 B1 C2), the production cost was determined to be Rs. 232 per kg. It is also suggested that the study be used to produce high-quality paneer using an extract from moringa leaves for the dairy industry and regional sweets.

Keywords: *Moringa*; paneer; technology; chemical qualities; physical quality.

1. INTRODUCTION

One popular product made from heat- and acid-coagulated milk is paneer, which tastes like soft cheese (Ray and De 1953).

In addition to the Indian subcontinent, it has made appearances in the Middle Eastern and Western markets. When kept refrigerated, paneer has a very short shelf life and loses freshness after two to three days. Researchers have suggested several preservation methods to extend its shelf life, including low-temperature storage, thermal processing, packaging, and chemical additions (Ray and De 1953).

Because of the potential for toxicity, the use of antibacterial agents is not advised. One of the greatest methods for extending the shelf life of paneer is modified atmosphere packaging, or (MAP) (Ray and De 1953).

Except minerals and vitamins, paneer has a pretty high food and nutritional value because it contains nearly all of the proteins found in milk [1-3,4-9]. It is slightly sour and sweet taste along with its nutty flavour appeals to Indian palates. It is the perfect diet for babies, expecting and nursing mothers, developing kids, teens, and adults [10-12]. It is an excellent source of all the essential amino acids for vegetarians due to its high content of animal protein. Because of its fat content, it provides energy, linoleic, linolenic, and arachidonic acid, as well as the fat-soluble vitamins A and D [13-15]. It also offers special nutritional value for people with milk sensitivity issues (Cow chhana has an energy content of 250–280 calories per 100 grams. Additionally, chhana maintain a significant amount of fat-soluble vitamins, such as A and D (Ray and De 1953).

Moringa oleifera belongs to the Moringaceae family is a useful treatment for malnutrition [16-20]. Because its leaves, pods, and seeds contain a range of vital compounds, moringa is high in nutrients (Rockwood et al, 2013). Moringa is believed to have seven times the amount of vitamin C as oranges, ten times the amount of vitamin A as carrots, seventeen times the

amount of calcium as milk, nine times the amount of protein as yoghurt, fifteen times the amount of potassium as bananas, and twenty-five times the amount of iron as spinach. (Rockwood et al, 2013). Moringa is a sustainable treatment for malnutrition since it is simple to grow. Moringa is used to cure youngsters in nations like Senegal and Benin [21-25]. Youngsters who aren't given enough breast milk frequently exhibit signs of malnutrition. (Rockwood et al, 2013).

In order to increase milk production, breastfeeding moms are typically prescribed galactagogues. The phytosterol-based lactagogue functions as a precursor to the hormones needed for the development of reproductive organs. Hormone precursors, such as stigmasterol, sitosterol, and kampesterol, are abundant in moringa phytosterols [26-30]. These substances raise the synthesis of estrogen, which in turn promotes the growth of the mammary gland ducts, resulting in the secretion of milk. It is used to children under three years old to address malnutrition [16-20,31,32]. During pregnancy, a woman can consume around six spoonfuls of leaf powder to meet her daily needs for calcium and iron. An overview of the pharmacological characteristics, nutritional benefits, and commercially useful therapeutic qualities of moringa is given in this paper. There are no in-depth studies on the use of moringa to treat cancer and diabetes (Rockwood et al, 2013).

2. MATERIALS AND METHODS

The Chandra Shekhar Azad University of Agricultural and Technology in Kanpur's Dairy Technology Laboratory was the site of the current study, "Technology of preparation of Moringa paneer from buffalo milk." The manufacturing process for moringa paneer was standardized based on several criteria that were being studied, and the finished product was evaluated for its sensory and chemical attributes. This chapter describes the materials used in the experiment, the methods used to process milk in order to prepare paneer, and other tests.

