Innovations in Noodle Formulation for Enhanced Nutrition: A Review

Sinthiya R., Budriya Sulthana M., Karthikeyini S., Sreemathi T V

Department of Food Processing and Preservation Technology, School of Engineering, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. India

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ABSTRACT

Extrusion is a mechanical operation in which hydrated dough is subjected to controlled pressure and shear to form continuous noodle strands. Noodles are one of the convenient foods produced by the extrusion process. Enhancing the nutritional quality of noodles has gained significant attention in recent years to meet consumer demand for healthier alternatives. Pumpkin (*Cucurbita maxima*) is rich in dietary fiber and antioxidants like β-carotene, macronutrients such as carbohydrates & protein, vitamins, and minerals. Oats contribute significant amounts of β-glucan, a physiologically active soluble fiber known for modulating cholesterol metabolism. Our project primarily focuses on adding pumpkin and oats to the noodles, which improve their nutritional profile and aesthetic appeal because they contain β-carotene and β-glucan.

Keywords: Noodles, Pumpkin, Oats, Extrusion, β-carotene, β-glucan, Dietary fiber.

INTRODUCTION

A global shift toward health-oriented food choices has accelerated the development of value-added products enriched with functional ingredients such as noodles enriched with nutrient-dense ingredients. Noodles remain a staple food worldwide due to their convenience, affordability, and adaptability across various culinary traditions (Natocho et al., 2024). The extrusion process, a preferred method for noodle production, allows for precise control over cooking and textural properties, which are vital for maintaining nutritional integrity and sensory appeal during the manufacturing of enriched noodles (Natocho et al., 2024).

Incorporating pumpkin and oats into noodle formulations is a strategic approach to enhance their health benefits. Pumpkin offers a naturally high concentration of β-carotene and other antioxidants, which enhance both nutritional and functional attributes.

Moreover, oats recognized for their high soluble fiber and protein content, help improve the nutritional profile of noodles by increasing protein levels and enhancing sensory characteristics at optimal incorporation levels.

The process of incorporating these ingredients involves dehydrating pumpkin and oats to create powders, which are then optimized in specific proportions with maida to achieve the desired nutritional and sensory qualities. Response surface methodology (RSM) is a useful tool in this optimization process, allowing for precise control and adjustment of these variables to maximize quality (Sandrin et al., 2018; Zhou et al., 2022). This study seeks to refine the ratio of these components to produce noodles that not only meet health criteria but also retain consumer acceptability through careful optimization of formulation and processing conditions.

REVIEW OF LITERATURE

Noodles

Noodles are widely consumed across many regions of the world, especially throughout Asia, where they form an essential component of daily diets (Xu et al., 2023); yet traditional wheat-based noodles often lack essential nutrients and functional components that contribute to optimal health, being typically low in dietary fiber, vitamins and micronutrients compared with other food sources (Wisdom Library, 2025).

Nutritional Profile

Noodles offer a diverse range of nutritional profiles, influenced by their ingredients and preparation methods (Zhu et al., 2021). The incorporation of nutrient-rich ingredients can significantly enhance the health benefits of noodles, making them a more appealing option for health-conscious consumers (Xu et al., 2023). Noodles serve as an excellent energy source due to their carbohydrate content, making them a staple in many diets worldwide (Park & Lee, 2020). Incorporating high-fiber ingredients into noodle formulations can enhance their nutritional value, addressing dietary fiber gaps prevalent in many diets today (Thakur et al., 2022).

Nutritional Benefits of Pumpkin

Pumpkin (*Cucurbita* spp.) is characterized as a nutrient-dense, low-fat vegetable with exceptional concentrations of carotenoids and measurable antioxidant activity. Pumpkin is recognized for its high dietary fiber content, which contributes to improved digestive health and can aid in maintaining healthy cholesterol levels (Shajan et al., 2024). The antioxidant properties of pumpkin are primarily attributed to its high carotenoid content, particularly beta-carotene, which plays a vital role in combating oxidative stress and supporting overall health (Aldakhoul et al., 2024). Additionally, pumpkin powder has been extensively studied for its antidiabetic properties, demonstrating its ability to enhance insulin secretion, reduce blood glucose levels, and lower the risk of diabetes-related kidney damage (Batool et al., 2022).

