



Evaluation of Antioxidant Activity and Sensory Attributes of Functional Paneer Enriched with Wheatgrass and Moringa

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ABSTRACT: This study focuses on the formulation of functional paneer to meet the growing demand for convenient and health-promoting foods. Functional paneer was developed by incorporating moringa powder and wheatgrass juice. Wheatgrass is highly nutritious and possesses various beneficial properties, including antioxidant, anti-inflammatory, and antibacterial activities. It is known to help in managing conditions ranging from mild illnesses to life-threatening diseases. Moringa is rich in macro and micronutrients and shows diverse pharmacological effects, including anti-inflammatory, antioxidant and antidiabetic. Paneer was formulated by incorporating different concentrations of wheatgrass juice (3%, 6%, 9%) and moringa powder (2%, 4%, 6%). The addition of wheatgrass and moringa altered the colour and taste characteristics, which influenced consumer acceptability. Sensory evaluation was conducted, and the WMP1, containing 3% wheatgrass juice and 2% moringa powder received the highest overall acceptability score on the nine-point hedonic scale. The overall acceptability is 8.1 ± 0.54 , with 8.15 ± 0.83 for colour 7.9 ± 0.73 for texture, 8.1 ± 0.73 for appearance, 7.9 ± 0.58 for aroma and 7.95 ± 0.72 for taste and were statistically comparable with their control counterparts. There was a significant increase in antioxidant activity was observed. The antioxidant activity of control paneer and paneer incorporated with 3%, 6%, and 9% wheatgrass juice, and 2%, 4%, and 6% moringa powder was 1.07%, 13.35%, 15.77%, and 22.33%, respectively. Although the antioxidant activity of WMP 3 was higher, its overall acceptability decreased due to its bitter taste. The optimal formulation WMP1 was subjected to a paired t test against the control sample. The results indicate a statistically significant preference for WMP1 across all attributes, including overall acceptability ($p = 0.0006$) confirming its acceptance. The study concluded that adding wheatgrass juice and Moringa powder to paneer resulted in desirable sensory qualities and could provide health benefits due to its high antioxidant activity.

Keywords: functional paneer, wheatgrass juice, moringa powder, antioxidant activity, sensory evaluation.

INTRODUCTION

There is a growing worldwide trend after pandemic era of choosing food that are convenient and offer health benefits, especially those that help boost immunity, prevent diseases and support better health (Ozcan *et al.*, 2016). Among different food products, milk is recognized as a highly beneficial food for human health. It is a rich source of crucial nutrients such as proteins, fat, lactose, vitamins, minerals, enzymes, hormones, immunoglobulins, and cells. Dairy products are not only consumed to fulfill basic nutritional needs but also because they help in preventing various health problems such as osteoporosis (Uenishi, 2006), tooth decay (Shimazaki *et al.*, 2008; Ferrazzano *et al.*, 2008), heart diseases (Lamarche, 2008), high blood pressure (Jauhiainen & Korpela, 2007), colon cancer (Weaver,

2009), bone-related conditions, aging problems (Ginter, 2008), digestive issues (Pufulete, 2008), obesity (Jaffiol, 2008), and other health issues (Sharma & Rajput, 2006). Milk, along with other dairy products, has traditionally been valued for its plenty of nutrients and associated health benefits (Alam *et al.*, 2024). Milk and its derivatives are considered beneficial for individual across all stages of life (Visioli & Strata 2014). Milk and dairy products have long been acknowledged as important constituents of a balanced and nutritious diet (Rogelj, 2000). According to the Food and Agriculture Organization, global per capita consumption of dairy products is expected to rise by 12.5% by the year 2025 (Coutinho *et al.*, 2018). Approximately 5% of the milk produced in India is utilized for paneer preparation (ICMR 2000; Chandan, 2007). Paneer is one of the most popular types of

