



Effect of Pumpkin (*Cucurbita moschata*) Powder Incorporation on the Nutritional Composition and Bioactive Components of Amaranth Kheer Mix

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ABSTRACT

Background: Traditional kheer is a cereal-milk dessert with high consumer acceptance but limited functional attributes. The present investigation aimed to develop a value-added ready-to-cook kheer mix using germinated amaranth flour as a base and pumpkin powder as a source of natural antioxidants, fibre and bioactive components.

Methods: Kheer mix formulations were prepared by replacing germinated amaranth flour with pumpkin powder at 0, 5, 10, 15 and 20% levels while keeping other ingredients constant. The products were evaluated for sensory attributes using a 9-point hedonic scale, proximate composition, mineral profile and bioactive components.

Result: Incorporation of pumpkin powder significantly improved sensory scores, nutritional composition and bioactive components. The treatment containing 15% pumpkin powder (KG₃) was the most acceptable with the highest overall acceptability score (8.60). Moisture and fat decreased from 5.47 to 4.18% and 5.01 to 4.00%, respectively, while crude fibre (2.95%), ash (3.61%) and carbohydrate (70.05%) increased in KG₃. Mineral analysis showed enhanced iron (11.38 mg/100 g), potassium (766.08 mg/100 g), manganese (27.16 mg/100 g) and copper (0.72 mg/100 g), whereas calcium and phosphorus declined due to partial replacement amaranth flour. Bioactive constituents increased markedly in the sensory selected sample, recording 33.03 µg/g total carotenoids, 179.48 mg GAE/100 g total phenolics and 49.19 mg QE/100 g total flavonoids. The combination of pumpkin powder and germinated amaranth flour significantly improved the sensory quality, micronutrient density and bioactive component of the kheer mix. The formulation containing 15% pumpkin powder was identified as the optimum and can be recommended as a functional, nutrient-enriched ready-to-cook dessert.

Key words: Germinated amaranth, Kheer mix, Proximate composition bioactive compounds, Pumpkin powder, Sensory evaluation.

INTRODUCTION

Kheer is a traditional Indian milk-based dessert prepared by cooking cereals, mainly rice, in milk until starch gelatinization occurs, followed by the addition of sweeteners such as sugar or jaggery (Jha *et al.*, 2015). With changing lifestyles and increasing demand for convenience foods, instant kheer mixes have gained importance, as multiple heat treatments during processing improve texture, shelf life and ease of preparation (Bunkar *et al.*, 2012). The traditional rice kheer has been diversified using pulses, cereals, tubers, fruits and seeds to enhance its nutritional quality (Unnikrishnan *et al.*, 2000). Instant kheer mix represents a growing segment within India's ready-to-mix food market, which was valued at USD 451.3 million in 2024 and is expanding rapidly, with dessert mixes gaining increasing market share due to demand for convenient traditional sweets (TechSci Research, 2024).

Pumpkin (*Cucurbita moschata* Duch ex Poir) is a nutrient-rich vegetable containing β-carotene, ascorbic acid, dietary fibre, pectin, minerals and several bioactive compounds with antioxidant and hypocholesterolaemia properties, making it valuable for combating malnutrition (Pandey *et al.*, 2003; Dhiman *et al.*, 2018). However, due to its high moisture content and perishability, drying is an effective method to extend shelf life, reduce storage

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and transportation costs post-harvest loss and enable off-season utilization. Drying into powder improves shelf life and enables its use in value-added products (Guine *et al.*, 2011).

Amaranth is gaining attention as a climate-resilient, nutrient-dense pseudo-cereal with higher protein content and better lysine balance than conventional cereals, making it suitable for addressing protein malnutrition and for gluten-free product development (Capriles *et al.*, 2008; Caselato-Sousa and Amaya-Farfan, 2012). It is also a rich source of essential minerals, including calcium, magnesium, copper, zinc, iron, potassium and phosphorus. Additionally, amaranth contains various bioactive compounds such as phytosterols, polyphenols, saponins and squalene, which contribute to its nutritional and health-promoting properties (Mlakar *et al.*, 2009; Alvarez-Jubete *et al.*, 2009).