Fig.1 Pumpkin

Nutritional Benefits of Oats

Oats contain a diverse set of macronutrients, including β-glucan, high-quality proteins, lipids, and slowly digestible starches, which collectively enhance their nutritional profile. They are especially valued for their high β-glucan content, which has been associated with reducing cholesterol levels and improving cardiovascular health. Oats also offer a superior protein profile compared to many other cereals, with typical protein levels ranging from 12% to 17%. Their amino acid composition is notable for containing relatively high levels of lysine compared to wheat, making oat protein complementary to wheat protein in fortified or composite products (Bhatt et al., 2021).

Both pumpkin and oats have been widely explored in food applications due to their significant nutritional value and growing relevance as sustainable, functional food ingredients. The aim of this formulation is to introduce a value-added noodle variation enriched with these nutrient-dense materials while simultaneously enhancing product quality. Recent studies have shown increasing interest in understanding the development, processing characteristics, and functional properties of composite noodles that incorporate such ingredients.

PROPOSED METHODOLOGY

Preparation of Pumpkin Powder

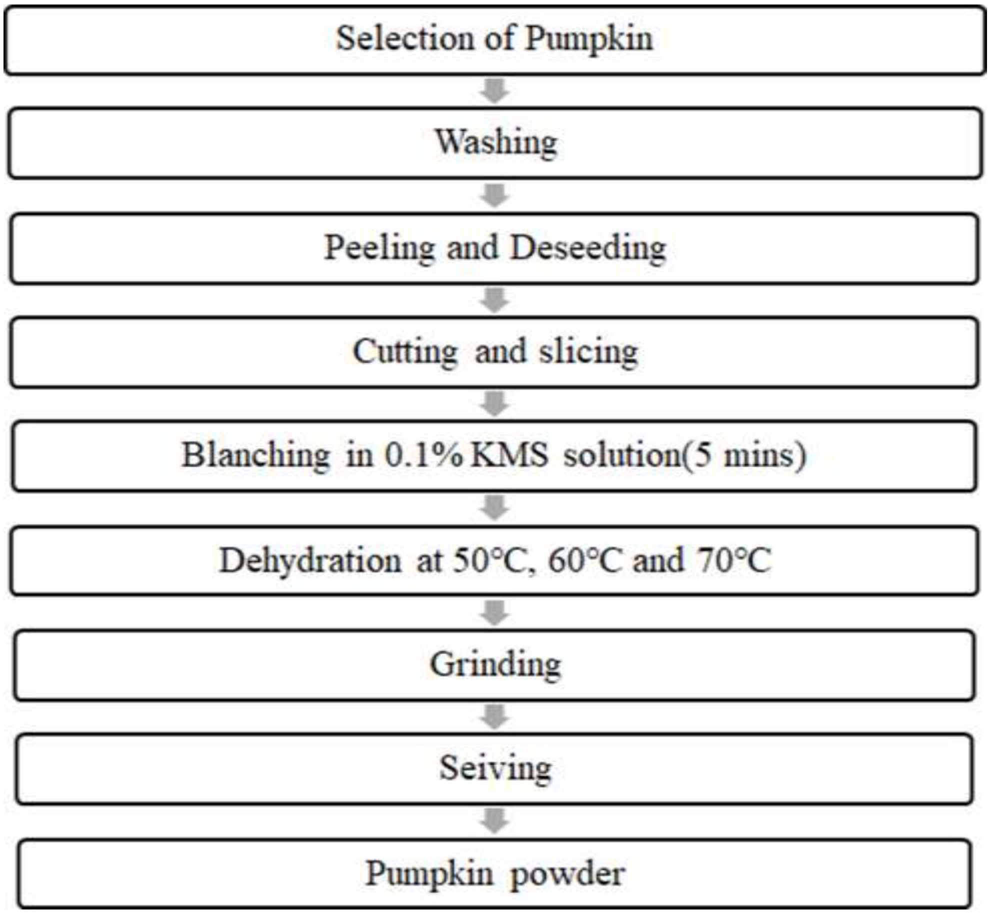

Fig.2 Process Flowchart for Pumpkin powder

Pumpkin Powder

The pumpkin powder is a fundamental preparatory step in developing composite flour and formulating pumpkin oats noodles. In this context, extraction refers to the process of separating usable nutritional components of pumpkin primarily its dry matter, fiber, β-carotene, minerals, and functional compounds by removing moisture through controlled dehydration (Shajan et al., 2024). With moisture levels reaching 85-90%, fresh pumpkin is highly perishable and prone to rapid deterioration, making moisture reduction essential for enhancing stability. Converting fresh pumpkin into a stable, low-moisture powder preserves its nutritional quality, extends shelf life, and facilitates easy incorporation into value-added food products. Dehydration is one of the most effective extraction approaches, as it reduces water activity, retains most heat-stable nutrients, and produces a concentrated, functional powder suitable for composite flour development (Aldakhoul et al., 2024).

In this Tray Drying was chosen over other drying methods because it provides better control over temperature, time, and nutrient retention, which is critical for pumpkin powder preparation (Shajan et al., 2024; Aldakhoul et al., 2024). Pumpkin contains heat-sensitive nutrients such as β-carotene, natural sugars, and volatile compounds, which can easily degrade under high-heat drying methods like sun drying or high-temperature oven drying. Controlled dehydration at temperatures of 50 °C, 60 °C, and 65°C allows moisture removal at a steady rate without causing browning, burning, or nutrient loss, resulting in a higher-quality, nutrient-rich powder (Batool et al., 2022). Using a dehydrator also ensures uniform air circulation, promoting consistent drying, reducing the risk of microbial growth, and improving the shelf stability of the powder. This makes dehydration the most suitable method for producing pumpkin powder that preserves colour, aroma, β-carotene levels and overall functional quality all essential factors for developing high-quality composite flour and noodles.

