JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

NUTRITIONAL AND FUNCTIONAL POTENTIAL OF FINGER MILLET AND MANGO SEED KERNEL POWDER IN THE DEVELOPMENT OF CHOCOS: A REVIEW

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ABSTRACT

Finger millet (*Eleusine coracana* L.), commonly known as ragi, is a nutrient-dense cereal characterized by its relatively high dietary fibre, calcium, mineral and polyphenol contents. Mango seed kernel, a major by-product of mango processing, contains carbohydrates, starch, fat, protein, dietary fibre and bioactive compounds and has therefore attracted interest as a potential value-added food ingredient. The combination of finger millet and mango seed kernel powder in chocos provides an opportunity to develop a nutrient-oriented cereal product while utilizing an underexploited mango-processing by-product. This review summarizes the nutritional composition, processing characteristics, functional properties, health-related potential and food applications of finger millet and mango seed kernel powder, with particular emphasis on their relevance to chocos and extruded cereal products. Finger millet contributes dietary fibre, calcium, minerals and phenolic compounds, whereas mango seed kernel provides starch, dietary fibre, fat, protein and phenolic constituents. Processing treatments such as soaking, blanching, drying, milling and extrusion can influence the nutritional, physicochemical and functional properties of both ingredients. Research on extruded products containing finger millet and mango seed kernel flour demonstrates the feasibility of incorporating these ingredients into value-added cereal products. However, excessive incorporation of mango seed kernel powder may influence colour, flavour, texture and consumer acceptability, while its processing requires attention to tannins and other antinutritional components. Overall, the incorporation of finger millet and mango seed kernel powder represents a promising approach for developing nutrient-dense chocos while supporting food by-product utilization and value addition.

Keywords: Finger millet; Mango seed kernel powder; Chocos; Extruded food; Functional properties; Nutritional composition; Food by-product utilization.

INTRODUCTION

Finger millet (*Eleusine coracana* L.) is an important small millet cultivated mainly in Africa and Asia. It has received increasing attention because of its nutritional density, particularly its dietary fibre, calcium, minerals and phytochemicals. Finger millet contains approximately 65–75% carbohydrate, 5–8% protein, 1–2% fat, 15–20% dietary fibre and 2.5–3.5% minerals, although composition varies with cultivar and processing conditions (Kaur et al., 2024).

Finger millet is also characterized by the presence of polyphenols and other bioactive compounds. Reviews have reported its potential antioxidant, hypoglycaemic and other health-related properties, although the strength of evidence differs among outcomes and further human intervention studies are required for firm health claims (Shobana et al., 2013; Kaur et al., 2024).

Mango (*Mangifera indica* L.) processing generates substantial quantities of seeds, which are frequently discarded despite containing useful nutritional and bioactive components. The seed kernel contains carbohydrates, starch, lipids, protein, minerals and phenolic compounds and can therefore be converted into flour or powder for food applications (Arogba, 1997; Jahurul et al., 2015). Recent research has further demonstrated that mango seed kernel flour can exhibit useful nutritional and functional properties. A 2025 study on Arumanis mango seed kernel flour reported approximately 74.15% carbohydrate, 7.38% protein, 9.67% fat, 12.15% dietary fibre and 52.15% starch, together with measurable phenolic and antioxidant activity (Wiadnyani et al., 2025). The combination of finger millet and mango seed kernel powder in chocos is therefore of interest from both nutritional and food-product-development perspectives. Finger millet can contribute minerals, fibre and phytochemicals, whereas mango seed kernel powder provides starch, fibre and other nutrients while simultaneously contributing to the utilization of a food-processing by-product. Research has already demonstrated the feasibility of using both ingredients together in an extruded food product, although the formulation also contained rice and soybean (Sapariya et al., 2020).

NUTRITIONAL COMPOSITION

A)FINGER MILLET

Finger millet is particularly recognized for its calcium content. A classical review reported approximately 344 mg calcium/100 g and 408 mg potassium/100 g, together with comparatively high dietary fibre and mineral content (Shobana et al., 2013).