Despite their nutritional potential, limited studies have explored the combined use of these ingredients in ready-to-cook products like kheer mix, with most focusing on individual incorporation rather than synergistic effects. Meanwhile, growing urbanization has increased demand for convenient, hygienic and shelf-stable premixes that save time while ensuring consistent quality and improved nutrition. Therefore, the development of an amaranth kheer mix incorporated with pumpkin powder using amaranth as a base and enrichment with pumpkin powder provides a nutritious, functional and value-added ready-to-cook dessert.

MATERIALS AND METHODS

The research was carried out during the year 2024-2025 at the College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani. The good quality raw materials such as pumpkin (*Cucurbita moschata*), amaranth seeds, skim milk powder, sugar, dry fruits like almond, dry dates, coconut shreds and cardamom *etc.* were procured from local market of Parbhani.

Preparation of pumpkin powder

Pumpkin powder was produced with minor changes to the procedure of Mittal *et al.* (2019). Fully matured pumpkins were washed, cut, deseeded, peeled and sliced uniformly, followed by rewashing. The slices were steam-blanching and treated with 750 ppm potassium metabisulphite for 10 min, then dried in a cabinet dryer at 60±2°C for 6-7 h. The dried slices were milled, sieved through an 80-mesh (180 µm) screen and stored in polyethylene pouches for further analysis. The separated seeds were also dried and their kernels were used for subsequent studies.

Preparation of flour from germinated amaranth seeds

Germinated flour was prepared with slight modifications to the method of (Thakur *et al.* 2021; Bachate *et al.*, 2025). Cleaned grains (250 g) were soaked in 1000 mL water for 8 h at room temperature in darkness using a muslin-covered beaker. The soaked grains were drained, wrapped

in a moist muslin cloth and allowed to sprout for 72 h with periodic sprinkling of water to maintain moisture. The germinated grains were then dried in a cabinet dryer at 60°C for 4 h, cooled, milled into flour, sieved through a 70-mesh screen and stored in polyethylene zipper bags for further analysis.

Preparation of kheer mix

The kheer mix was prepared by blending raw or germinated amaranth flour with pumpkin powder, while keeping the levels of skim milk powder, sugar, pumpkin seeds, dry dates powder, coconut shreds, almond powder and cardamom powder constant. The control contained 35% untreated amaranth flour without pumpkin powder, whereas in the treatments (KG₀-KG₄) germinated amaranth flour was progressively replaced with pumpkin powder at 0, 5, 10, 15 and 20%. All ingredients were accurately weighed, mixed uniformly and packed in laminated airtight pouches. The detailed formulation is presented in Table 1.

For reconstitution, about 100 g of the mix was added to boiling potable water in a 1:8 ratio and cooked at 90±2°C for 5-6 min with intermittent stirring until the desired consistency was obtained and the product was served hot or after cooling.

Sensory analysis of prepared kheer

Sensory evaluation of the kheer will be conducted by a semi-trained panel comprising staff and students of the College of Food Technology, VNMKV, Parbhani, having prior experience in sensory analysis. The samples will be assessed for colour and appearance, texture/mouthfeel, flavour, taste and overall acceptability using a 9-point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely) as described by (Ocheme and Chinma, 2008; Kolwate *et al.*, 2021).

Proximate and Mineral composition analysis

The proximate composition and mineral content of the amaranth kheer mix incorporated with pumpkin powder were analysed using standard AOAC (2005) methods. Moisture, crude fat, protein, fibre, ash and carbohydrate contents were determined to evaluate the nutritional quality. The mineral profile, including calcium, phosphorus, iron, magnesium, potassium, sodium, zinc, manganese, copper and selenium, was evaluated.

Bioactive component analysis

Total carotenoids, total phenolics and total flavonoids in amaranth kheer mix incorporated with pumpkin powder were determined using standard analytical procedures.