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Tray Drying Process

Drying is a pivotal and common system of food preservation. It extends shelf life by reducing the humidity content in food to a position that stops microbial growth and slows down chemical responses. The introductory idea of drying involves using heat to dematerialize water from the food, followed by removing humidity through air rotation. Lowering water exertion helps help the growth of corruption and dangerous microorganisms and reduces biochemical changes that beget decay. Proper drying conditions maintain the nutritive quality, colour, flavour, and texture of food products. They also reduce bulk, making storehouse easier and handling better (Batool et al., 2022; Shajan et al., 2024).

By drying the pumpkin using a tray dryer. This system is popular for drying fruits and vegetables in labs and diligence because it's simple, cost-effective, and provides indeed drying. Fresh pumpkins were completely washed with clean water, hulled, deseeded, and sliced unevenly. This assured harmonious heat transfer and humidity prolixity during drying. We dried the pumpkin slices in a tray dryer at controlled temperatures of 50 °C, 60 °C and 65 °C for 10 to 12 hours, depending on the consistence of the slices and drying conditions. These temperatures were chosen for their effectiveness in gradationally removing humidity while minimizing quality loss. Lower drying temperatures help retain heat-sensitive nutrients like β- carotene, while advanced temperatures speed up drying but may slight losses of colours and bioactive composites (Aldakhoul et al., 2024; Shajan et al., 2024). Tray drying effectively lowers humidity content and water exertion, producing a shelf-stable dried product that can be reused into greasepaint form.

Before drying, we treated the pumpkin slices in normal (ambient temperature) water with potassium metabisulphite to stop enzymatic browning and quality during drying. The slices were dipped in a potassium metabisulphite (KMS) result at an attention of 0.1% for 5 to 10 minutes, grounded about vegetable drying and sulphiting treatments. Potassium metabisulphite works as an effective anti-browning agent by inhibiting polyphenol oxidase exertion and reducing oxidation. Also,sulphiting provides antimicrobial protection and improves the stability of colours and sensitive nutrients during drying and storehouse. We chose normal water sulphiting over thermal blanching to avoid heat- related nutrient loss while still controlling enzymatic exertion and conserving quality (Batool et al., 2022; Aldakhoul et al., 2024).