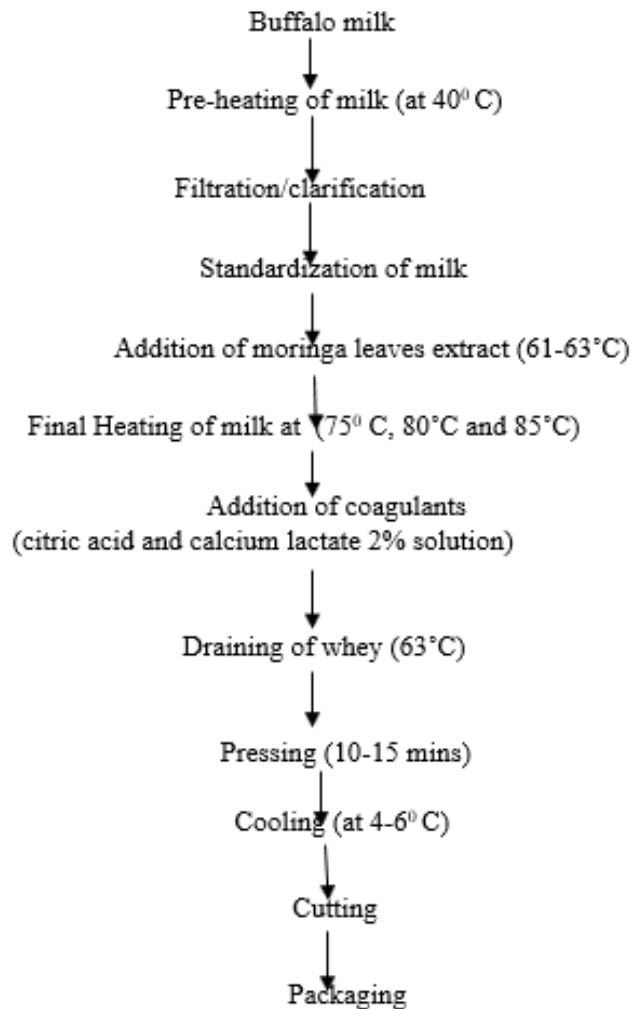


Chart 1. Flow diagram of manufacture of moringa paneer prepared with Moringa Leaf Extract

2.1 Manufacturing Technology

According to Ray and De's recommended approach, the required amount of buffalo milk was standardized at 6.0% fat and 9.0% SNF (1953). Adding varying amounts of extract from moringa leaves (e.g., 0%, 5%, 10%, 15%, and 20%), buffalo milk was heated to a temperature of 64–66 degrees Celsius. The milk was heated to a final temperature of 75°, 80°, and 85°. A stainless steel ladle was used to ensure enough churning during heating in order to prevent burning and the formation of skin. Milk was mixed with a 2 percent solution of calcium lactate and a 2 percent solution of citric acid. The coagulated curd clear whey was obtained by gently stirring the milk. The curd was not stirred and was allowed to settle for five to ten minutes. A muslin cloth was used to drain the whey, and the temperature was never permitted to drop

below 63°C while the draining was happening. Once the whey was drained, the curd that had collected in the muslin fabric was rolled up and compressed for ten to fifteen minutes, using enough force to extract any remaining whey.

To obtain a hard curd, the strained curd was lastly submerged in cooled water (4-6°C) for two hours. It was then taken out of the water to be processed further.

Next, a plastic pouch was used to package the moringa paneer blocks.

3. RESULTS AND DISCUSSION

The present investigation entitled, "(Technology of preparation of moringa paneer from buffalo milk)" was carried out in the department of

Animal Husbandry and Dairying, C.S. Azad University of Agriculture and Technology, Kanpur. In order to study the effect of different factors like different types of moringa leaf extract (A), two type of coagulants (B), and three type of temperature (C), on moringa paneer concerning (1) Sensory evaluation, (2) Chemical characteristics. The laboratory experiment on the variance of these data was worked out based on factorial experiment in a completely randomized design. The results are drawn and their interpretations for different characters have been discussed systematically. All the samples were made in laboratory. The data thus obtained were analyzed in Factorial Complete Randomized Design. The results drawn and their interpretation were presented systematically in the following tables.

3.1 Chemical Quality of Moringa Paneer from Buffalo Milk

3.1.1 Moisture

The moisture content in the samples of moringa paneer using buffalo milk and Moringa leaf extract at various combination level was observed in the laboratory.