Total carotenoid estimation

A known weight of sample was extracted with acetone and transferred to petroleum ether using 5% sodium sulphate solution. The volume was made up to 25 ml and absorbance was recorded at 452 nm. The carotenoid

content was calculated from a standard curve following Ranganna (2019).

$$\text{Total carotene} \left(\frac{\text{g}}{100 \text{ g}} \right) = \frac{\text{Concentration of carotene in solution from standard curve} \times \text{Final volume (ml)} \times \text{Dilution}}{\text{Weight of the sample (g/ml)}} \times 100$$

Determination of total phenolic content (TPC) and total flavonoid content (TFC)

Sample extraction

Sample extraction was carried out with slight changes to the method of Halim *et al.* (2024). One gram of the sample was mixed with 9 mL of 90% methanol and stirred at 100 rpm for 20 min. The mixture was filtered through Whatman No. 41 filter paper and the filtrate was kept at 4°C in the dark until further analysis.

Total phenolic content (TPC)

Total phenolic content was measured by the Folin-Ciocalteu procedure as outlined by Halim *et al.* (2024). A 0.5 mL portion of the extract was combined with an equal volume of Folin-Ciocalteu reagent, then 2 mL of 7.5% sodium carbonate and distilled water were added. The mixture was kept at room temperature for colour development, centrifuged and the absorbance was taken at 725 nm. The phenolic content was quantified from a gallic acid calibration curve and reported as gallic acid equivalents.

Total flavonoid content (TFC)

Total flavonoid content was determined by a modified spectrophotometric procedure described by Halim *et al.* (2024). The extract was treated successively with sodium nitrite, aluminium chloride and sodium hydroxide, then

centrifuged and kept in the dark for colour development. The absorbance was recorded at 510 nm and the results were calculated from a quercetin standard curve and expressed as quercetin equivalents.

Statistical analysis

All experimental data were subjected to statistical analysis using a completely randomized design (CRD). The significance of differences among treatments was evaluated through analysis of variance (ANOVA) in accordance with the method described by Panse and Shukhatame (1985).

RESULTS AND DISCUSSION

Sensory evaluation of amaranth kheer incorporated with pumpkin powder

Sensory evaluation of kheer incorporated with pumpkin powder, as presented in Table 2, showed a significant improvement in all quality attributes compared to the control. The control sample recorded the lowest scores for appearance, colour, taste, flavour, texture and overall acceptability, whereas a progressive increase in scores was observed from KG₀ to KG₃. The highest overall acceptability (8.60) with superior sensory scores was obtained in KG₃, indicating it as the most preferred treatment. A slight decline in KG₄ suggests that excessive incorporation negatively influenced sensory quality. The enhancement in appearance and colour can be attributed to the presence of carotenoid pigments in pumpkin, which impart an attractive creamy yellow to orange hue. Improved taste and flavour may be due to the natural sweetness and characteristic cooked pumpkin flavour that blended well with the milk base. The higher texture scores in optimized treatments might be associated with the dietary fibre and pectic substances in pumpkin powder that increased viscosity and provided a desirable body,

Table 1: Formulations of amaranth kheer mix incorporated with pumpkin powder.

Treatments	Raw materials								
	Amaranth flour (%)	Pumpkin powder (%)	Skim milk powder (%)	Sugar (%)	Pumpkin seeds (%)	Dry dates powder (%)	Coconut shreds (%)	Almand (%)	Cardamom powder (%)
Control	35	-	25	30	05	02	1.5	01	0.5
KG ₀	35	-	25	30	05	02	1.5	01	0.5
KG ₁	30	05	25	30	05	02	1.5	01	0.5
KG ₂	25	10	25	30	05	02	1.5	01	0.5
KG ₃	20	15	25	30	05	02	1.5	01	0.5
KG ₄	15	20	25	30	05	02	1.5	01	0.5

Control-35% untreated amaranth flour and 25% Skim milk powder + 30% Sugar + 5% pumpkin seeds + 2% dry dates powder + 1.5% coconut shreds + 1% almond + 0.5% cardamom powder.

KG₀- 35% germinated amaranth flour and 25% skim milk powder + 30% Sugar + 5% pumpkin seeds + 2% dry dates powder + 1.5% coconut shreds + 1% almond + 0.5% cardamom powder constant in all treatments.

KG₁- 30% germinated amaranth flour + 5 % pumpkin powder.