unripened cheese in India. It is a soft, fresh cheese commonly consumed in South Asian countries and is prepared by heat-treating milk followed by acid-induced coagulation (Alam *et al.*, 2024). Good quality paneer is recognised by its white colour, sweet and mildly acidic flavour, spongy body, and closely knit texture (Arora & Khetra, 2025). Paneer retains all the constituents of milk, except for the loss of soluble whey proteins, lactose, minerals and typically contains 53-55% moisture, 23-25% fat, 17-18% protein, 2-2.5% lactose, 1.5-2.0% minerals. Due to its fat content, it supplies energy along with essential fatty acids such as linoleic, linolenic, and arachidonic acid, as well as the fat-soluble vitamins A and D (Kumar *et al.*, 2024). In India, it enjoys great popularity and is commonly used in the preparation of various food items (Sen *et al.*, 2023). Due to the growing trend of health-conscious lifestyles, paneer is regarded as an excellent source of protein for the vegetarian population (Kapoor *et al.*, 2021). Because of the rising demand for paneer among health-conscious consumers, there is need to make new types and varieties of paneer (Kinjal *et al.*, 2015).

Wheatgrass refers to the young shoots of the common wheat plant (Mujoriya *et al.*, 2012). Often referred to as 'living food,' it is a superior source of chlorophyll, earning the nickname 'green blood.' It can be consumed either as a fresh juice or in dried powder form for both human and animal use, with supplying of chlorophyll, amino acids, minerals, vitamins, and enzymes (Padalia *et al.*, 2010). Wheatgrass is considered beneficial when added in a raw food diet, as it is believed to help detoxify the body and serve as a balanced source of supplemental nutrients (Hattarki *et al.*, 2017). A healthy individual is recommended to consume 30 ml of fresh wheatgrass juice daily two times a day. Wheatgrass is highly nutritious, providing (per 3.5 grams) approximately 860 mg of protein, 18.5 mg of chlorophyll, 15 mg of calcium, 38 mg of lysine, and 7.5 mg of vitamin C, along with a great supply of B-complex vitamins, amino acids, and various other micronutrients (Sareen *et al.*, 2014). Wheatgrass is a good source of numerous vitamins and minerals and exhibits multiple bioactive properties, including antioxidant, anti-inflammatory, and antibacterial activities, among others (Minocha *et al.*, 2022). Wheatgrass juice has been scientifically verified and traditionally used since ancient times to cure various disease and disorder (Hattarki *et al.*, 2017). Wheatgrass has shown clinical utility across a range of conditions, from minor ailments to severe, life-threatening diseases including cancer (Basanti *et al.*, 2019). Wheatgrass has a potential to diminish fatigue, improve sleep, improve strength, naturally regulate blood pressure and blood sugar, support weight loss, improve digestion and elimination, support healthy skin, teeth, eyes, muscles and joints, support mental health, improve the function of heart, lungs, reproductive organs, heal ulcers and skin sores, and is helpful in cancer, asthma, arthritis, inflammatory bowel disease and hemolytic anemia (Chauhan, 2014). There was incorporation of Singh *et al.*,

wheatgrass in milk to make green paneer and incorporated at 3, 6, 9% in preparation of milk. The acceptability and antioxidant activity of paneer was 7.93 and 22.33% respectively (Basanti *et al.*, 2019).