Fig.3 Tray dryer

Preparation of Oats Powder

The preparation of oats powder used a careful processing method to ensure consistent quality, safety, and suitability for use in composite food formulations. First, whole oats were thoroughly cleaned to remove dust, dirt, husk fragments, stones, and damaged grains. This step improves the hygiene of the raw material and lowers the initial microbial load. The Second process the oats were spread evenly in a thin layer on stainless steel trays to ensure even heat distribution during drying. Drying took place in a hot air tray dryer at 110 °C for 2.5 hours. This temperature and time combination effectively dehydrates cereals by quickly reducing moisture, inhibiting microbes, and partially inactivating the enzymes that cause lipid oxidation and quality loss during storage (Kumar et al., 2019; Pathak et al., 2023). After drying, the oats cooled to room temperature to prevent moisture condensation and clumping during grinding. The dried oats were ground in a laboratory grinder until they formed

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a fine powder. The ground oats powder was then sifted through a 200-mesh sieve, which is standard for achieving a uniform and fine particle size. This size improves dispersibility, hydration capacity, and mixing behaviour when added to composite flour systems and noodle recipes (Singh et al., 2021; Verma et al., 2024). Finally, the sieved oats powder was packed in airtight containers and stored in dry conditions until needed for product development and analysis.

Addition of Oats Powder to Pumpkin Powder

Oats powder is incorporated into the pumpkin powder based composite flour at levels of 5-10% to improve the nutritional and functional characteristics of the final noodle formulation (Bhatt et al., 2021; Martínez-Villaluenga & Peñas, 2024). Oats flour is naturally rich in β-glucan, a soluble dietary fiber known for enhancing viscosity, improving water-holding capacity and contributing to better dough handling and texture. When combined with pumpkin powder, oats flour helps balance the composite flour by increasing its protein and fiber content while supporting the structural integrity of noodles during processing.

The mild flavour and fine granulation of oats ensure that its addition does not negatively impact the sensory quality of the final product. Therefore, incorporating 5-10% oats powder provides functional stability and nutritional enhancement without overpowering the pumpkin component, producing a more balanced and health-promoting noodle formulation (Bhatt et al., 2021; Martínez-Villaluenga & Peñas, 2024).

Formulation of Composite Flour

Once the powders are prepared, they are blended with oats flour and maida to obtain a nutritionally enriched composite flour (Bhatt et al., 2021; Martínez-Villaluenga & Peñas, 2024; Shajan et al., 2024). Oats are incorporated primarily for their β-glucan content, soluble fiber functionality, and ability to enhance water absorption, viscosity, and overall nutritional value. Pumpkin powder contributes natural colour, flavour, β-carotene, and dietary fiber, while maida provides the gluten strength and elasticity required for noodle formation.

The formulation step involves determining appropriate blending ratios based on desired nutritional enhancement, dough handling characteristics, extrusion performance, drying behaviour, and final noodle quality. The composite flour is subjected to functional property testing, including moisture content, ash content, swelling capacity, water absorption capacity, and colour analysis, to understand how drying temperature affects the behaviour of pumpkin powder within the composite system. The resulting flour blend must develop a cohesive dough with sufficient viscoelasticity to tolerate extrusion without fracturing. Because the inclusion of pumpkin and oats flour alters the gluten matrix, fine-tuning the formulation is crucial to achieving noodles with acceptable cooking quality parameters, such as cooking loss, water absorption, and texture profile analysis values (Bhatt et al., 2021; Shajan et al., 2024).

Response Surface Methodology (RSM)

To identify the best formulation among variations produced from powders dried at different temperatures, Response Surface Methodology (RSM) is employed as a scientific tool for optimization (Montgomery, 2020; Myers et al., 2016). RSM provides a structured statistical framework that simultaneously evaluates how multiple processing variables influence product responses. In this project, the variables may include drying temperature, the level of pumpkin powder substitution, and the proportion of oats flour, while the responses could include β-carotene retention, β-glucan content, moisture, colour values and noodle quality parameters such as hardness, cohesiveness, and cooking loss.

RSM uses a set of designed experiments, typically based on central composite or Box-Behnken designs, to generate polynomial equations capable of predicting how each factor influences final product quality (Montgomery, 2020). This methodology allows for the scientific selection of the best-performing formulation rather than relying on trial-and-error. Since drying temperature significantly affects the functional properties of pumpkin powder, RSM helps determine the optimal combination that ensures both nutritional enhancement and acceptable sensory and physical quality. Moreover, this approach guides the development of noodles by identifying formulations that achieve superior structural integrity, enhanced β-carotene and β-glucan values, lower cooking loss, and desirable texture upon cooking (Myers et al., 2016).