KG₂- 25% germinated amaranth flour + 10 % pumpkin powder.

KG₃- 20% germinated amaranth flour + 15 % pumpkin powder.

KG₄- 15% germinated amaranth flour + 20 % pumpkin powder.

while higher levels produced a slightly heavy consistency and dominant flavour, thereby reducing acceptability. Similar findings were reported in pumpkin fortified dairy products and traditional milk sweets, where sensory scores increased up to an optimum level and declined at higher incorporation levels due to intense flavour and increased thickness (Kulkarni *et al.*, 2016; Kaur and Sharma, 2017; Waghmare *et al.*, 2019).

Proximate composition of amaranth kheer mix incorporated with pumpkin powder

The proximate composition of kheer mix incorporated with different levels of pumpkin powder analysed and reported in Table 3. Moisture content decreased significantly from 5.47% in the control to 4.03% in KG₄. This reduction may be attributed to the low moisture content of pumpkin powder and its higher total solids, which lowered the overall water content of the mix. Fat content also showed a significant decreasing trend from 5.01 to 3.95% with increasing levels of pumpkin powder, which could be due to the dilution effect caused by replacement of milk solids with a low-fat plant material. A similar decreasing pattern was observed in protein content (16.55 to 14.63%), which might be related to the lower protein content of pumpkin powder compared to dairy ingredients.

In contrast, crude fibre and ash content increased significantly with the increase in pumpkin powder level. Crude fibre rose from 2.40% in the control to 2.99% in KG₄,

which is directly associated with the high dietary fibre content of pumpkin. The ash content increased from 3.24 to 3.74%, indicating improvement in total mineral content due to the presence of minerals in pumpkin powder. Carbohydrate content showed a significant increasing trend (67.27 to 70.66%), which may be explained by the higher proportion of carbohydrates in pumpkin powder and the simultaneous reduction in fat, protein and moisture. These changes clearly indicate that incorporation of pumpkin powder enhanced the fibre, mineral and carbohydrate content of the kheer mix while reducing fat and protein levels.

The results reported that the incorporation of pumpkin powder in amaranth kheer mix significantly affected its proximate composition. An increase in pumpkin powder concentration led to a decrease in moisture, fat and protein contents, while crude fiber, ash and carbohydrate contents increased proportionally. These trends were in close agreement with previous findings by (Adil *et al.*, 2023), Who emphasized that pumpkin addition enhances the fiber, ash and carbohydrate content of value-added products. From nutritional point of view, the fortification of kheer mix with pumpkin powder enhances nutritional quality, reduces fat content and contributes to a healthier, fiber enriched product suitable for all age group consumers.

The present results are consistent with earlier studies on the use of fruit and vegetable powders in traditional dairy products. Comparable trends were reported in vegetable-based kheer mix (Dhiman *et al.*, 2018) and pumpkin-

Table 2: Sensory evaluation of amaranth kheer incorporated with pumpkin powder.

Treatments	Appearance	Colour	Taste	Flavour	Texture	Overall acceptability
Control	7.09	7.02	7.30	7.25	7.34	7.35
KG ₀	7.11	7.06	7.42	7.96	7.97	7.99
KG ₁	7.75	7.90	8.06	8.15	8.04	8.19
KG ₂	8.30	8.20	8.32	8.40	8.37	8.40
KG ₃	8.50	8.55	8.59	8.56	8.58	8.60
KG ₄	8.40	8.58	8.45	8.44	8.42	8.44
SE ±	0.027	0.042	0.055	0.028	0.053	0.044
CD at 5%	0.090	0.126	0.180	0.086	0.159	0.132

*Each value is mean of three determinations.

Table 3: Proximate composition of amaranth kheer mix incorporated with pumpkin powder.