More recent reviews indicate that the proximate composition of finger millet generally consists of approximately 65–75% carbohydrate, 5–8% protein, 1–2% fat, 15–20% dietary fibre and 2.5–3.5% minerals. The grain also contains phenolic compounds, flavonoids and tannins, although the levels vary according to genotype, colour, geographical origin and processing conditions (Kaur et al., 2024). The relatively high fibre and mineral contents make finger millet a suitable ingredient for the development of nutrient-dense cereal-based foods. Its low fat content and gluten-free nature further increase its applicability in diversified food products (Kumar et al., 2016; Saleh et al., 2013)

B)MANGO SEED KERNEL POWDER

Mango seed kernel is obtained from the hard seed generated during mango consumption and processing. The seed is separated from the fruit pulp, the outer shell is removed to recover the kernel, and the kernel can be subjected to pretreatment, drying and milling to obtain mango seed kernel flour or powder.

Processing is important because raw mango kernels can contain tannins and may develop undesirable browning. Research has investigated soaking, blanching and different drying methods to improve the quality and usability of mango seed kernel flour (Zikri et al., 2022).

A recent study investigated water soaking, hot-water soaking and salt soaking combined with blanching, followed by convective, heat-pump or freeze drying. Water soaking was selected as a suitable pretreatment, while freeze drying showed the greatest retention of nutritional and bioactive characteristics among the drying methods examined (2025).

FUNCTIONAL PROPERTIES

A)FINGER MILLET

Finger millet contains dietary fibre and polyphenols that have been associated with antioxidant and other potentially beneficial biological activities. Reviews have described possible antidiabetic, antioxidant, antimicrobial and cardiovascular-related effects; however, some of these findings are based on in-vitro or animal studies and should not be presented as established clinical effects (Shobana et al., 2013; Kaur et al., 2024). Processing can influence these characteristics. Soaking, germination, malting, fermentation, popping and milling may alter nutrient availability and reduce antinutritional factors such as phytate and tannins (Kaur et al., 2024)

B)MANGO SEED KERNEL POWDER

Mango seed kernel flour demonstrates several functional properties relevant to food formulation, including water absorption, oil absorption, emulsification, foaming and gelling.Arogba reported functional properties of processed Nigerian mango kernel flour and demonstrated that processing could alter its composition and functional behaviour. Importantly, the study also showed that soaking and thermal treatment could reduce a considerable proportion of the tannin content (Arogba, 1997).

Research on mango-kernel/wheat flour blends has shown that mango kernel flour can increase water- and oil-absorption characteristics, although excessive incorporation may negatively influence some emulsifying and foaming properties (Hashmi et al., 2016). These properties are important when mango seed kernel powder is incorporated into chocos because water absorption, starch behaviour and particle characteristics can influence dough development, extrusion behaviour, expansion and final texture.

FINGER MILLET AND MANGO SEED KERNEL POWDER IN EXTRUDED FOODS

Extrusion is an important technology for producing ready-to-eat cereal products. During extrusion, a mixture of cereal and other ingredients is subjected to heat, pressure, shear and mechanical processing, resulting in changes in starch structure, moisture and product texture.

A particularly relevant study by Sapariya et al. (2020) developed a nutrient-rich extruded product using rice, finger millet, soybean and mango seed kernel flour. The optimized formulation contained 75% rice, 5% finger millet, 7.5% soybean and 12.5% mango seed kernel flour. The extrusion process was conducted at a die temperature of 120 °C, screw speed of 275 rpm and feed moisture of 18%. The selected formulation increased true protein by 35.15% compared with the control product.

This study provides direct research support for the concept of combining finger millet and mango seed kernel flour in an extruded cereal product. However, because it also contained rice and soybean, it should not be cited as evidence that the exact finger-millet–mango-seed-kernel chocos formulation has already been scientifically established.

CHOCOS AS A VALUE-ADDED CEREAL PRODUCT

Chocos are ready-to-eat cereal products generally produced through processes such as mixing, extrusion, drying and coating. Extrusion allows cereal flours to be transformed into expanded, crisp products with desirable shapes and textures.

