



## RESEARCH PAPER

## OPEN ACCESS

# Effect of Moringa Seed Flours on Phytochemical, Functional and Structural Attributes of Savoury Indian Pancake (*Cheela*): An Approach to Enhance Nutritional Value of Traditional Food

Diksha Arora<sup>1</sup>, Jagbir Rehal\*<sup>1</sup>, Jaspreet Kaur<sup>1</sup>, Kamaljit Kaur<sup>1</sup> and Preetinder Kaur<sup>2</sup>

<sup>1</sup>Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, India-141004

<sup>2</sup>Department of Processing and Food Engineering, Punjab Agricultural University, Ludhiana, India-141004

\*Correspondence for materials should be addressed to JR (email: jagbir@pau.edu)

## Abstract

The current study focuses on utilization of moringa seed flour in traditional food products and analyzes its effect on phytochemical, functional and structural attributes of the food product. Moringa seeds were subjected to debittering, thus two types of moringa seed flours were obtained: raw and debittered. Savory Indian pancake (also known as *cheela*) mix was supplemented with moringa seed flours by 0 to 50% replacement of chickpea flour. On the basis of sensory evaluation, the *cheela* mix with 40% (DMSF) yielded most acceptable *cheelas* and hence was selected for further analysis. The supplemented *cheela* mix showed protein (24.70%), fat (14.63%), fibre (7.63%) which was higher as compared to control mix. Functional properties like water and oil absorption capacities of increased after addition of DMSF. Minerals like potassium, phosphorus and zinc showed increment in *cheela* instant mix with incorporation of DMSF. The developed *Cheela* stored in laminates at ambient temperature ( $25 \pm 10^\circ\text{C}$ ) had lower values for free fatty acids and peroxide value as compared to one stored in HDPE for the 90 days of storage study period. The laminates were therefore better suited as a packaging material for *cheela* instant mix. The *cheela* instant mix with DMSF will provide the masses with a convenient product to supplement their diet with a nutritionally enhanced ingredient.

**Keywords:** Cheela; Moringa oleifera; Seed Flour; Product Development; Phytochemical properties

## Introduction

Moringa (*Moringa oleifera* Lam.), often known as the "miracle tree," has emerged as a good source of nutrients and functional components in food applications (Giuberti et al., 2021). *Moringa oleifera* is still the most studied of the thirteen species that have been reported till now (Abd Rani et al., 2018). Almost every part of this plant can be utilised for food, medicine, or industrial uses, making it one of the most versatile trees on the planet. The anti-inflammatory, anti-hyperglycemic, and antioxidant properties of this plant's leaves, pods, and seeds have been extensively researched (Mushtaq et al., 2021). Its high concentration of polyphenols, bioactive peptides, carotenoids, and glucosinolates is the only cause of the majority of the functional activities which are widely reported (Gopalakrishnan et al., 2016). The majority of this plant's nutraceutical qualities are associated with the presence of isothiocyanates and glucosinolates. Isothiocyanates are bioactive substances that, since they can activate detoxifying enzymes, have demonstrated antioxidant and anti-inflammatory properties.

Received:

2026/02/24

Accepted:

2026/04/08

Published:

2026/04/12



With approximately 1.3 million metric tonnes produced over 380 km<sup>2</sup> of land, India is the world leader in the production of moringa seeds. The states of Andhra Pradesh, Karnataka, and Tamil Nadu are major producers (Radha et al., 2015). Minerals including calcium, phosphorus, and iron as well as vitamins A, B, and C are abundant in moringa seeds. Moringa seeds have a high concentration of protein and considerable amounts of fat with lower quantity of carbohydrates (OA and OF, 2017). These seeds are a rich source of oleic acid, beta carotene, lutein, and unsaturated fatty acids, all of which are very beneficial to human health (Leone et al., 2016).

The utilisation and consumption of moringa seeds in tropical food systems are becoming better recognised whereas ample studies are available on the utilization of moringa leaf powder in value added products like RTE snacks. Many researchers have underlined the necessity of conducting more studies on turning moringa seeds into food products considering their excellent nutritional and antioxidant properties (Dzuovor et al., 2022). Savory Indian pancake, also known as *Cheela*, is a popular dish in the Indian subcontinent which is made from a batter of gram flour (*besan*), water, spices and some vegetables. It is often enjoyed with a variety of accompaniments such as chutneys and pickles. Even though *cheela* is a simple breakfast staple, there are easy ways to transform it into a nutritious meal. Instant savory Indian pancake mix is readily available in the market to facilitate the customers. The reference of *cheela* instant mix in the manuscript means the dry mixture and the *cheela* refers to the cooked final ready to eat product.

Instant mixes have gained significant demand in the food industry. Busy lifestyles and time constraints have led to inclination towards hassle-free cooking options. People often go for these products to save time on chopping, measuring and mixing ingredients to prepare a meal. Instant mixes are designed to provide consistent taste and quality to the consumers. In most cases these mixes emerge as a cost-effective option, especially for people living away from their homes. It is an easy option to add nutritional value to the diet of an individual. The Indian Ready to Mix Food Market is expected to exceed US\$ 915.18 million in sales by the end of 2028, increasing at a CAGR of 16% from 2021 to 2028. Many ready-to-eat food firms have reported higher demand after the Covid-19 pandemic for their products, including frozen snacks, instant mixes, sweets, and curries/meals.