As regards the mean values of moisture content of moringa paneer, it was observed that maximum moisture (59.20%) was in the case of sample prepared with 10% moringa leaves extract (A₃) followed by A₄, samples, while lowest moisture content (56.31%) was noted in A₁ sample. Significant differences were observed in between A₁, A₂, A₃, A₄, A₅, samples when compared one another.

Table 1. The effect of moringa leaves extract (A), Coagulants(B), Temperature (C), on moisture per cent of moringa paneer

Treatment	B ₁	B ₂	C ₁	C ₂	C ₃	Mean
A ₁	56.61	56.01	56.43	56.25	56.25	56.31
A ₂	57.67	57.08	57.32	58.21	56.61	57.37
A ₃	59.38	59.03	59.45	59.42	58.74	59.20
A ₄	58.76	58.05	58.24	58.95	58.03	58.40
A ₅	57.43	56.77	57.03	57.67	56.60	57.10
B ₁						
B ₂						
C ₁	57.90	57.49				57.69
C ₂	58.48	57.71				58.09
C ₃	57.53	56.96				57.24
Mean	57.97	57.38	57.69	58.10	57.24	

Factors	A	B	C	AxB	AxC	BxC	AxBxC
SE (M)	0.0289	0.0183	0.0224	0.0408	0.0500	0.0316	0.0707
SE (D)	0.0408	0.0258	0.0316	0.0577	0.0707	0.0447	0.0999
CD	0.0816	0.0516	0.0632	0.1154	0.1414	0.0894	0.1999

Table 2. The mean effect of ABC on moisture per cent of moringa paneer

Treatment	C ₁	C ₂	C ₃	Mean
A ₁ B ₁	56.61	56.97	56.25	56.61
A ₁ B ₂	56.25	55.54	56.25	56.01
A ₂ B ₁	57.67	58.39	56.97	57.67
A ₂ B ₂	56.97	58.03	56.25	57.08
A ₃ B ₁	59.81	59.25	59.10	59.38
A ₃ B ₂	59.10	59.60	58.39	59.03
A ₄ B ₁	58.10	59.80	58.39	58.76
A ₄ B ₂	58.39	58.10	57.67	58.05
A ₅ B ₁	57.32	58.03	56.96	57.43
A ₅ B ₂	56.75	57.32	56.25	56.77
Mean	57.69	58.10	57.24	

Table 3. Analysis of variance for moisture per cent of moringa paneer

Source	D.F.	S.S.	M.S.S.	F- cal	Significance
A	4	93.000	23.250	1539.310	0.0000
B	1	7.781	7.781	515.172	0.0000
A xB	4	0.219	0.055	3.621	0.0104
C	2	11.125	5.562	368.276	0.0000
A X C	8	4.906	0.613	40.603	0.0000
B x C	2	0.344	0.172	11.379	0.0001
A x B x C	8	5.531	0.691	45.776	0.0000
Error	60	0.906	0.015		
Total	89	123.812			

Table 4. The effect of moringa leaves extract (A), Coagulants (B), Temperature (C), on fat per cent of moringa paneer

Treatment	B ₁	B ₂	C ₁	C ₂	C ₃	Mean
A ₁	24.15	23.89	24.08	23.99	23.99	24.02
A ₂	24.60	24.35	24.45	24.83	24.14	24.47
A ₃	25.36	25.17	25.36	25.38	25.05	25.26
A ₄	25.19	24.90	25.05	25.34	24.75	25.04
A ₅	24.50	24.43	24.33	24.60	24.47	24.46
B ₁						
B ₂						
C ₁	24.79	24.52				24.65
C ₂	24.95	24.70				24.82
C ₃	24.54	24.42				24.48
Mean	24.76	24.54	24.65	24.82	24.48	

Treatment	A	B	C	AxB	AxC	BxC	AxBxC
SE (M)	0.0380	0.0240	0.0294	0.0537	0.0658	0.0416	0.1622
SE (D)	0.0537	0.0339	0.0416	0.0760	0.0930	0.0588	0.2293
CD	0.1075	0.0679	0.0832	N.S.	0.1862	N.S.	0.4586