The nutrient dense and vitamin packed Moringa tree is extensively cultivated in various tropical and subtropical countries (Stohs and Hartman, 2015). Moringa oleifera serves as a rich source of both macro- and micronutrients, along with antioxidants (Sahay *et al.*, 2017). Every part of M. oleifera serves as a reservoir of essential nutrients as well as antinutrients. Its leaves are particularly abundant in minerals such as calcium, potassium, zinc, magnesium, iron and copper (Gopalakrishan *et al.*, 2016). Moringa oleifera exhibits a wide range of pharmacological properties, including anti-inflammatory, antispasmodic, antihypertensive, antitumor, antioxidant, antipyretic, anti-ulcer, anti-epileptic, diuretic, cholesterol-lowering, renal-protective, anti-diabetic (Paliwal *et al.*, 2011; Sharma *et al.*, 2012), and hepatoprotective activities (Lai *et al.*, 2010; Huang *et al.*, 2012). The chemical composition showed protein content ranging from 19.34% to 22.42%, lipid content between 1.28% and 4.96%, ash content from 7.62% to 14.60%, and dietary fibre varies from 30.97% to 46.78% (Hossain *et al.*, 2022). Glucosinolates, niazimicin, and benzyl isothiocyanate present in the leaves of moringa are considered the key compounds responsible for their anticancer effects (Islam *et al.*, 2021). The most suitable formulation of moringa paneer was observed in samples prepared with 10% moringa leaf extract, using a 2% citric acid solution at 80°C, which outperformed other treatment combinations. Hence, it can be concluded that incorporating 10% moringa leaf extract into milk yields good-quality moringa paneer with significant nutritional value (Kumar *et al.*, 2021). Moringa leaf powder was utilized in the preparation of value-added paneer. The resulting product demonstrated significant ($p > 0.05$) antioxidant, antipolytic, and antimicrobial activities. Incorporation of 4% Moringa leaf powder not only improved the sensory attributes of the paneer but also extended its shelf life. These findings highlight the potential of Moringa leaf powder (4%) as a natural source of antioxidants and antimicrobials in the development of value-added dairy products with enhanced health benefits (Tanwar, 2022). The main aim of this research to formulate functional paneer by incorporating wheatgrass juice and moringa powder. In recent studies, the individual incorporation of either wheatgrass or moringa in paneer preparation. After exploring results and benefits of moringa and wheatgrass the present study aimed to combine both wheatgrass and moringa in a single formulation to enhance the antioxidant potential, and overall functional properties of paneer.

MATERIALS AND METHODS

Procurement. Three main ingredients are used for the preparation of functional paneer that are moringa powder, wheatgrass juice and milk. The moringa

powder and milk is procured from the local market of the Chandigarh. The standardization of milk was 6.0% FAT and 9.0% S.N.F of Verka company. Freshly harvested wheatgrass was used for the preparation of wheatgrass juice.

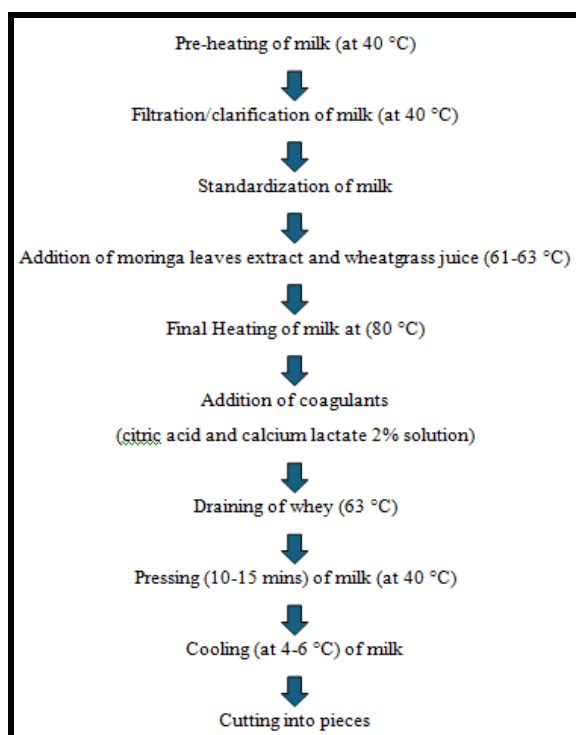
Preparation of wheatgrass juice. Fresh wheatgrass was required for the preparation of wheatgrass juice. Wheatgrass cultivated under optimized environmental conditions in the Chandigarh Colleges Hospitality, Landran. A total of 150g of wheat seeds were used for sowing. The sowing was completed in 10 trays, each measuring 10 inches in length and 3 inches in width. Wheatgrass was harvested after seven days of sowing. The harvested wheatgrass was properly washed with water to remove any dirt or impurities then it was crushed in electric grinder with 1:2 ratio of wheatgrass and water. The resulting mixture was filtered through a

1 mm stainless steel mesh to obtain a clear green extract suitable for incorporation into milk (Basanti *et al.*, 2019).