Research and institutional product-development work have demonstrated the feasibility of producing millet-based chocos through extrusion. The Indian Institute of Millets Research has reported development of finger-millet chocos using millet flour, corn flour, maida and cocoa powder, followed by extrusion and drying.

A 2021 study also developed value-added chocolates using finger millet milk and reported increased protein, fibre, calcium and iron compared with control chocolates, demonstrating the potential of finger millet in chocolate-flavoured snack products (Kanchana & Parameshwari, 2021). For your project, however, the product should be described scientifically as a **finger-millet-based chocos formulation incorporated with mango seed kernel powder**, rather than claiming that previous studies have already established your exact formulation.

FOOD APPLICATIONS OF MANGO SEED KERNEL

Mango seed kernel flour has been investigated in several food applications.Research has demonstrated its use in **biscuits and cookies**, with acceptable products reported at selected substitution levels (Hashmi et al., 2016).

Mango seed kernel flour has also been incorporated into **cakes**, demonstrating its potential as a partial wheat-flour substitute (Das et al., 2019). Other studies have evaluated mango seed kernel powder in **biscuits, biscuit cakes and baked products**, with lower incorporation levels generally providing better sensory acceptance (Chaudhary & Chhabra, 2023).

PROCESSING CHALLENGES

Finger millet contains phytate and tannins, while mango seed kernel also contains tannins. Processing treatments such as soaking, blanching, germination and thermal processing can reduce these compounds (Kaur et al., 2024; Arogba, 1997).

Mango seed kernel powder can influence the colour, aroma, taste and texture of food products. Studies on mango-kernel biscuits and other products demonstrate that sensory acceptability can decrease at higher incorporation levels (Hashmi et al., 2016; Chaudhary & Chhabra, 2023).

The amount of fibre, starch and moisture in the formulation can affect extrusion expansion, density, hardness and crispness. Therefore, the optimum incorporation level of mango seed kernel powder cannot simply be selected from a biscuit or cake study; it needs to be optimized specifically for **chocos extrusion**.

Variety, processing method, drying temperature and particle size can alter mango seed kernel flour properties. Similarly, cultivar and processing influence finger millet composition. Standardization is therefore essential for obtaining reproducible chocos quality (Zikri et al., 2022; Kaur et al., 2024).

FUTURE PROSPECTS

Future research can focus on optimizing the proportion of finger millet and mango seed kernel powder specifically for chocos. Studies should examine the influence of incorporation level on expansion ratio, bulk density, hardness, crispness, colour, water absorption, nutritional composition and sensory acceptability.

Extrusion conditions such as barrel temperature, screw speed, feed moisture and die characteristics should also be optimized. The previous study involving rice, finger millet, soybean and mango seed kernel flour demonstrates that these ingredients can be successfully processed through extrusion, providing a foundation for further formulation research (Sapariya et al., 2020).

Future studies should also evaluate the shelf life, oxidative stability, microbial quality and consumer acceptability of mango-seed-kernel-incorporated chocos.

From a sustainability perspective, converting mango seed kernels into food ingredients provides an opportunity to reduce the disposal of a major fruit-processing by-product and generate additional value from the mango processing chain.

CONCLUSION

Finger millet and mango seed kernel powder represent two promising ingredients for the development of value-added cereal foods. Finger millet provides dietary fibre, calcium, minerals and phenolic compounds, whereas mango seed kernel powder contributes carbohydrate, starch, fat, protein, dietary fibre and bioactive constituents. Research has demonstrated the use of finger millet in cereal and chocolate-type products and the use of mango seed kernel flour in biscuits, cakes, extruded products and other value-added foods. Most

importantly, a research study has already demonstrated the feasibility of incorporating both finger millet and mango seed kernel flour into an extruded product, supporting the scientific basis for further development of a chocos formulation. However, the **exact finger millet + mango seed kernel powder chocos formulation remains an area for product-specific optimization**. Future research should therefore establish the appropriate incorporation level and extrusion conditions while evaluating nutritional, functional, sensory and storage characteristics. Such a product could provide a promising combination of nutritional enhancement, food innovation and mango by-product utilization.

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