Table 5. The mean effect of ABC on fat per cent of moringa paneer

Treatment	C ₁	C ₂	C ₃	Mean
A ₁ B ₁	24.30	24.18	23.99	24.15
A ₁ B ₂	23.69	23.99	23.99	23.89
A ₂ B ₁	24.90	24.60	24.30	24.60
A ₂ B ₂	24.76	24.30	23.99	24.35
A ₃ B ₁	25.35	25.52	25.21	25.36
A ₃ B ₂	25.42	25.21	24.90	25.17
A ₄ B ₁	25.47	25.21	24.90	25.19
A ₄ B ₂	25.21	24.90	24.60	24.90
A ₅ B ₁	24.75	24.45	24.30	24.50
A ₅ B ₂	24.45	24.21	24.65	24.43
Mean	24.83	24.64	24.48	

3.1.2 Fat

The fat content of moringa paneer as affected by different factors have been presented in (A & B) and its analysis of variance.

As regards the mean values of fat content of moringa paneer, it was observed that maximum fat (25.26%) was in the case of sample prepared

with 10% moringa leaves extract (A₃) followed by (A₄) sample, while the lowest fat content (24.02) was noted in A₁ sample. Significant differences were observed in between A₁, A₃, A₄ samples.

As regards the mean values of fat content of moringa paneer, it was observed that maximum fat (24.76%) in case of B₁ sample, while minimum fat (24.54) in B₂ samples.

Significant differences were observed between B₁, B₂ sample when compared to one another.

The mean interaction of treatment combination AxBxC, fat per cent of moringa paneer, it was observed that the maximum score (25.52) in A3xB1xC2 in samples, while minimum score (23.69) in A1xB2xC1 samples.

3.1.3 Protein

The protein percent in the samples of paneer using Moringa leaf extract at various combination levels was observed in the laboratory.

The protein content of moringa paneer as affected by different factors has been

presented in Table 9 and its analysis of variance.

It was observed that the main effects of A, B, and C were found highly significant and all first order, second order interactions and ABC were also found significant.

As regards the mean values of protein content of moringa paneer, it was observed that maximum Protein (14.81%) was in case of the sample prepared with 10% moringa leaves extract (A3) followed by A4 sample, while the lowest protein content (14.04%) was noted in A1 samples. Significant differences were observed in between A1, A2, A3 A4 and A5 samples when compared with another.

Table 6. Analysis of variance for fat per cent of moringa paneer.

Source	D.F.	S.S.	M.S.S.	F- cal	Significance
A	4	17.957	4.489	170.259	0.0000
B	1	1.031	1.031	39.111	0.0000
A xB	4	0.121	0.030	1.148	0.3428
C	2	1.832	0.916	34.741	0.0000
A X C	8	1.289	0.161	6.111	0.0000
B x C	2	0.074	0.037	1.407	0.2527
A x B x C	8	0.789	0.099	3.741	0.0013
Error	60	0.582	0.026		
Total	89	38.258			

Table 7. The effect of moringa leaves extract (A), Coagulants (B), and Temperature (C), on protein per cent of moringa paneer

Treatment	B1	B2	C1	C2	C3	Mean
A1	14.12	13.97	14.07	14.03	14.03	14.04
A2	14.38	14.24	14.29	14.52	14.12	14.31
A3	14.90	14.72	14.83	14.95	14.65	14.81
A4	14.75	14.56	14.65	14.85	14.47	14.65
A5	14.32	14.16	14.22	14.38	14.12	14.24
B1						
B2						
C1	14.49	14.34				14.41
C2	14.65	14.44				14.54
C3	14.35	14.20				14.27
Mean	14.49	14.32	14.41	14.54	14.27	

Factors	A	B	C	AxB	AxC	BxC	AxBxC
SE(M)	0.012	0.008	0.010	0.018	0.022	0.014	0.031
SE(D)	0.018	0.011	0.014	0.025	0.031	0.019	0.044
CD	0.036	0.023	0.028	N.S.	0.063	0.039	0.089