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Incorporation of Maida in Composite Flour Formulation

In the formulation of pumpkin-oats enriched composite flour, maida serves as the primary base ingredient to provide the structural, functional, and processing characteristics required for noodle production (Hoseney, 2020; Kumar et al., 2022). Maida is preferred over other flours because it contains high levels of gluten-forming proteins, primarily glutenin and gliadin, which develop a strong viscoelastic dough matrix. This gluten network is essential for dough binding, elasticity, and the ability to withstand sheeting, cutting, and drying during noodle manufacture.

The incorporation of pumpkin and oats powders tends to dilute gluten strength because of their higher fiber content and comparatively lower protein functionality. Therefore, the inclusion of maida plays a critical role in maintaining dough integrity, elasticity, and machinability while enabling nutritional enhancement through pumpkin and oats. Furthermore, maida is extensively used in conventional noodle formulations and is considered safe, stable, and suitable for food applications. Its use ensures that the composite flour achieves a desirable balance between nutritional improvement and processing performance, which is necessary for producing high-quality noodles (Hoseney, 2020; Kumar et al., 2022).

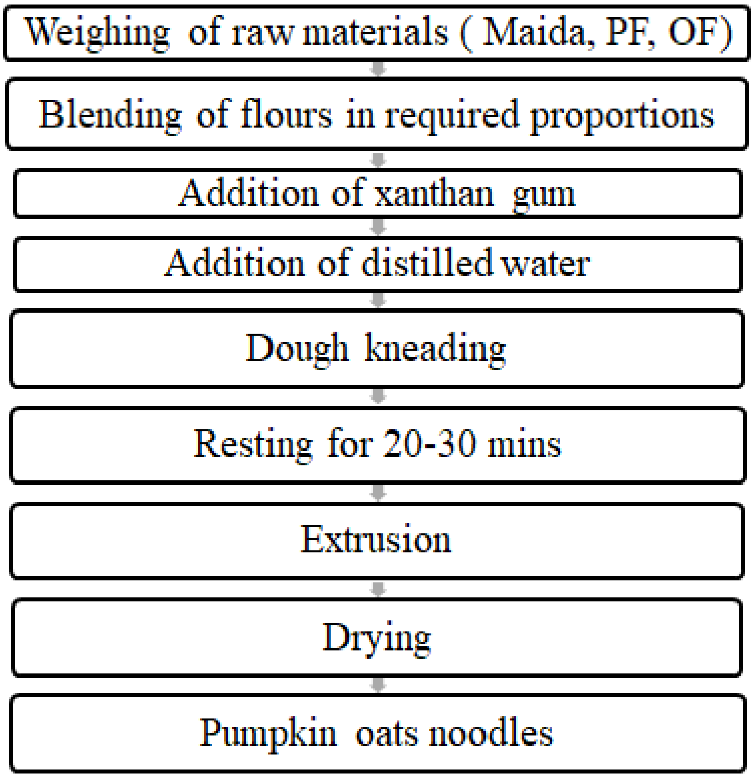

Fig.4 Process Flowchart for Noodles

Noodle Making

Noodle processing is a complex sequence of unit operations that combines ingredient balancing, dough formation, extrusion, cutting, and controlled drying to produce a structurally stable and nutritionally enriched final product (Hoseney, 2020; Kumar et al., 2022). When functional ingredients such as pumpkin powder and oats flour are incorporated into the formulation, their inherent physicochemical properties alter hydration characteristics, gluten development, rheological behaviour, and drying kinetics. Therefore, the noodle-making process must be carefully optimized to ensure that the enriched product maintains superior textural, sensory, and nutritional qualities (Bhatt et al., 2021; Shajan et al., 2024).

Ingredient Mixing and Dough Formation

The preparation of a uniform and consistent dough begins with the blending of maida, pumpkin powder, and oats flour (Hoseney,2020; Bhatt et al., 2021). Maida contributes gluten-forming proteins essential for dough elasticity, while pumpkin and oats introduce dietary fiber, β-carotene, and β-glucan, which significantly increase the water absorption capacity of the composite flour. During mixing, water is added gradually to facilitate proper hydration and interaction between starch, gluten, and the soluble fiber components.