As there is a substantial demand for convenience foods in the market, they present a viable opportunity for exploration when it comes to incorporating healthy functional ingredients. The main objective of this study was to partially substitute gram flour with the under-utilised moringa seed flours in *cheela* instant mix and choose the best suited formulation in order to maximise the utilisation of moringa seed flour. The development of this type of food is an opportunity for the communities to take advantage of the nutritional and functional properties offered by moringa seeds.

## Materials and methods

### Materials

K-8 variety of Moringa oleifera seeds was procured from an authorized seed supplier from Dehradun, India.

### Production of moringa seed flours

Moringa seeds were sundried and cleaned to remove any extraneous matter. The seeds were then dehulled manually to obtain seed kernels. The dehulled seeds were grinded using Laboratory mill 3303 (Perten Instruments) to obtain seed flour. The flour was then sieved through 40 mm sieve to achieve finer particle size. The debittering of seeds was done according to the method given by (Ogunsina et al., 2010) where the kernels were boiled in water (1:30 w/v) for 35 mins, followed by overnight tray drying at 50°C. Subsequently, the seeds were grinded, sieved and stored in suitable packaging material. The two types of moringa seed flours (raw and debittered) were thus obtained (Fig. 1a and 1b).



Fig. 1: Moringa seed flours

### **Formulations of cheela instant mix incorporated with moringa seed flour:**

Moringa seed flours were mixed with gram flour with 0, 10, 20, 30, 40 and 50 % substitution levels. Other ingredients like spices and condiments were kept constant for all the blends. These blends were mixed thoroughly and packed in 2 types of packaging material, viz, HDPE and laminates and stored at ambient temperature for analysis and storage studies.

### **Cooking of cheelas**

The appropriate amount of water was added to the *cheela* instant mix to obtain a pourable batter which was then poured onto a preheated griddle with a little oiling on the edges to make the *cheela* from this instant mix. The *cheela* was gently turned over, cooked on the other side until done, and then subjected to sensory evaluation.

### **Sensory Evaluation**

The *cheela* samples were coded and served to thirty randomly selected semi-trained panel comprising of people aged between 20 - 58 years of age. The panelists were asked to score the *cheela* samples for colour, texture, flavor, taste and overall acceptability, using a nine-point hedonic scale. *Cheela* prepared from chickpea flour was used as control.

### **Methods**

#### **Proximate composition**

Using standard analytical approach, the moisture, crude protein, crude fibre, ash, fat, and carbohydrate content of the *cheela* instant mix samples were determined. The following parameters were measured using (Quinton, 2002) methods: moisture, crude protein, crude fibre, fat, and ash. By deducting the quantity of moisture, protein, fat, ash, and crude fibre from 100, the sample's carbohydrate content was determined (Yadav et al., 2012).

#### **Physical and functional properties**

Bulk density, True density was calculated using the methods given by (Tscheuschner, 1987). Water and oil absorption capacities were measured according to methods of (Obadi et al., 2018) with slight modifications. Foaming capacity was measured according to a method by (Alobo et al., 2009) In order to measure swelling power, method given by (Kusumayanti et al., 2015) was used. The amount of water needed to hydrate was calculated by measuring the ml of water needed to make a pourable and spreadable batter out of the *Cheela* Instant Mix. The color of flours was assessed in terms of L\*, a\* and b\* using a hunter colorimeter Model D 25 optical sensor (Hunter Associates Laboratory Inc., Reston, VA, USA).

#### **Texture Analysis**

The texture analyzer (TA, XT Plus, Stable Microsystems, UK) was used to test the *cheela's* tensile strength. The *cheela* strip of dimensions 5×2.5 cm was measured from its center and then placed between the two clamps. The maximum force (N) needed to tear the sample, the extensibility (mm), and the duration (seconds) of the tear were recorded (Cheng and Bhat, 2016).

#### **Rheology**

Rheological characteristics for the *cheela* batter were determined using a Rheometer (MCR 72, Anton Paar, Austria) equipped with 50 mm parallel plate geometry set at 1 mm gap and 25 °C temperature. The *cheela* batter was placed on the rheometer plate and the excess sample was trimmed using a spatula. Ther apparent viscosity was measured as a function of shear rate at shear rates 1–100s<sup>-1</sup>.

#### **Phytochemical Composition and antioxidant capacity**

For calculating DPPH radical scavenging ability, 3.9 ml of DPPH dye was added to 0.1 ml of methanolic sample extract. After incubating the solution for 30 mins in dark, the absorbance at 515 nm was measured. Aluminium chloride calorimetric analysis was used to determine the total flavonoids concentration (Xu and Chang, 2008). The Folin-Ciocalteu method, as reported by (Singleton et al., 1999), was used to calculate the total phenolics/phenols.

#### **Mineral Estimation**

The mineral components were identified using the inductively coupled plasma atomic emission spectroscopy (ICP-AES). Nitric acid and perchloric acid (3:1) were added to 1 g of the sample and incubated at room temperature for an overnight period. The digestion process was carried out on a hot plate (150°C) until the solution was crystal clear. Using double distilled water, the final volume was brought to 25ml. Then ICP-AES was used to do the mineralogical analysis.