Table 8. The mean effect of ABC on protein per cent of moringa paneer

Treatment	C ₁	C ₂	C ₃	Mean
A ₁ B ₁	14.12	14.21	14.03	14.12
A ₁ B ₂	14.03	13.85	14.03	13.97
A ₂ B ₁	14.38	14.56	14.21	14.38
A ₂ B ₂	14.21	14.48	14.03	14.24
A ₃ B ₁	14.92	15.05	14.74	14.90
A ₃ B ₂	14.74	14.86	14.56	14.72
A ₄ B ₁	14.74	14.96	14.56	14.75
A ₄ B ₂	14.56	14.70	14.38	14.56
A ₅ B ₁	14.29	14.48	14.21	14.32
A ₅ B ₂	14.16	14.29	14.03	14.16
Mean	14.41	14.54	14.27	

Table 9. Analysis of variance for protein per cent of moringa paneer

Source	D.F.	S.S.	M.S.S.	F- cal	Significance
A	4	7.066	1.767	616.705	0.0000
B	1	0.629	0.629	219.545	0.0000
A xB	4	0.010	0.002	0.852	0.4979
C	2	1.092	0.546	190.568	0.0000
A x C	8	0.328	0.041	14.318	0.0000
B x C	2	0.020	0.010	3.409	0.0396
A x B xC	8	0.100	0.012	4.347	0.0004
Error	60	0.172	0.003		
Total	89	9.416			

3.1.4 Lactose

It was observed that maximum lactose (1.94%) was in case of sample prepared with 10% moringa leaves extract (A₃) followed by A₄ sample, while lowest lactose content (1.83%) was noted in A₁ samples. The significant

differences were observed in between A₁, A₂, A₃, A₄, A₅ sample. As regards the mean values of lactose content of moringa paneer, it was observed that maximum lactose (1.89%) in case of B₁ sample, while minimum in B₂ sample. The significant differences were observed between B₁, B₂ sample when compared with others.

Table 10. The effect of moringa leaves extract (A), Coagulants (B), Temperature (C), on Lactose per cent of moringa paneer

Treatment	B1	B2	C1	C2	C3	Mean
A1	1.85	1.83	1.84	1.83	1.84	1.83
A2	1.88	1.86	1.87	1.90	1.85	1.87
A3	1.95	1.93	1.94	1.96	1.92	1.94
A4	1.93	1.90	1.92	1.94	1.89	1.91
A5	1.87	1.85	1.86	1.88	1.85	1.86
B1						
B2						
C1	1.89	1.87				1.88
C2	1.92	1.89				1.90
C3	1.88	1.86				1.87
Mean	1.89	1.87	1.88	1.90	1.87	

Factors	A	B	C	AxB	AxC	BxC	AxBxC
SE(M)	0.019	0.012	0.015	0.027	0.034	0.021	0.048
SE(D)	0.027	0.017	0.021	0.011	0.048	0.030	0.068
CD	0.055	0.035	0.043	N.S.	N.S.	N.S.	0.136

Table 11. The mean effect of ABC on Lactose percent of moringa paneer

Treatment	C ₁	C ₂	C ₃	Mean
A ₁ B ₁	1.85	1.86	1.84	1.85
A ₁ B ₂	1.84	1.81	1.84	1.83
A ₂ B ₁	1.88	1.91	1.86	1.88
A ₂ B ₂	1.86	1.90	1.84	1.86
A ₃ B ₁	1.95	1.97	1.93	1.95
A ₃ B ₂	1.93	1.95	1.91	1.93
A ₄ B ₁	1.93	1.96	1.91	1.93
A ₄ B ₂	1.91	1.93	1.88	1.90
A ₅ B ₁	1.87	1.90	1.86	1.87
A ₅ B ₂	1.85	1.87	1.84	1.85
Mean	1.88	1.90	1.87	