Preparation of paneer. Four different samples were prepared named as C, WMP1, WMP2, WMP3. According to the Ray and De's method, the buffalo milk was standardized to 6.0% fat and 9.0% SNF. Milk was taken and pre-heated at 40°C. The filtration and standardization of milk was done. The varying amount of moringa powder and wheatgrass juice was added in milk at 61-63°C. Subsequently, the milk was heated to final temperature at 80°C. There was addition of 2% citric acid in milk for coagulation. After coagulation, draining of whey is done. Obtaining product is collected in a muslin cloth and pressed for 10-15 minutes. At last, the paneer is cooled for 2 hours at 4-6°C and cut into pieces.

Table 1: Different formulations of paneer.

TREATMENTS				
	C	WMP1	WMP2	WMP3
Milk	100%	95%	90%	85%
Wheatgrass juice	–	3%	6%	9%
Moringa powder	–	2%	4%	6%



Sensory Evaluation. The sensory evaluation of paneer was carried out using a 9-point hedonic scale, assessing attributes such as appearance, flavour, texture, colour, and overall acceptability (Quershi *et al.*, 2023). Sensory evaluation of the developed products was conducted by ten semi-trained panelists from Chandigarh College of Hospitality, who scored the samples for colour, appearance, texture, taste, and overall acceptability using a 9-point hedonic scale, where 1 indicated 'dislike extremely' and 9 indicated 'like extremely'. The scale included the following descriptors: 8 shows

like very much, 7 shows like moderately, 6 represents like a little, 5 indicates neither like nor dislike, 4 shows dislike a little, 3 represents dislike moderately, and 2 indicates dislike very much. Overall acceptability was calculated as the mean of the scores assigned by each panelist across all evaluated attributes (Bhatt *et al.*, 2025).

Antioxidant activity (DPPH Assay). The free radical scavenging activity of the samples was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) Assay (Dehshahri *et al.*, 2012). For the preparation of extracts,

two grams of each sample were homogenized with 20 ml of methanol and subjected to continuous shaking for two hours to ensure optimum extraction of bioactive compounds. The extraction process was repeated twice to enhance yield, and the obtained extracts were pooled together. The combined extract was then centrifuged at 10,000 rpm for 15 minutes to remove any particulate matter. The resulting clear supernatant was collected and stored at -20°C until further analysis.

For the assay, 100 μl aliquots of the methanolic extract were transferred into test tubes, to which 2.9 ml of freshly prepared DPPH solution was added. The mixture was vortexed for 1 minute to ensure uniform mixing and then incubated in the dark for 3 minutes to allow the reaction to occur. The reduction in the purple coloration of the DPPH radical, indicating scavenging activity, was measured spectrophotometrically against a blank at 517nm. The extent of discoloration was directly proportional to the radical scavenging potential of the sample extracts. The DPPH scavenging effect was measured using by formula

$$\text{DPPH scavenging activity (\%)} = \frac{A_B - A_A}{A_B} \times 100$$

Where, A_B = absorbance of blank, A_A = absorbance of sample.

Statistically Analysis. The sensory evaluation data, comparing the optimal functional paneer formulation (WMP1) with control sample, were analyzed using a Paired t test. This test was performed because the data

sets are dependent. The analysis was executed using GraphPad Prism 8.0.2. The t statistic was calculated. The results were evaluated using a two-tailed test and values with a $p < 0.05$ were considered statistically significant.