#### **Storage studies**

Selected *Cheela* instant mix was packaged in 2 types of packaging material: HDPE and laminates at ambient temperature. Water activity was monitored with a digital water activity metre (Pawkit, Decagon Devices, Inc.,

Pullman, Washington, USA). The estimation of free fatty acid content was conducted using the method outlined in the (Townshend, 1987). The determination of peroxide value was conducted in accordance with the methodology described in AOCS, 1970.

### Statistical Analysis

The results are presented as mean  $\pm$  standard deviation. One way Analysis of variance (Jones, 1994) was carried out using SPSS software. Each analysis was carried out in triplicates while for sensory analysis,  $n=30$ .

## Result and discussion

### Sensory Analysis

The sensory analysis results have shown that the incorporation of different moringa seed flours impacted the sensorial score of the prepared cheela. The addition of up to 20% of RMSF achieved the maximum overall acceptability scores while 40% addition of DMSF showed maximum acceptability (Fig 2 and 3).

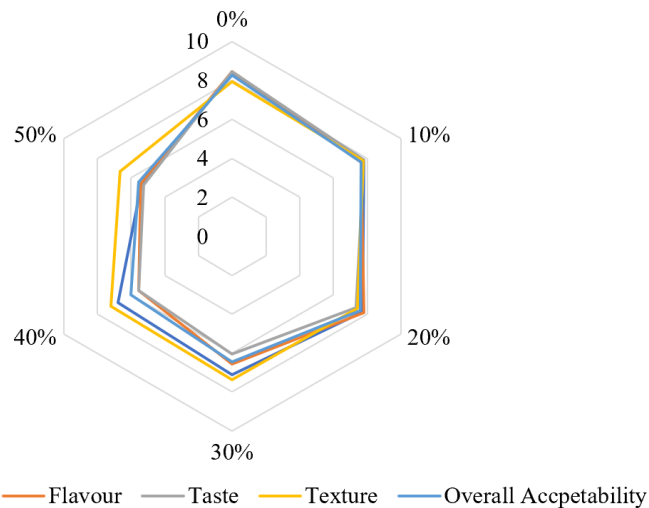


Fig. 2. Sensory evaluation of *cheelas* incorporated with different levels of RMSF

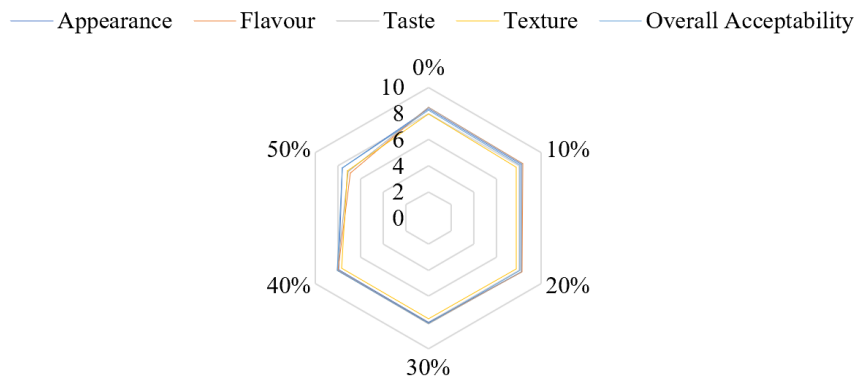


Fig. 3. Sensory evaluation of *cheelas* incorporated with different levels of DMSF

Based on this study, the *cheela* instant mix having 40 per cent DMSF was selected for further analysis and storage studies as the objective of this study was to maximize the utilization of moringa seed flour without adversely affecting the sensorial properties and acceptance of the product.

### Nutritional and Phyto-chemical properties

There was a significant ( $p < 0.05$ ) increase in the fat, crude fibre and crude protein of the *cheela* instant mix with 40% DMSF from 6.27 to 14.63, 5.6 to 7.63 and 20.47 to 24.7 per cent respectively as compared to the control as shown in Table 1. It was due to the inherent high fat and protein content of the debittered moringa seed flour. On the other hand, there was decrease in moisture, carbohydrate and ash content of 40% DMSF *cheela* instant mix sample as compared to control. The DPPH radical scavenging ability and TPC also improved in *cheela* instant mix with addition of 40% DMSF by 15 and 12.35 per cent respectively. Páramo-Calderón et al (2019) also reported significant ( $p < 0.05$ ) increase in TPC and anti-oxidant activity in tortilla chips incorporated with moringa seed powder.

### Functional Properties

The addition of 40% DMSF altered the functional properties of the *cheela* instant mix. The decrease in bulk density and true density indicates that the addition of moringa seed powder made the *cheela* less compact and denser. The 40% DMSF *cheela* instant mix's improved capacity for water absorption from 210.68 to 262.13 per cent suggests

that it had better water soaking capabilities, which may have helped it retain moisture and maintain its overall texture. It was observed that water for hydration significantly ( $p < 0.05$ ) increased from 204.67 to 234.33 ml with the addition of debittered seed flour to the *cheela* instant mix (Table 1). This might be due to the higher fibre content of the moringa seed flour.

