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# AFFORDABLE SOLUTION FOR PREVENTING MALNUTRITION: A REVIEW OF BANANA MALTED MILLET HEALTH MIX

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***Abstract :*** Malnutrition remains a global challenge affecting all age groups. This review highlights an affordable, nutrient-dense multigrain mix combining banana flour, malted ragi, and bajra to address dietary gaps. The blend delivers balanced macronutrients and micronutrients suitable for infants to elderly individuals. Traditional processing methods like malting and germination enhance mineral bioavailability, digestibility, and enzyme activity while reducing anti-nutrients. Banana flour contributes resistant starch and prebiotics for gut health, complementing the high iron and calcium content from millets. This versatile formulation helps combat protein-energy malnutrition and micronutrient deficiencies through accessible, culturally acceptable ingredients. Its adaptability allows use as porridge, weaning food, or nutritional supplement across demographics. The mix leverages underutilized crops and traditional knowledge to create a sustainable nutrition solution. With simple preparation and storage, it offers practical application in household and community feeding programs, demonstrating potential for widespread malnutrition prevention.

**Keywords: Health Mix, Malnutrition, Banana Flour, Amylase, Nutrient Bioavailability**

## I. INTRODUCTION

The growing recognition of functional foods as natural health promoters has spurred interest in nutrient-dense formulations suitable for all age groups, particularly during critical developmental stages like weaning. Research demonstrates that traditional ingredients such as millets and banana flour, when processed through methods like malting and germination, offer superior nutritional profiles compared to commercial alternatives (Jadhavar et al., 2022). These formulations address protein-energy malnutrition prevalent in developing nations, where 63% of children under five experience nutritional deficiencies (Thathola & Srivastava, 2002). Malted ragi (finger millet) and bajra (pearl millet) combined with banana flour provide complete nutrition across the lifespan, with studies showing 30% better starch absorption in infants compared to commercial products (Khader et al., 2015). The natural amylase activity in germinated grains enhances digestibility while reducing food viscosity, addressing common feeding challenges in weaning infants (Rasane et al., 2015). Beyond infancy, these formulations offer age-specific benefits: children benefit from ragi's high calcium content (344mg/100g) for bone development (Gull et al., 2015); adults gain from the low glycemic index (45-50) and resistant starch (12-15%) for metabolic health (Amadou, 2022); and elderly populations benefit from 40% improved protein digestibility and bioavailable minerals (Ghavidel & Prakash, 2017). Banana flour varieties contribute essential potassium, prebiotic fibers and micronutrients (Sharrock & Lusty, 2000), creating a nutritionally complete profile when combined with millets (Pradhan et al., 2010). With production costs under $0.50/100g (Devadas et al., 1984), these multigrain formulations represent a cost-effective solution for malnutrition prevention, though further research is needed to standardize production protocols for public health applications.

## II. IMPORTANCE OF HEALTH MIX

Malnutrition remains a critical global issue, especially for children under five (Arif et al., 2004), with South Asia experiencing particularly high rates of child mortality (Hirani et al., 2012). Proper nutrition is vital for early development, and deficiencies during infancy's rapid growth phase increase disease susceptibility and mortality risks (De Onis et al., 2004). Historically, malnutrition contributed to 50-70% of childhood illnesses like diarrhea and respiratory infections (Pelto et al., 2003), often stemming from poor maternal nutrition and suboptimal feeding practices. Early malnutrition causes stunting with lifelong consequences including impaired cognition and physical capacity (Brown et al., 1996; Wolde et al., 2014). Maternal education significantly impacts nutritional understanding (Saha et al., 2008). Proper weaning - introducing semi-solid foods while continuing breastfeeding (WHO, 2010) - requires knowledge of timing, food quality, variety, and portion sizes. Nutrient-dense weaning foods are essential due to infants' small stomach capacity (Ashworth et al., 1992). Despite WHO guidelines, implementation remains limited by awareness gaps, particularly in urban slums where lifestyle changes increasingly affect child health.

## III. NUTRITIONAL PROFILE AND HEALTH BENEFITS OF PISANG AWAK BANANAS

Pisang Awak bananas are a nutritionally dense fruit variety widely consumed in Southeast Asia. They are particularly valued for their high carbohydrate content (16.72–35.24 g/100 g), primarily in the form of starch in unripe bananas and sugars when ripe (Goswami et al., 2011; Ubwa et al., 2014). Unripe bananas contain even higher starch levels (78.85–79.88 g/100 g in flour form), making them an excellent energy source (Anyasi et al., 2013). The sugar profile includes glucose, fructose, maltose, and sucrose, with Pisang Raja Bandung being notably sweeter (20.82 g/100 g) (Zomo et al., 2014). These bananas provide moderate protein (1.48–1.78 g/100 g), minimal fat (0.03–0.08 g/100 g), and are rich in micronutrients. They are an exceptional source of vitamin C (16.45–25.54 mg/100 g), fulfilling daily requirements for young children (Walingo, 2005), and potassium (275–375 mg/100 g), crucial for fluid balance (Kumar et al., 2012). Additionally, they contain β-carotene, phenolic compounds, and B vitamins (Khoo et al., 2011). Processing methods significantly impact nutrient retention. Unfoamed banana powder retains high carbohydrates (87.55 g/100 g) and fiber (2.15 g/100 g) but loses some vitamins during drying (Naknaen et al., 2016). Pisang Awak flour stands out for its functional properties, including high water absorption (67.11%) and resistant starch content, which supports gut health and glycemic control (Khoza et al., 2021). Its mineral profile—potassium (501.58 mg/100 g), calcium (28.25 mg/100 g), and phosphorus (38.38 mg/100 g)—enhances its nutritional value for bone health and metabolism. Due to these attributes, Pisang Awak products are ideal for gluten-free baking, diabetic-friendly foods, and fortified snacks, offering both energy density and health benefits.