Table 12. Analysis of variance for Lactose percent of moringa paneer

Source	D.F.	S.S.	M.S.S.	F- cal	Significance
A	4	0.121	0.030	45.609	0.0000
B	1	0.010	0.010	15.482	0.0002
A xB	4	0.000	0.000	0.092	0.9847
C	2	0.018	0.009	13.897	0.0000
A X C	8	0.007	0.001	1.384	0.2220
B x C	2	0.000	0.000	0.368	0.6940
A x B x C	8	0.002	0.000	0.350	0.9420
Error	60	0.040	0.001		
Total	89	0.040			

Table 13. The effect of moringa leaves extract (A), Coagulants (B), Temperature (C), on Ash per cent of moringa paneer

Treatment	B1	B2	C1	C2	C3	Mean
A1	2.05	2.03	2.04	2.03	2.04	2.03
A2	2.08	2.07	2.07	2.11	2.05	2.07
A3	2.16	2.14	2.15	2.17	2.13	2.15
A4	2.14	2.11	2.13	2.15	2.10	2.12
A5	2.08	2.05	2.06	2.09	2.05	2.06
B1						
B2						
C1	2.10	2.08				2.09
C2	2.12	2.09				2.10
C3	2.08	2.06				2.07
Mean	2.10	2.07	2.09	2.10	2.07	

Factors	A	B	C	AxB	AxC	BxC	AxBxC
SE (M)	0.007	0.004	0.005	0.010	0.012	0.025	0.017
SE (D)	0.010	0.006	0.008	0.014	0.017	0.035	0.025
CD	0.020	0.013	0.016	N.S.	N.S.	N.S.	N.S.

Table 14. The mean effect of ABC on Ash per cent of moringa paneer

Treatment	C ₁	C ₂	C ₃	Mean
A ₁ B ₁	2.05	2.06	2.04	2.05
A ₁ B ₂	2.04	2.01	2.04	2.03
A ₂ B ₁	2.08	2.12	2.06	2.08
A ₂ B ₂	2.06	2.11	2.04	2.07
A ₃ B ₁	2.16	2.18	2.14	2.16
A ₃ B ₂	2.14	2.16	2.12	2.14
A ₄ B ₁	2.14	2.17	2.12	2.14
A ₄ B ₂	2.12	2.14	2.08	2.11
A ₅ B ₁	2.07	2.11	2.06	2.08
A ₅ B ₂	2.05	2.07	2.04	2.05
Mean	2.09	2.11	2.07	

Table 15. Analysis of variance for Ash per cent of moringa paneer

Source	D.F.	S.S.	M.S.S.	F- cal	Significance
A	4	0.148	0.037	38.470	0.0000
B	1	0.011	0.011	11.803	0.0011
A × B	4	0.001	0.000	0.199	0.9380
C	2	0.023	0.011	11.819	0.0000
A × C	8	0.010	0.001	1.308	0.2569
B × C	2	0.001	0.000	0.445	0.6427
A × B × C	8	0.002	0.000	0.262	0.9755
Error	60	0.058	0.001		
Total	89	0.253			

3.1.5 Ash

The ash per cent in the sample of paneer using moringa extract combination levels were observed in the laboratory.

The ash content of moringa paneer as affected by different factors have been presented in (A & B) and its analysis of variance.

As regards the mean values of ash content of moringa paneer, it was observed that maximum ash (2.10%) in case of B₁ samples, while minimum in B₁ sample. The significant differences were observed between B₁, B₂ sample.

The effect type of temperature (C) on ash content of moringa paneer, it was revealed that maximum ash (2.10%) in case of sample prepared with 80°C temperature (C₂) and minimum ash content (2.07%) observed in C₃ sample.

4. CONCLUSION

The data was obtained on the basis of sensory, and physical qualities of moringa paneer

prepared from different levels of moringa leaves extract, coagulants and temperature. The overall suitability of moringa paneer was found in samples prepared from 10% moringa leaf extract, citric acid (2% solution) at 80°C temperature, which is the best as compared to other treatment combinations. It is, therefore, concluded that 10% moringa leaves extract can be easily mixed in milk to produce good quality moringa paneer, it is suitable for nutritional importance.

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 manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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