**Table 1:** Nutritional, phyto-chemical, physical and functional attributes of *Cheela* instant mix

Parameters	<i>Cheela</i> Instant Mix (Control)	<i>Cheela</i> Instant Mix (40% DMSF)
<b>Nutritional and Phyto-chemical attributes</b>		
Moisture (%)	8.73 ± 0.21	7.83 ± 0.31
Fat (%)	6.27 ± 0.35	14.63 ± 0.42
Crude Protein (%)	20.47 ± 0.35	24.70 ± 0.56
Crude Fiber (%)	5.60 ± 0.56	7.63 ± 0.38
Carbohydrate (%)	55.38 ± 0.32	43.56 ± 0.73
Ash (%)	3.56 ± 0.29	1.64 ± 0.11
DPPH Radical Scavenging Ability (%)	53.27 ± 0.67	62.01 ± 1.54
Total Phenolic Content (mg GAE/100g)	0.81 ± 0.03	0.91 ± 0.03
<b>Functional attributes</b>		
Bulk Density (g/ml)	0.77 ± 0.02	0.44 ± 0.03
True Density (g/ml)	1.15 ± 0.02	0.58 ± 0.04
Foaming Capacity (%)	20.04 ± 0.82	21.53 ± 1.03
Water Absorption Capacity (%)	210.68 ± 0.82	262.13 ± 2.44
Oil Absorption Capacity (%)	198.37 ± 0.80	202.70 ± 0.37
Water Solubility Index	26.93 ± 0.25	22.63 ± 1.02
Water Activity ( $a_w$ )	0.61 ± 0.006	0.62 ± 0.006
Water for Hydration (ml)	204.67 ± 1.28	234.33 ± 1.92
Swelling Power (%)	551.14 ± 0.90	371.56 ± 1.80
<b>Physical and Structural attributes</b>		
Loop Tensile Strength (g)	1001.31 ± 383.11	159.49 ± 30.29
Extensibility (mm)	-2.48 ± 0.03	-2.99 ± 0.65
L*	87.37 ± 0.14	79.43 ± 1.12
a*	3.17 ± 0.17	3.67 ± 0.13
b*	25.08 ± 0.48	30.17 ± 0.42
Hue (°)	82.79 ± 0.38	83.06 ± 0.32
Chroma	25.28 ± 0.48	30.40 ± 0.40
ΔE	-	9.53 ± 1.30

### Physical and Structural Properties

The color properties of the *cheela* instant mix were observed post addition of moringa seed flour. The L\* value describes how light the flour is; higher values correspond to lighter colors while b\* value indicates how much the color is yellow (positive values) or blue (negative values). The L\*, a\* and b\* values of control *cheela* instant mix were 87.37, 3.17 and 25.08 respectively, while those for 40% DMSF *cheela* instant mix were 79.43, 3.67 and 30.17 respectively (Table 1).

The textural properties of the *cheela* were determined by measuring the loop tensile strength and extensibility as shown in Fig 4a and 4b. Loop tensile strength is the maximum force required to resist tension of the cooked food strand which gives the indication of its break strength and extensibility is denoted by the break distance or length (mm) until the rupture takes place. The loop tensile strength of the *cheela* with added 40 per cent DMSF was decreased by nearly 84 per cent which might be due to more water holding capacity of the seed flour, resulting in softer *cheela*. The extensibility showed no significant changes in both the *cheelas*.

The apparent viscosity of the *cheela* batters of different formulations were investigated at 25°C. Decrease in apparent viscosity of both *cheela* batter samples was observed with increase in shear rate from 1 to 100 s<sup>-1</sup>. This depicted a shear thinning behaviour for both batter samples. Further the apparent viscosity of batter containing 40% DMSF, was higher than control mix batter throughout the shear rate range as shown in Fig 5. Similar results were reported by Sung et al (2020), when addition of chia seed flour to rice flour gluten-free layer cake resulted in increased viscosity of batter which is reported due to mucilages in chia seeds.

### Mineral Profiling

The addition of 40% DMSF to *cheela* resulted in increase in potassium, phosphorus and zinc contents from 296.87 to 434.47, 212.98 to 303.60 and 213.32 to 272.76 mg/100g respectively. Some increase in Iron, Magnesium, Sodium

and Calcium was also noticed in the 40 per cent DMSF *cheela* instant mix (Fig 6). There was also significant increase in calcium, phosphorus and potassium content in buffalo yoghurt fortified with moringa and fenugreek seed powder as reported by (Dhawi et al., 2020).