The β-glucan from oats increases dough viscosity, whereas pumpkin fiber enhances swelling and contributes to a slightly denser dough matrix. Despite their nutritional benefits, these components dilute gluten strength, making it essential to maintain an adequate proportion of maida in the blend to support viscoelasticity. The dough is kneaded until a cohesive, smooth structure is achieved, ensuring proper gluten development and uniform distribution of non-wheat components. Proper dough formation is fundamental for maintaining extrusion stability and reducing defects such as breakage or non-uniform strand formation (Martínez-Villaluenga&Peñas, 2024; Shajan et al., 2024).

Extrusion

In noodle production, extrusion functions as the primary shaping operation in which hydrated dough is transformed into continuous strands (Hoseney, 2020; Kumar et al., 2022). In the present study, cold extrusion was adopted, where the dough was processed under ambient temperature conditions without the application of external heat. Within the extruder barrel, the dough was mainly subjected to mechanical shear and compressive forces as it moved through the screw channel towards the die opening.

For pumpkin–oats enriched noodles, the incorporation of pumpkin fiber and oat β-glucan influences dough rheology and flow behaviour during extrusion. Since heat-sensitive bioactive compounds such as β-carotene are prone to degradation at elevated temperatures, low-temperature or cold extrusion is preferred to enhance nutrient retention in non-instant, non-fried noodle products (Bhatt et al., 2021; Shajan et al., 2024). As the extrusion process was carried out at low and nearly constant temperature, temperature variation was minimal and hence not considered a critical processing parameter in this study.

Instead, greater emphasis was placed on maintaining uniform dough consistency and stable extrusion pressure to ensure smooth and continuous strand formation. The noodles extruded through the die exhibited the characteristic colour imparted by pumpkin, while oats contributed to improved structural integrity. Proper control of mechanical parameters resulted in strands with smooth surface texture, controlled porosity, and acceptable mechanical strength (Hoseney, 2020).

Cutting

After extrusion, the continuous noodle strands are cut into uniform lengths to ensure consistency in handling and cooking characteristics (Hoseney, 2020). Uniform cutting is essential to maintain product standardization and to prevent variation in strand length, which can affect packaging and consumer acceptability. Freshly extruded noodles possess high moisture content and are relatively soft; therefore, careful cutting is required to avoid deformation or breakage of the strands during this stage.

For pumpkin–oats enriched noodles, the presence of dietary fiber influences dough texture and strand strength, making precise cutting particularly important. Proper control of the cutting operation helps preserve strand integrity, maintain smooth edges, and ensure uniform appearance prior to subsequent processing steps. Effective cutting contributes to improved product quality and facilitates further drying or storage operations commonly employed in noodle manufacture (Hoseney, 2020; Kumar et al., 2022).

Drying

Drying represents a critical phase in noodle manufacturing, as it determines shelf stability, mechanical strength, colour retention, and cooking quality (Hoseney, 2020; Kumar et al., 2022). Fibre-enriched noodles require controlled drying conditions to minimize nutrient degradation and prevent defects such as cracking or case hardening. The drying phase generally progresses through sequential stages characterized by surface moisture

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removal, internal moisture migration, and final stabilization. The initial stage involves rapid surface moisture removal, which reduces microbial activity and prevents stickiness without causing thermal stress. This is followed by a slower intermediate phase, during which moisture migrates gradually from the core to the surface. Maintaining a moderate temperature gradient during this phase prevents internal fissuring and allows uniform structural stabilization. The final stage completes moisture reduction to storage-stable levels, typically around 8-12%, ensuring that noodles achieve the hardness and brittleness necessary for packaging and long term storage (Shajan et al., 2024; Batool et al., 2022).

Pumpkin powder contributes natural pigments and antioxidants that support colour stability during drying, while the gel forming properties of β-glucan from oats enhance internal moisture distribution and reduce brittleness. The combined effect results in noodles with improved physical structure, reduced strand breakage, and better retention of functional compounds (Bhatt et al., 2021; Aldakhoul et al., 2024).