Treatments	Parameters (%)					
	Moisture	Fat	Protein	Crude fiber	Ash	Carbohydrate
Control	5.47	5.01	16.55	2.40	3.24	67.27
KG ₀	4.73	4.18	16.98	2.78	3.18	68.15
KG ₁	4.55	4.13	16.39	2.84	3.32	68.82
KG ₂	4.35	4.06	15.80	2.89	3.47	69.43
KG ₃	4.18	4.00	15.21	2.95	3.61	70.05
KG ₄	4.03	3.95	14.63	2.99	3.74	70.66
SE ±	0.1134	0.095	0.1139	0.1121	0.1064	0.1726
CD at 5%	0.3402	0.2853	0.3417	0.3363	0.3192	0.5178

*Each value is mean of three determinations.

enriched milk sweets (Waghmare *et al.*, 2019), where higher levels of supplementation enhanced fibre and mineral content. These findings indicate that pumpkin powder effectively improves the nutritional and functional quality of the kheer mix while altering its compositional profile.

Mineral composition of amaranth kheer mix incorporated with pumpkin powder

Mineral analysis of the samples was analysed and depicted in Table 4. The mineral composition of the kheer mix was significantly influenced by the incorporation of pumpkin powder and the treatment differences were statistically significant ($p \leq 0.05$) for Ca, P, K, Fe, Mg, Zn, Mn and Cu, while Na and Se showed non-significant variation. The sensory selected treatment, KG₃ containing 15% pumpkin powder, recorded 313.12 mg/100 g calcium and 445.06 mg/100 g phosphorus, both of which were lower than the control. This decline is mainly the result of partial replacement of amaranth flour, which are naturally rich in these minerals, with pumpkin powder having comparatively lower calcium and phosphorus content. Magnesium and zinc also showed a decreasing trend with higher levels of incorporation, which may be attributed to the reduced proportion of amaranth flour in the formulation.

A reverse trend was observed for potassium and iron. Potassium increased markedly from 666.04 mg/100 g in the control to 766.08 mg/100 g in KG₃, while iron increased from 9.297 to 11.38 mg/100 g in the same treatment. The rise in these minerals is associated with the inherent mineral composition of pumpkin, which is particularly rich in potassium and contains appreciable amounts of iron. In addition, the use of germinated amaranth flour in the formulation may have contributed to the improved mineral profile. Germination is known to reduce phytic acid through activation of endogenous phytase, thereby releasing bound minerals and enhancing their extractability and bioavailability. This could explain the progressive increase in manganese and copper content with increasing incorporation level. The sensory selected sample (KG₃) thus showed higher values of iron, potassium, copper and manganese, indicating its improved micronutrient density. Sodium and selenium remained almost constant across treatments,

suggesting that the added ingredients had minimal influence on these minerals.

The observed changes in mineral composition are consistent with earlier reports on pumpkin-fortified dairy products. Shaikh *et al.* (2015) documented an increase in iron and potassium along with a reduction in calcium in pumpkin-based kheer due to replacement of amaranth flour. Similar observations were made by Shaikh *et al.* (2017) in reconstituted kheer supplemented with pumpkin pulp. The beneficial effect of germination on mineral availability in amaranth has also been reported, where sprouting improved iron and zinc accessibility as a result of phytate degradation and enzymatic modification of the grain matrix (Suri *et al.*, 2019). The compositional data of pumpkin published by the USDA further support its role as a rich source of potassium and a contributor to iron enrichment in food formulations (USDA, 2019). Therefore, the incorporation of pumpkin powder in combination with germinated amaranth flour resulted in a nutritionally improved kheer mix with enhanced levels of iron and potassium.

Bioactive components of amaranth kheer mix incorporated with pumpkin powder

The incorporation of pumpkin powder resulted in a significant ($p \leq 0.05$) enhancement of all the analysed bioactive components of the kheer mix, as reported in Table 5. Total carotenoid content increased markedly from 6.670 µg/g in the control to 41.77 µg/g in KG₄, while total phenolic content rose from 139.12 to 188.15 mg GAE/100 g and total flavonoid content from 27.52 to 55.21 mg QE/100 g. The optimized treatment, KG₃ containing 15% pumpkin powder, recorded 33.03 µg/g carotenoids, 179.48 mg GAE/100 g phenolics and 49.19 mg QE/100 g flavonoids, indicating a pronounced improvement in antioxidant potential compared to the control. This progressive increase is primarily associated with the inherent richness of pumpkin in carotenoids, particularly β-carotene, along with its substantial polyphenolic and flavonoid fractions (Nawirska-Olszańska *et al.*, 2011). The higher total solids and lower moisture content of the supplemented mixes might have further contributed to the increased concentration of these phytochemicals on a dry weight basis (Dhiman *et al.*, 2018).