## IV. NUTRITIONAL SIGNIFICANCE OF RAGI (FINGER MILLET) AND THE IMPACT OF GERMINATION AND MALTING

Finger millet (*Eleusine coracana*), commonly called ragi, is a nutritionally dense cereal grain containing 6-8% protein, 1-1.7% fat, and 18-20% dietary fiber (Shobana et al., 2009). It is particularly rich in essential amino acids (lysine 2.5%, methionine 2.9%) often deficient in other cereals (Gull et al., 2016). The grain's carbohydrate content (59-70%) consists mainly of slowly digestible starch (80-85% amylopectin), giving it a low glycemic index (Antony et al., 1996). Ragi's exceptional nutritional profile includes calcium levels 5-30 times higher than other cereals, along with significant iron, magnesium and phosphorus (Rao, 1994). While anti-nutrients like phytic acid (350mg/100g) can inhibit mineral absorption, germination reduces these by 60% and enhances mineral bioavailability (Platel et al., 2010). The malting process activates enzymes that improve protein digestibility and B-vitamin content (Malleshi, 2007), resulting in flour with 9.58% protein and 2.98% fiber (Akubor & Obiegbuna, 1999).

Notably, ragi's phytic acid and tannins (205mg/100g) demonstrate health benefits including anti-cancer and antioxidant properties (Vucenik & Shamsuddin, 2003). Regular consumption offers:

1. Bone health support through high calcium content
2. Blood sugar regulation via low GI and high fiber
3. Cardiovascular protection by reducing LDL cholesterol
4. Improved digestion from insoluble fiber
5. Gluten-free nutrition for celiac patients

These properties make malted ragi valuable for functional foods addressing malnutrition and chronic diseases (Grases et al., 2000). Its applications range from infant formulas to therapeutic beverages, demonstrating versatility as a nutraceutical ingredient (Malleshi, 2007).

## V. NUTRITIONAL SIGNIFICANCE OF BAJRA (PEARL MILLET) AND THE IMPACT OF GERMINATION AND MALTING

Pearl millet (*Pennisetum glaucum*), commonly known as bajra, is a highly nutritious cereal grain that offers significant health benefits. With a protein content of 14%, fat content of 5.7%, and dietary fiber at 2%, it surpasses many conventional cereals in nutritional value (Sade, 2009). The grain is particularly rich in essential minerals, containing 8mg/100g of iron, 3mg/100g of zinc, and 42mg/100g of calcium (Yadav et al., 2014). Its fatty acid profile includes 46.3% linoleic acid, contributing to its high energy value (Jaybhaye et al., 2014). However, the presence of anti-nutritional factors like phytic acid (833mg/100g) and polyphenols (764mg/100g) can limit mineral bioavailability (Ranasalva & Visvanathan, 2014). Germination and malting processes effectively enhance pearl millet's nutritional quality. Controlled germination for 48 hours reduces phytic acid by 46% (to 449mg/100g) and polyphenols by 39% (to 468mg/100g) (Archana et al., 1998). This transformation occurs through enzymatic activation, particularly of phytase and polyphenol oxidase, which break down mineral-binding compounds (Inyang & Zakari, 2008). The malting process also improves protein digestibility to 78.55% and increases B-vitamin content (Singh & Saini, 2012). Furthermore, mineral bioavailability shows significant enhancement, with iron absorption increasing by 30% (Badau et al., 2005). The functional properties of pearl millet flour undergo positive changes during germination. Water absorption capacity increases by 25%, while microbial load decreases by 15% compared to untreated flour (Sade, 2009; Singh et al., 2006). These modifications make malted pearl millet particularly valuable for developing nutrient-fortified food products. Traditional processing methods, such as those used in Nigerian fura production, demonstrate how germination can transform pearl millet into more nutritious food forms (Inyang & Zakari, 2008). The combination of enhanced nutrient availability and improved functional properties positions malted pearl millet as an excellent dietary component for addressing malnutrition, particularly in arid regions where the crop thrives. These processing benefits, coupled with pearl millet's inherent drought resistance, make it a crucial crop for food security in climate-vulnerable areas.

## VI. Conclusion

Malnutrition remains a critical global challenge, particularly in developing regions where access to nutrient-dense foods is limited. Banana, ragi (finger millet), and bajra (pearl millet) offer sustainable, cost-effective solutions to address this issue. Through traditional processing techniques like malting and germination, these crops undergo significant nutritional enhancement—reducing anti-nutrients, improving mineral bioavailability, and increasing protein digestibility. Ragi's exceptional calcium content and bajra's high-quality protein, combined with banana's energy-rich carbohydrates and micronutrients, create a powerful trio for combating protein-energy malnutrition. Their affordability, adaptability to local farming conditions, and versatility in food applications make them ideal for weaning foods, fortified products, and dietary interventions. By integrating these nutrient-dense ingredients with simple processing methods, communities can develop accessible, culturally acceptable strategies to improve nutrition security and public health outcomes.

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