RESULT AND DISCUSSION

Sensory attributes evaluation of paneer:

Paneer is formulated by incorporating wheatgrass juice (3%, 6%, 9%) and moringa powder (2%, 4%, 6%) for achieving maximum sensory attributes. The sensory evaluation of the paneer samples revealed various differences in their acceptability across distinct attributes, as presented in Table 2.

Colour: The Table 2, shows the results of sensory evaluation of wheatgrass and moringa enriched paneer and Fig. 1 shows the colour difference. The appearance was affected as the colour of paneer became a little darker, when the amount of moringa and wheatgrass was increased. The WMP3 which contains 9% wheatgrass juice and 6% moringa powder had a little darker colour. The overall acceptability, on the basis of colour was highest in WMP1 sample (containing 2% moringa and 3% wheatgrass) was 8.15 ± 0.83 . Overall acceptability on the basis of colour is reduced in WMP3 because the colour gets little darker.

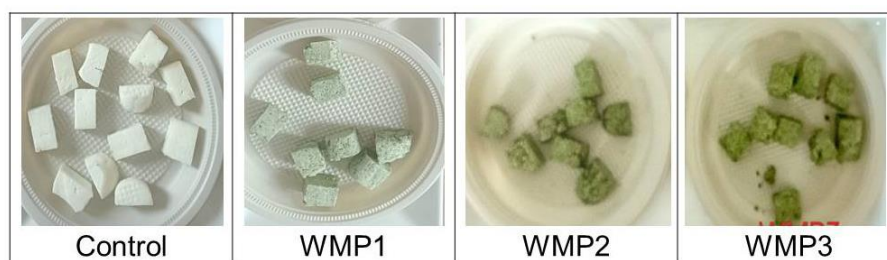


Fig. 1. Represents the differences in colour among the paneer Formulation.

Aroma and Taste: Aroma and taste also affected, as the aroma was very stronger in WMP2 and WMP3 that reduces its overall scores. The overall acceptability, on the basis of taste was 7.95 ± 0.72 in WMP1 (containing 2% moringa and 3% wheatgrass), which was the highest. WMP2 and WMP3 had a mild bitterness that reduces their acceptability (Apilado *et al.*, 2013). In their study, the addition of moringa powder decrease scores of taste of cheese due to the bitter taste. The panelist detected a bitter taste in cheese.

Texture: The overall acceptability on basis texture was more in WMP1 (3% wheatgrass juice and 2% moringa powder) as compared to other samples was 7.9 ± 0.73 .

Overall Acceptability: The overall acceptability was highest in the WMP1 was 8.1 ± 0.54 that means it was the most liked paneer on the basis of colour, texture, appearance, aroma and taste. WMP2 also showed the overall acceptability of 6.45 ± 1.31 which was better as compared to WMP3. Due to the bitter taste, strong aroma, and little dark green, the overall acceptability of WMP3 was reduced.

Table 2: Sensory evaluation of wheatgrass juice and moringa powder enriched paneer.

Product	Colour	Texture	Appearance	Aroma	Taste	Overall Acceptability
Control	7.25 ± 0.87	7.2 ± 1.1	6.95 ± 0.72	7 ± 0.92	7.2 ± 0.6	7.18 ± 0.74
WMP1	8.15 ± 0.83	7.9 ± 0.73	8.1 ± 0.73	7.9 ± 0.58	7.95 ± 0.72	8.1 ± 0.54
WMP2	7.2 ± 0.87	6.4 ± 1.36	6.45 ± 1.31	6.3 ± 1.62	6.4 ± 1.36	6.45 ± 1.31
WMP3	6.75 ± 0.98	6.25 ± 1.72	6.2 ± 1.25	6.1 ± 1.14	6.25 ± 1.72	6.2 ± 1.25

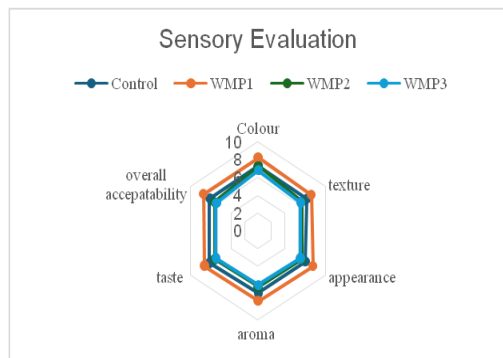


Fig. 2. Represents the results of sensory evaluation.