Table 4: Mineral composition of amaranth kheer mix incorporated with pumpkin powder.

Treatments	Parameters (mg/100 g)									
	Ca	P	K	Fe	Mg	Zn	Mn	Cu	Na	Se
Control	316.46	482.25	666.04	9.297	139.11	2.86	1.484	0.42	119.02	0.1051
KG ₀	318.34	492.51	682.28	10.31	152.41	3.47	1.516	0.59	119.90	0.1057
KG ₁	316.60	476.69	710.21	10.67	143.38	3.29	10.06	0.64	119.72	0.1050
KG ₂	314.86	460.88	738.15	11.02	134.36	3.10	18.61	0.68	119.54	0.1043
KG ₃	313.12	445.06	766.08	11.38	125.34	2.92	27.16	0.72	119.37	0.1036
KG ₄	311.38	429.24	794.03	11.73	116.31	2.74	35.71	0.76	119.19	0.1029
SE ±	0.3207	0.2703	0.1339	0.1178	0.1016	0.061	0.0568	0.018	0.0578	0.048
CD at 5%	0.990	0.8109	0.4017	0.3534	0.3048	0.190	0.1704	0.060	0.1734	0.150

*Each value is mean of three determinations.

Table 5: Bioactive components of amaranth kheer mix incorporated with pumpkin powder.

Treatments	Nutrients		
	Total carotenoids content (µg/g)	Total phenolic content (mg GAE/100 g)	Total flavonoids content (mg QE/100 g)
Control	6.670	139.12	27.52
KG ₀	6.810	153.45	31.14
KG ₁	15.55	162.12	37.15
KG ₂	24.29	170.80	43.17
KG ₃	33.03	179.48	49.19
KG ₄	41.77	188.15	55.21
SE ±	0.087	0.072	0.0414
CD at 5%	0.27	0.220	0.130

*Each value is mean of three determinations.

The improvement in phenolic and flavonoid content can also be attributed to the inclusion of germinated amaranth flour. Germination activates endogenous enzymes such as amylases, proteases and phytases, which hydrolyse complex storage constituents and reduce antinutritional factors, particularly phytic acid. This enzymatic modification facilitates the release of bound phenolic compounds and enhances their extractability, thereby increasing the measurable antioxidant fraction (Alvarez-Jubete *et al.*, 2010; Suri *et al.*, 2019). The continuous rise in all bioactive constituents across treatments without any decline indicates that both pumpkin powder and germinated amaranth flour served as stable and concentrated sources of phytochemicals and that the processing conditions employed were not severe enough to cause noticeable thermal degradation.

The results agree with earlier studies on pumpkin-based kheer and similar products. Increased carotenoid content after pumpkin addition has been attributed to its rich β -carotene level (Shaikh *et al.*, 2015), while the rise in phenolics and flavonoids is linked to its inherent antioxidant compounds (Nawirska-Olszańska *et al.*, 2011). The optimized sample showed much higher carotenoids than traditional kheer, indicating that pumpkin powder is effective for provitamin-A fortification and enhancement of antioxidant potential.

CONCLUSION

The study established that incorporation of pumpkin powder into a germinated amaranth-based kheer mix markedly improved its sensory, nutritional and functional quality. The formulation containing 15% pumpkin powder (KG₃) was the most preferred, with the highest overall acceptability (8.60) and a balanced flavour, colour and texture. Nutritional assessment indicated lower moisture and fat with higher fibre, ash and carbohydrates, suggesting better shelf stability and enhanced dietary value. The optimized product also exhibited higher iron, potassium, manganese and copper contents, while the slight reduction in calcium and phosphorus was due to partial replacement of amaranth flour. A substantial rise in

carotenoids, phenolics and flavonoids confirmed the role of pumpkin powder and germinated amaranth in improving antioxidant potential and micronutrient density. The developed kheer mix can serve as a convenient and nutrient-dense traditional dessert with scope for commercial production and dietary diversification.