Cooking Quality Characteristics

The performance of pumpkin–oats composite noodles during cooking reflects the cumulative influence of formulation and processing conditions (Hoseney, 2020; Kumar et al., 2022). Cooking quality is primarily assessed through parameters such as water absorption, structural integrity, and textural behaviour. The increased fiber content from pumpkin and oats enhances the water uptake capacity of noodles, producing cooked strands that are softer yet structurally stable. β-glucan forms a viscous network during heating, contributing to smooth mouthfeel and improving overall cohesiveness (Bhatt et al., 2021; Martínez-Villaluenga & Peñas, 2024).

The presence of dietary fiber helps maintain strand integrity by reducing the loss of solids into the cooking water, resulting in lower cooking loss compared to refined wheat noodles (Bhatt et al., 2021; Shajan et al., 2024). Texturally, the enriched noodles exhibit a balanced firmness and chewiness attributed to the interplay between gluten elasticity and the hydration properties of non-wheat components. The visual appeal of the cooked product is also enhanced by the characteristic yellow-orange hue imparted by pumpkin. Overall, well-optimized processing conditions ensure that composite noodles achieve desirable sensorial and functional qualities without compromising their nutritional value (Martínez-Villaluenga&Peñas, 2024; Hoseney, 2020).

CONCLUSION

The formulation and optimization of pumpkin–oats composite noodles demonstrate the potential of integrating nutrient-rich, functional ingredients into traditional cereal-based products to enhance their health-promoting attributes (Shajan et al., 2024; Bhatt et al., 2021). Incorporation of pumpkin powder contributes substantial β-carotene, dietary fiber, natural pigments, and antioxidant activity, all of which elevate the nutritional and functional value of noodles while imparting a characteristic colour and mild sweetness. Similarly, oats flour provides β-glucan, a soluble dietary fiber known for cholesterol-lowering properties, improved glycemic response, and significant contribution to dough viscosity and water-binding behaviour (Martínez-Villaluenga & Peñas, 2024). The combined addition of these components results in composite noodles with improved nutritional density, enhanced functional properties and flavourable textural characteristics when processed under optimized conditions.

Processing parameters including dehydration of pumpkin at controlled temperatures, proportional blending of composite flours, careful dough development, low-temperature extrusion and multi-stage drying play a crucial role in preserving heat-sensitive nutrients while maintaining structural and sensory integrity (Hoseney, 2020; Kumar et al., 2022). Response Surface Methodology (RSM) supports the optimization of these parameters by identifying ideal formulations that balance nutritional enhancement with acceptable cooking performance, strand integrity, and consumer acceptability (Montgomery, 2020; Myers et al., 2016).

The optimized formulation produced noodles with enhanced hydration capacity, lower cooking loss, and balanced firmness, reflecting improved nutritional and functional performance. These characteristics indicate that the product maintains high quality despite the dilution of gluten normally caused by fiber-rich ingredients. Overall, the findings suggest that pumpkin and oats can be successfully incorporated into noodles without compromising processing efficiency or product stability, thereby creating a viable, value-added food product suitable for health-conscious consumers. The outcomes reinforce the feasibility of developing functional noodles that align with current dietary trends while offering improved nutritional benefits and market potential (Bhatt et al., 2021; Shajan et al., 2024).