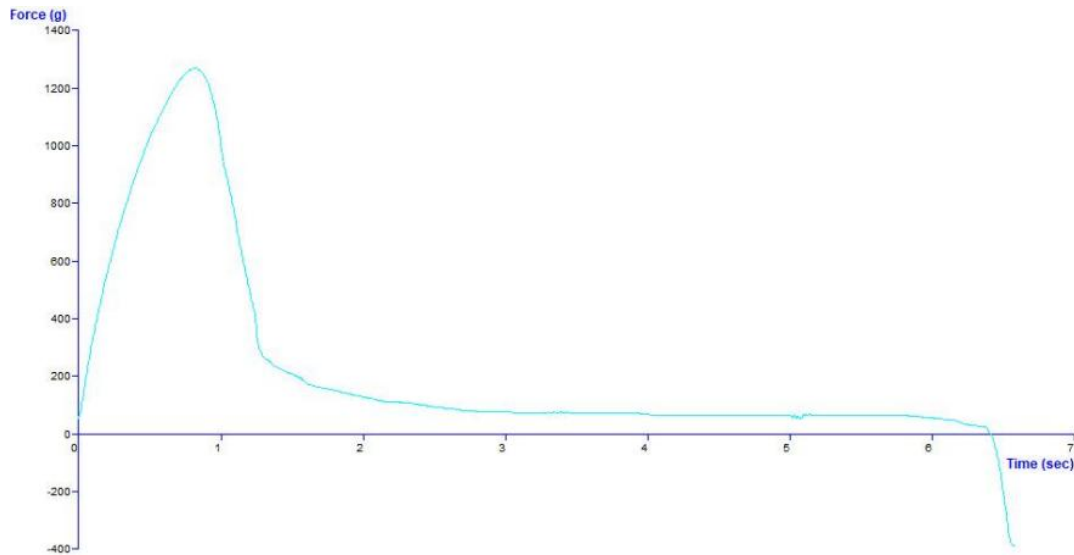


Fig. 4a. Textural properties of the control *Cheela* (0% DMSF)