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Disclaimer

The views presented in this manuscript are those of the author, who is solely responsible for its content and accuracy.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

- Adil, S., Narnaware, G., Meshram, B., Dhotre, A., Gawande, H., Shinde, N., Kele, V. and Chavhan, B. (2023). Studies on proximate composition and cost structure of dried kheer mix using pumpkin powder. *Biological Forum-An International Journal*. **15(5a)**: 52-57.
- Alvarez-Jubete, L., Arendt, E.K. and Gallagher, E. (2009). Nutritive value of pseudocereals and their increasing use as functional gluten-free ingredients. *Trends in Food Science and Technology*. **20(11-12)**: 576-590. <https://doi.org/10.1016/j.tifs.2009.07.003>.
- Alvarez-Jubete, L., Wijngaard, H., Arendt, E.K. and Gallagher, E. (2010). Polyphenol composition and *in vitro* antioxidant activity of amaranth, quinoa and buckwheat as affected by sprouting and baking. *Food Chemistry*. **119(2)**: 770-778. <https://doi.org/10.1016/j.foodchem.2009.07.032>.
- AOAC, (2005). Official Methods of Analysis. 16th edition. Association of Official Analytical Chemists, Washington, DC, U.S.A.
- Bachate, A.H., Pawar, V.S., Pawar, G.S., Rodge, S.M. and Joshi, M.M. (2025). Effect of soaking, roasting and germination on nutritional quality and colour properties of pearl millet flour. *Asian Journal of Dairy and Food Research*. **44(6)**: 962-967. doi: 10.18805/ajdfr.DR-2371.