Antioxidant Activity. The antioxidant activity of wheatgrass juice and moringa powder enriched paneer at all the three levels 3, 6 and 9 % and 2, 4, 6% respectively was significantly ($p \leq 0.05$) higher in comparison to the control, the antioxidant activity of C, WMP1, WMP2, WMP3 was 1.07%, 13.35%, 15.77%, 22.33% respectively. It was observed that the antioxidant activity increased with increasing level of wheatgrass juice and moringa powder incorporation.

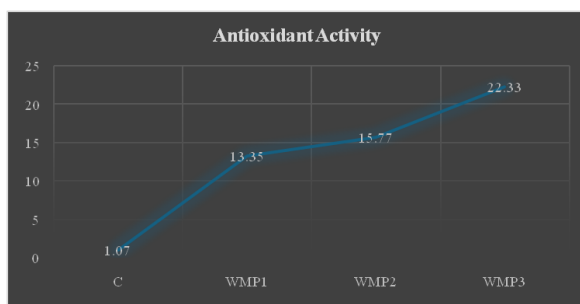


Fig. 3. Represents the antioxidant activity.

Statistically Analysis. The sensory data for the optimal formulation (WMP1) and the control were statistically compared using a paired t test to assess the impact of the incorporation on consumer acceptability. The results summarized in Table 3, revealed statistically significant difference ($p < 0.05$) across all attributes represents a strong preference for functional paneer. The mean scores for WMP1 were significantly higher than control for every attribute with the mean difference being positive in all cases. This consistent leads to the rejection of null hypothesis. The most difference was noted for overall acceptability ($p = 0.0006$) and appearance ($p = 0.0015$). Furthermore, taste ($p = 0.0008$) and aroma ($p = 0.0004$) also represents highly significant improvements. The incorporation of 3% wheatgrass and 2% moringa enhances the palatability of paneer.

Table 3: Represents the result of Paired t-test.

Attribute	Mean Control	Mean WMP1	Mean difference	P-value
Colour	7.3	8.15	0.8	0.0062
Texture	7.2	7.9	0.8	0.0129
Appearance	6.95	8.1	1.2	0.0015
Aroma	7	7.9	0.9	0.0004
Taste	7.1	7.95	1.05	0.0008
Overall Acceptability	7.18	8.1	1.01	0.0006

CONCLUSIONS

The incorporation of wheatgrass juice and moringa powder into paneer demonstrated its potential as a functional food by increasing the antioxidant activity of paneer. Moderate incorporation improves the sensory quality of paneer, as proved by higher scores. The paired t test confirmed that this formulation (WMP1) was significantly preferred and enhanced nutritional benefits with superior sensory quality. However, the antioxidant activity is increased with increasing the level of wheatgrass juice and moringa powder but its negatively effects the sensory attributes that leads to decrease in overall acceptability of paneer.

FUTURE SCOPE

The present study demonstrates the potential of incorporating wheatgrass juice and moringa powder in paneer to enhance its antioxidant activity while maintaining acceptable sensory qualities. However, further research may be undertaken to study the shelf life and storage stability of the developed functional paneer under different packaging and refrigeration conditions. Future investigations may also focus on assessing the bioavailability of antioxidants and the long-term health benefits associated with regular consumption of such functional dairy products. In addition, large-scale consumer acceptance studies and feasibility of commercial production could provide valuable insights for the wider application of this formulation.

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Conflict of Interest. The authors declare that there is no conflict of interest associated with this study.

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