REFERENCE

1. Ayustaningwarno, F., Suryaputra, A., & Anjani, G. (2025). A review of enhancing noodle quality: Fortification with micronutrients and substitution with nutrient-dense alternatives. Journal of Food Science, 90, e17677.
2. Pakhare, K. N., Dagadkhair, A. C., &Udachan, I. S. (2018). Enhancement of nutritional and functional characteristics of noodles by fortification with protein and fiber: A review. Journal of Pharmacognosy and Phytochemistry, 7(1), 351-357.
3. (Related review for noodles fortification background) Noodles processing, quality and nutritional aspects: Fortification with essential micronutrients, vitamins, minerals and fiber (2022). The Pharma Journal, 11(7S), S-11-6-215-787.
4. Zurbau, A., Noronha, J. C., Khan, T. A., Sievenpiper, J. L., & Wolever, T. M. S. (2021). The effect of oat β-glucan on postprandial blood glucose and insulin responses: A systematic review and meta-analysis. European Journal of Clinical Nutrition, 75, 1540–1554.
5. Paudel, D., et al. (2021). A review of health-beneficial properties of oats. Journal of Agricultural and Food Chemistry (PMC).
6. Lante, A. (2023). Beta-Glucans of cereals: Functional and technological properties. Comprehensive Reviews in Food Science and Food Safety (PMC).
7. Havrlentová, M. (2011). β-glucans and their significance for the preparation of functional foods: A review. Czech Journal of Food Sciences.
8. Aoe, S. (2021). β-Glucan in foods and health benefits. Nutrients, 14(1), 96.
9. Perspective article: β-glucan as functional ingredient for food industry (Open Access).
10. Article (2015). Structure and characteristic of β-glucan in cereal: A review. Journal of Food Processing and Preservation.
11. Ahmed, Z. (2024). Fundamental opportunities and challenges of nutraceutical noodles enriched with bioactive compounds: A review. Journal of Food Engineering.
12. Farzana, T. (2024). Enhancing prebiotic, antioxidant, and nutritional qualities of noodles with dietary fibers: A review. (PMC).
13. (Emerging, not noodle-specific but relevant to functional foods) Sasanski, D., & Stojanov, R. (2025). Food data in the semantic web: Nutritional resources and applications (review).
14. (Polysaccharide applications) Oliveira, L. S. de., et al. (2025). Edible polysaccharides as carriers for phenolics and pigments in food formulations (review).
15. (Nanotechnology bioavailability review) Ul Alam, M. A., et al. (2023). Nanotechnology applications to improve bio-accessibility of lycopene: A review
16. Lerdluksamee, C. (2025). Techno-functional, nutritional, and sensory properties of pumpkin-flour enriched dried egg noodles. Food Research/ScienceDirect.
17. Manalu, M., Julianti, E., &Romauli, N. D. M. (2024). Composite flour formulation made from yellow pumpkin, purple sweet potato, corn and other flours for replacement of wheat flour. Food Quality and Humanization.
18. Altaf, A. (2025). Phytochemical potential and biological activity of pumpkin: a review. Fish & Shellfish Nutrition (Wiley).
19. Arshad, M. T., et al. (2025). Exploring the nutritional, rheological, and textural attributes of pumpkin flour in composite formulations. PubMed Central.
20. da Silva Indrianingsih, A. W., et al. (2024). Physicochemical properties, antioxidant activities and β-carotene content of pumpkin-enriched bakery products. Food Chemistry / ScienceDirect.
21. Alija, D., Olędzki, R., Nikolovska Nedelkoska, D., et al. (2025). The addition of pumpkin flour impacts the functional and bioactive properties of soft wheat composite flour blends. Foods (MDPI).
22. Aydin, E., Turgut, S. S., Aydin, S., et al. (2023). Development and optimization of gluten-free noodles using byproducts of okra and pumpkin seeds. Foods

23. Gavril, R. N., et al. (2024). Pumpkin and pumpkin by-products: a comprehensive review of composition, bioactives and applications. Foods (MDPI).
24. Ha, M., et al. (2025). Effect of thermal treatment on nutritional and sensory properties of sweet pumpkin flour. PubMed Central.
25. Indrajaya / Ozgören, E. (2022). Physicochemical, microstructure and cooking quality of noodles with 5–10% pumpkin powder substitution. Latin American Applied Research (LAAR).
26. Fitriani, F. (2025). Effect of dried noodle with Patin fish and pumpkin flour substitution on nutritional outcomes (intervention study.
27. McArthur-Floyd, M., et al. (2024). Valorization of pumpkin flour in cookie formulations: nutritional and mineral improvements. EAS Journal of Nutrition and Food Science.
28. ResearchGate — Development of pumpkin powder incorporated instant noodles (thesis / conference project; methodologies and sensory results; ca. 2020–2021)
29. Potravinarstvo / Malá et al. (2021). Effect of pumpkin powder incorporation on pasta/pasta-type products: cooking, textural and sensory changes. Potravinarstvo journal (dataset/analysis).
30. ACS Food Science & Technology (2025). Carotenes from pumpkin flesh and peel: review of extraction, stability and applications. ACS Publications.