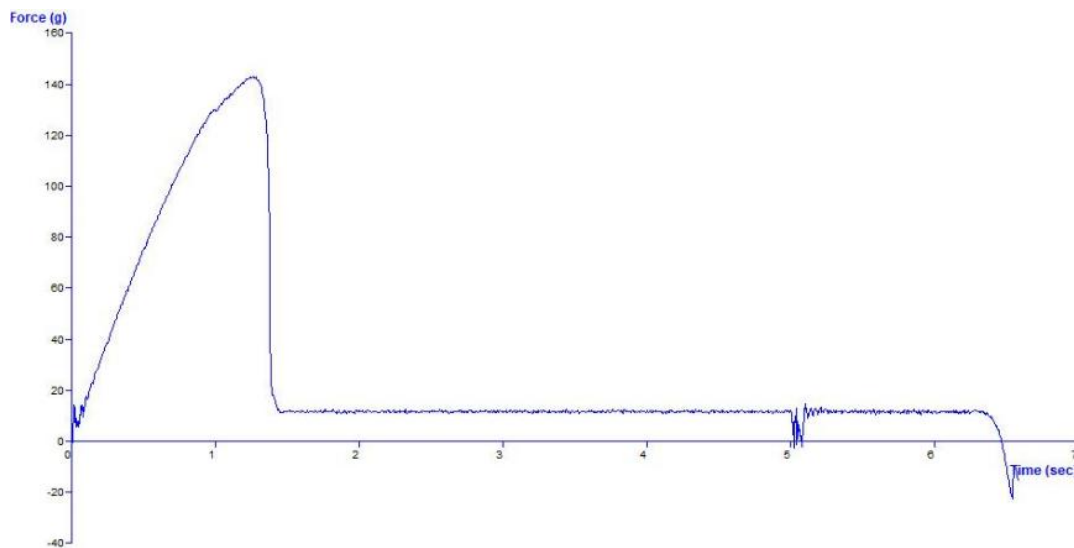


Fig. 4b. Textural properties of 40% DMSF *Cheela*

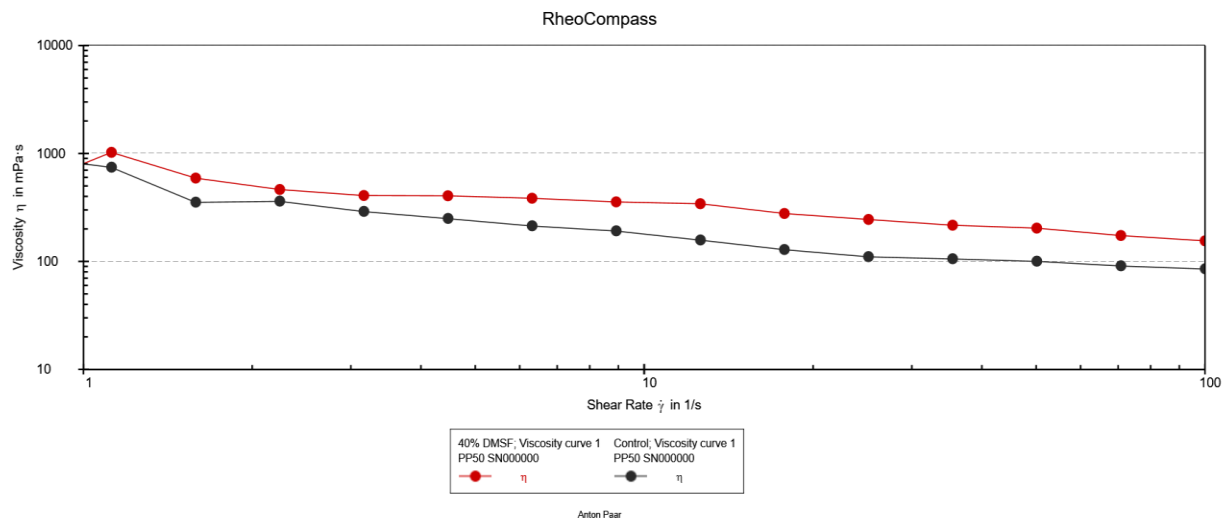


Fig. 5. Rheological properties of control and 40% DMSF *cheela* instant mix

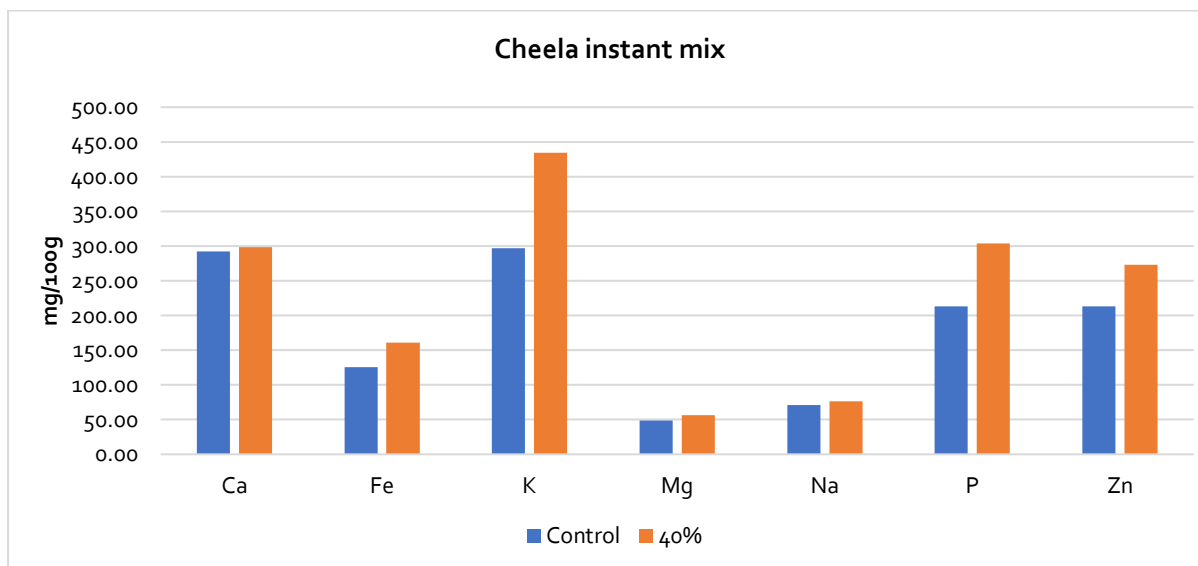


Fig. 6. Mineral composition of *cheela* instant mixes (control & 40% DMSF)

### Storage Studies

The *cheela* instant mix was stored in HDPE and laminates and analysed for a period of 90 days. Lipid oxidation, which causes unfavourable changes in flavour and nutritional value as well as having effects on health, is frequently the deciding factor during shelf studies of foods. In case of control, the peroxide value of *cheela* instant mix went from 0.4 to 0.84 in laminate packaging material while it rose to 1.04 in HDPE pouch. Similar trend was observed in free fatty acids from Fig 8 and 9. The water activity also rose from 0.58 to 0.64 in laminates and 0.66 in HDPE as shown in Fig 7. For 40% DMSF *cheela* instant mix similar trends were observed. The water activity rose from 0.59 to 0.64 in laminate and 0.65 in HDPE. Similarly, the free fatty acids and peroxide values also increased from their initial values. The rise was less in case of laminates, proving them to be a better choice for packaging material. Similar results were reported for flour blends of orange flesh, sweet potato, sorghum and soybean whose peroxide value and free fatty acids content increased during the storage period of 8 weeks from 0.05 to 1.28 and 1.02 to 2.26 respectively (Alawode et al., 2017). The values of free fatty acids and peroxide value for selected formulation of *cheela* instant mix after a period of 3 months were acceptable limits.

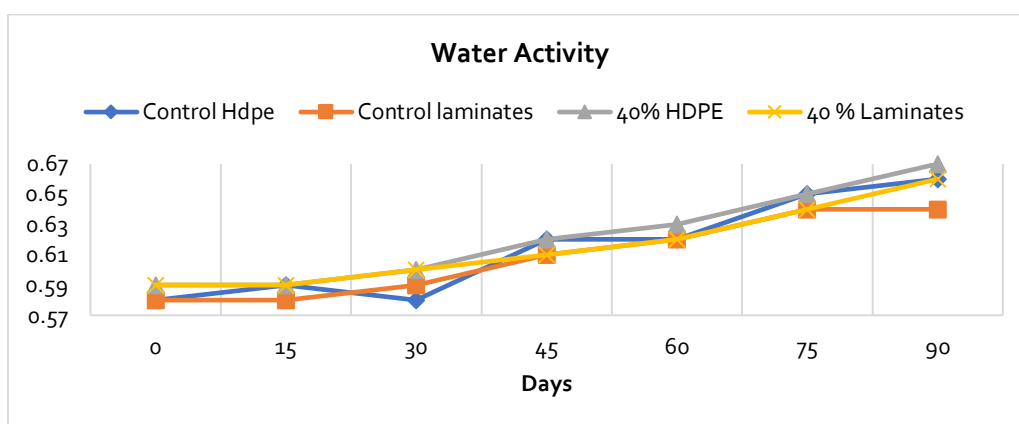


Fig. 7. Effect of storage period on water activity of control *cheela* and 40% DMSF *cheela*