- Bunkar, D.S., Jha, A. and Mahajan, A. (2012). Optimization of the formulation and technology of pearl millet based 'ready-to-reconstitute' kheer mix powder. *Journal of Food Science and Technology*. **51(10)**: 2404-2414.
- Capriles, V.D., Coelho, K.D., Matias, A.C.G. and Areas, J.A.G. (2008). Effect of amaranth on nutritional value and sensory acceptability of cookie and sandwich bread. *Alimentose Nutricao Brazilian Journal of Food and Nutrition*. **17**: 269-274.
- Caselato-Sousa, V.M. and Amaya-Farfan, J.J. (2012). State of knowledge on amaranth grain: A comprehensive review. *Journal of Food Science*. **77**: R93-R104.
- Dhiman, A.K., Sharma, K.D. and Attri, S. (2018). Development and quality evaluation of vegetable enriched ready-to-cook kheer mix. *Journal of Food Science and Technology*. **55(3)**: 1120-1127.
- Guine, R.P.F., Pinho, S. and Barroca, M.J. (2011). Study of the convective drying of pumpkin (*Cucurbita maxima*). *Food and Bio Products Processing journal*. **89(4)**: 422-428.
- Halim, M.A., Wazed, M.A., Obaid S.A., Ansari M.J., Tahosin A., Tajminur, R.M., Noor, F., Rubel, M.N.H.M. and Khatun, A.A. (2024). Effect of storage on physicochemical properties, bioactive compounds and sensory attributes of drinks powder enriched with pumpkin (*Cucurbita moschata* L.). *Journal of Agriculture and Food Research*. **18**: 1-12.
- Jha, A., Shalini, B.N., Patel, A.A., Singh, M. and Rasane, P. (2015). Optimization of instant dalia dessert pre-mix production by using response surface methodology. *Journal of Food Science and Technology*. **52(2)**: 920-927.
- Kaur, M. and Sharma, H.K. (2017). Effect of incorporation of different plant-based ingredients on the quality characteristics of traditional dairy products. *Journal of Food Science and Technology*. **54(6)**: 1574-1581.
- Kolwate, R.G., Uikey, A.A. and Shegokar, S.R. (2021). Effects of addition of pumpkin (*Cucurbita pepo*) pulp on the physico-chemical and sensory properties of *Burfi* and its cost structure. *Agricultural Reviews*. **42(4)**: 478-482. doi: 10.18805/ag.DR-1685.
- Kulkarni, A.S., Joshi, D.C. and Mudgal, V.D. (2016). Development and sensory evaluation of pumpkin incorporated dairy products. *Indian Journal of Dairy Science*. **69(5)**: 560-565.
- Mittal, S., Dhiman, A.K., Sharma, A., Attri, S. and Kathuria, D. (2019). Standardization of recipes for preparation of pumpkin (*Cucurbita moschata*) flour and its quality evaluation during storage. *International Journal of Current Microbiology and Applied Sciences*. **8(2)**: 3224-3235.
- Mlakar, S.G., Turinek, M., Jakop, M., Bavec, M. and Bavec, F. (2009). Nutrition value and use of grain amaranth: Potential future application in bread making. *Agricultural and Food Sciences*. **6**: 43-53.
- Nawirska-Olszańska, A., Biesiada, A., Sokół-Łętowska, A. and Kucharska, A.Z. (2011). Content of bioactive compounds and antioxidant capacity of pumpkin puree enriched with fruits. *Food Chemistry*. **129(2)**: 512-517. <https://doi.org/10.1016/j.foodchem.2011.04.127>.
- Ocheme, O.B. and Chinma, C.E. (2008). Effects of soaking and germination on some physicochemical properties of millet flour for porridge production. *Journal of Food Technology*. **6(5)**: 185-188.
- Pandey, S.J., Singh, A.K., Upadhyay, D.R. and Mathura, R. (2003). Ascorbate and carotenoid content in an Indian collection of pumpkin (*Cucurbita moschata* Duch. ex Poir.). *Cucurbit Genetics Cooperative Report*. **26**: 51-53.
- Panse, V.S. and Sukhatme, P.V. (1985). Statistical Methods for Agricultural Workers (4th ed.). New Delhi: Indian Council of Agricultural Research (ICAR).
- Ranganna, S. (2019). Handbook of Analysis and Quality Control for Fruit and Vegetable Products (2nd ed.). Tata McGraw Hill, New Delhi. pp. 1112.
- Shaikh, A., Changade, S.P., Dhotre, A.V. and Chopde, S. (2015). Studies on sensory and keeping quality of pumpkin based kheer. *Asian Journal of Dairy and Food Research*. **34(4)**: 270-274. doi: 10.18805/ajdfr.v34i4.6876.
- Shaikh, A., Changade, S.P., Dhotre, A.V. and Datir, R.P. (2017). Compositional characteristics of pumpkin based reconstituted kheer. *Indian Journal of Dairy Science*. **70(1)**: 1-6.
- Suri, D.J., Tanumihardjo, S.A. and Gannon, B.M. (2019). Effects of germination on the mineral bioaccessibility of amaranth. *Journal of Food Composition and Analysis*. **78**: 74-79.
- TechSci Research. (2024). India Ready-to-Mix Market by Type, Share and Forecast 2030. TechSci Research. <https://www.techsciresearch.com/report/india-ready-to-mix-market/1289.html#tab1>.
- Thakur, P., Kumara, K., Ahmeda, N., Chauhana, D., Hyder, R.Q.U.E., Jana, S., Singha, T.P. and Dhaliwal, H.S. (2021). Effect of soaking and germination treatments on nutritional, anti-nutritional and bioactive properties of amaranth (*Amaranthus hypochondriacus* L.), quinoa (*Chenopodium quinoa* L.) and buckwheat (*Fagopyrum esculentum* L.). *Current Research in Food Science*. **4**: 917-925.
- United States Department of Agriculture (USDA). (2019). Food Data Central: Pumpkin, Raw. U.S. Department of Agriculture, Agricultural Research Service.
- Unnikrishnan, V., Bhavadasan, M.K., Nath, B.S., Vedavathi, M.K. and Balasubramanya, N.N. (2000). Payasam and sweet delicacy. *Indian Dairyman*. **52(10)**: 37-42.
- Waghmare, R.B., Annapure, U.S. and Rathod, N.B. (2019). Effect of pumpkin powder incorporation on nutritional and storage quality of traditional milk products. *International Journal of Current Microbiology and Applied Sciences*. **8(10)**: 2054-2062.