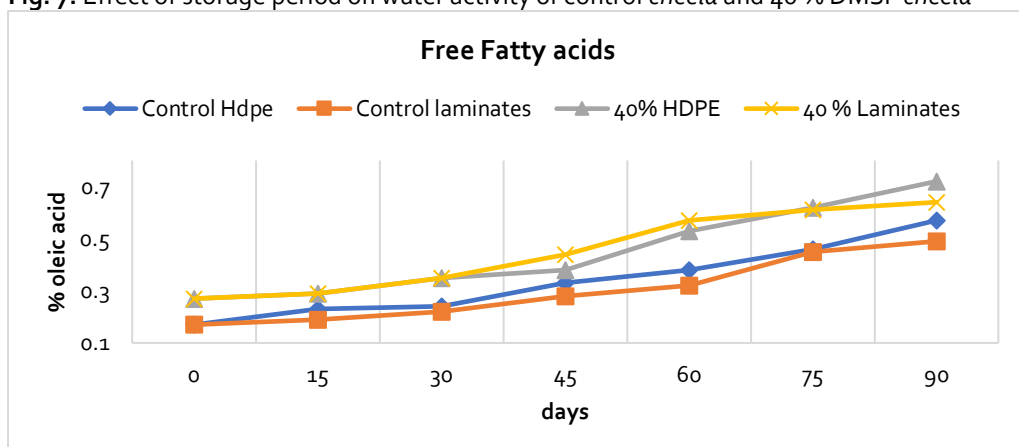


Fig. 8. Effect of storage period on free fatty acids of control *cheela* and 40% DMSF *Cheela*

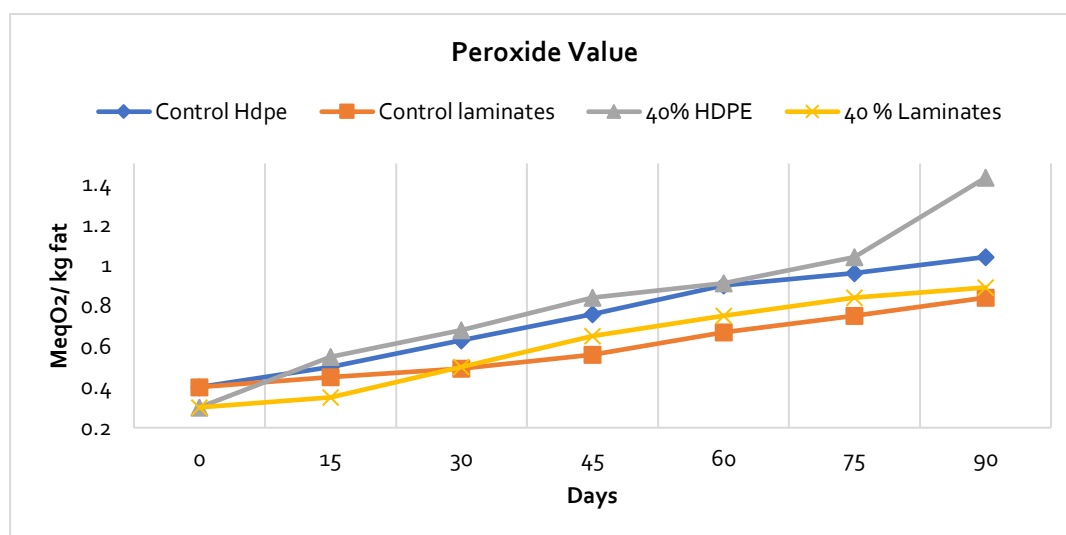


Fig. 9. Effect of storage period on peroxide value of control cheela and 40 % DMSF Cheela

### Conclusion

In the present-day scenario, there is a growing emphasis on health consciousness along with commitment to environmental sustainability. Consequently, *Moringa oleifera* emerges as a prime solution to address the pressing issues of food security and scarcity. The moringa seeds in particular are rich in nutritional and phytochemical profile but unfortunately, they are one the least exploited as a food ingredient. The addition of 40 percent DMSF to *cheela* instant mix improved its nutritional and functional properties like protein, fat, fibre and water absorption capacity, oil absorption capacity respectively. Minerals like potassium, phosphorus and zinc showed higher levels in *cheela* instant mix after incorporation. It was packed in two types of packaging materials: HDPE and laminates and stored at ambient temperature ( $25 \pm 10$  °C). The sample stored in laminates had lower values for free fatty acids and peroxide value as compared to one stored in HDPE for the 90 days of storage period. The laminates were therefore better suited packaging material for *cheela* instant mix. Therefore, this study shows that moringa seed flour can be used as functional ingredient in food applications, owing to its nutrition, anti-oxidant properties and health promoting components.

### References

- Abd Rani NZ, Husain K and Kumolosasi E (2018) Moringa Genus: A Review of Phytochemistry and Pharmacology. *Frontiers in Pharmacology* 9.
- Alawode EK, Idowu MA, Adeola AA, et al. (2017) Some quality attributes of complementary food produced from flour blends of orange flesh sweetpotato, sorghum, and soybean. *Croatian Journal of Food Science and Technology* 9(2): 122–129.
- Alobo AP, Agbo BN and Ilesanmi SA (2009) Physicochemical and functional properties of full fat and defatted cashew kernel flours. *International Journal of Food Science & Technology* 44(3): 581–585.
- Cheng YF and Bhat R (2016) Functional, physicochemical and sensory properties of novel cookies produced by utilizing underutilized jering (*Pithecellobium jiringa* Jack.) legume flour. *Food Bioscience* 14: 54–61.
- Dhawi F, El-Beltagi HS, Aly E, et al. (2020) Antioxidant, antibacterial activities and mineral content of buffalo yoghurt fortified with fenugreek and *Moringa oleifera* seed flours. *Foods* 9(9). MDPI Multidisciplinary Digital Publishing Institute.
- Dzuvor CKO, Pan S, Amanze C, et al. (2022) Bioactive components from *Moringa oleifera* seeds: production, functionalities and applications—a critical review. *Critical Reviews in Biotechnology*. Taylor and Francis Ltd.
- Giuberti G, Rocchetti G, Montesano D, et al. (2021) The potential of *Moringa oleifera* in food formulation: a promising source of functional compounds with health-promoting properties. *Current Opinion in Food Science* 42: 257–269.
- Gopalakrishnan L, Doriya K and Kumar DS (2016) *Moringa oleifera*: A review on nutritive importance and its medicinal application. *Food Science and Human Wellness* 5(2): 49–56.
- Jones DH (1994) *Statistical Methods*, 8th Edition George W. Snedecor and William G. Cochran Ames: Iowa State University Press, 1989. *Journal of Educational Statistics* 19(3): 304–307.
- Journal of the American Oil Chemists' Society (1970) AOCS official referee chemists—1970–71. *Journal of the American Oil Chemists' Society*, 47(10), pp. 425–426.

- Kusumayanti H, Handayani NA and Santosa H (2015) Swelling Power and Water Solubility of Cassava and Sweet Potatoes Flour. *Procedia Environmental Sciences* 23: 164–167.
- Leone A, Spada A, Battezzati A, et al. (2016) Moringa oleifera Seeds and Oil: Characteristics and Uses for Human Health. *International Journal of Molecular Sciences* 17(12): 2141.
- Mushtaq BS, Hussain MB, Omer R, et al. (2021) Moringa Oleifera in Malnutrition: A Comprehensive Review. *Current Drug Discovery Technologies* 18(2): 235–243.
- Adeoti O A and Osundahunsi O F (2017) Nutritional characteristics of maize-based complementary food enriched with fermented and germinated Moringa oleifera seed flour. *International Journal of Food Science, Nutrition and Dietetics*, 6(2): 350–357.
- Obadi M, Zhu KX, Peng W, et al. (2018) Effects of ozone treatment on the physicochemical and functional properties of whole grain flour. *Journal of Cereal Science* 81. Academic Press: 127–132.
- Ogunsina BS, Radha C and Govardhan Singh RS (2010) Physicochemical and functional properties of full-fat and defatted Moringa oleifera kernel flour. *International Journal of Food Science & Technology* 45(11): 2433–2439.
- Páramo-Calderón DE, Aparicio-Saguilán A, Aguirre-Cruz A, et al. (2019) Tortilla added with Moringa oleifera flour: Physicochemical, texture properties and antioxidant capacity. *LWT* 100: 409–415.
- Quinton, L.A. and Kennedy, J.F. (2002) *American Association of Cereal Chemists Approved Methods*, 10th ed., CD-ROM. *Carbohydrate Polymers*, 49(4), p. 515.
- Radha C, Ogunsina BS and Babu H (2015) Some Quality and Micro-structural Characteristics of Soup Enriched with Debittered Moringa Oleifera Seeds Flour. *American Journal of Food Science and Technology* 3(6): 145–149.
- Singleton VL, Orthofer R and Lamuela-Raventós RM (1999) [14] Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent., pp. 152–178.
- Sung WC, Chiu ET, Sun A, et al. (2020) Incorporation of chia seed flour into gluten-free rice layer cake: Effects on nutritional quality and physicochemical properties. *Journal of Food Science* 85(3): 545–555.
- Townshend A (1987) *Official methods of analysis of the association of official analytical chemists*, 14th edn. *Analytica Chimica Acta* 193: 400–401.
- Tscheuschner, H-D. (1987) N. N. Mohsenin: *Physical Properties of Plant and Animal Materials. Structure, Physical Characteristics and Mechanical Properties*. 2nd edn. *Food / Nahrung*, 31(7), p. 702.
- Xu B and Chang SKC (2008) Effect of soaking, boiling, and steaming on total phenolic content and antioxidant activities of cool season food legumes. *Food Chemistry* 110(1): 1–13.
- Yadav DN, Singh KK and Rehal J (2012) Studies on fortification of wheat flour with defatted rice bran for chapati making. *Journal of Food Science and Technology* 49(1): 96–102.

#### Author Contributions

DA, JR, JK, KK and PK conceived the concept, wrote and approved the manuscript.

#### Acknowledgements

The facilities provided by Punjab Agricultural University for smooth conductance of this study are duly acknowledged.

#### Funding

Not applicable.

#### Availability of data and materials

Not applicable.

#### Competing interest

The authors declare no competing interests.

#### Ethics approval

Not applicable.



**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution, and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license

unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. Visit for more details <http://creativecommons.org/licenses/by/4.0/>.

**Citation:** Arora D, Rehal J, Kaur J, Kaur K and Kaur P (2026) Effect of Moringa Seed Flours on Phytochemical, Functional and Structural Attributes of Savoury Indian Pancake (*Cheela*): An Approach to Enhance Nutritional Value of Traditional Food. *Environmental Science Archives* 5(1): 248-257.