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ORIGINAL PAPER

Improve children's nutrition status with low cost food

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Malnutrition is a public health problem. Globally, 149.2 million children below five are stunted, 45.4 million children are wasted and 38.9 million children are overweight. Nutritionists describe malnutrition as all kinds of nutritional deficiencies caused by food insecurity, resulting in deficiency, excess or imbalance in the intake of micro/macro-nutrients in the diet. The number of children with stunting is declining in all regions except in Sub-Saharan Africa (UNICEF/WHO, 2021). India accounts for the highest proportion of stunted (31 per cent) and wasted children (51 per cent) and under-five deaths (16 per cent) (FAO, IFAD, UNICEF, WFP and WHO, 2019; UNICEF, 2019). Young malnourished children are affected by compromised immune systems by succumbing to infectious diseases and are prone to cognitive development delays, damaging long term psychological and intellectual development effects, as well as mental and physical development that is compromised due to stunting (Black et al., 2008). Thus, to address malnutrition in India and Sub-Saharan Africa, low-cost but nutritious foods for infants and children are suggested with the following recipes here under:

PREPARATION OF FOOD MATERIAL

The preparation of germinated soybean flour, amaranth grain flour and ripe papaya powder were done in accordance with the standard procedures of Wang *et al.* (2015), Tanimola *et al*. (2016) and Attri *et al*. (2018) in Fig. 1, 2 and 3, respectively. The flours of soybean, refined wheat and amaranth grain were roasted separately in a nonstick pan for 2-3 min till brown. The muffin mix was formulated by mixing the dried ingredients according to the respective recipe. The muffin mix was packed in tightly closed containers and kept under ambient condition for nutrition evaluation and preparation of ready-to-save muffin mix. Refined oil was used during the preparation of muffin mix for serving only not in the dried mix.

Germinated soybean flour

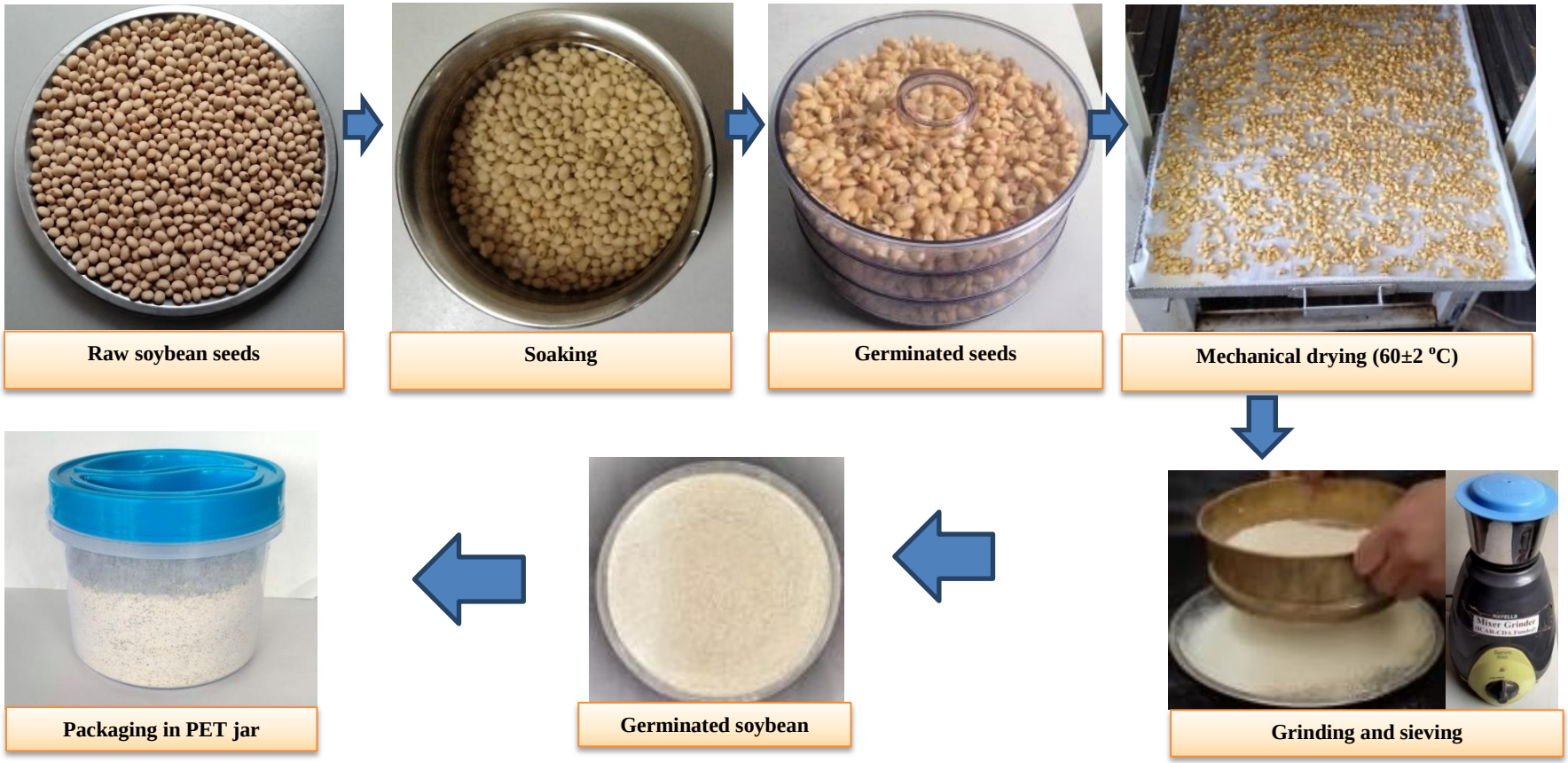

Plate 1: Unit operations for preparation of germinated soybean flour

Amaranth grain flour

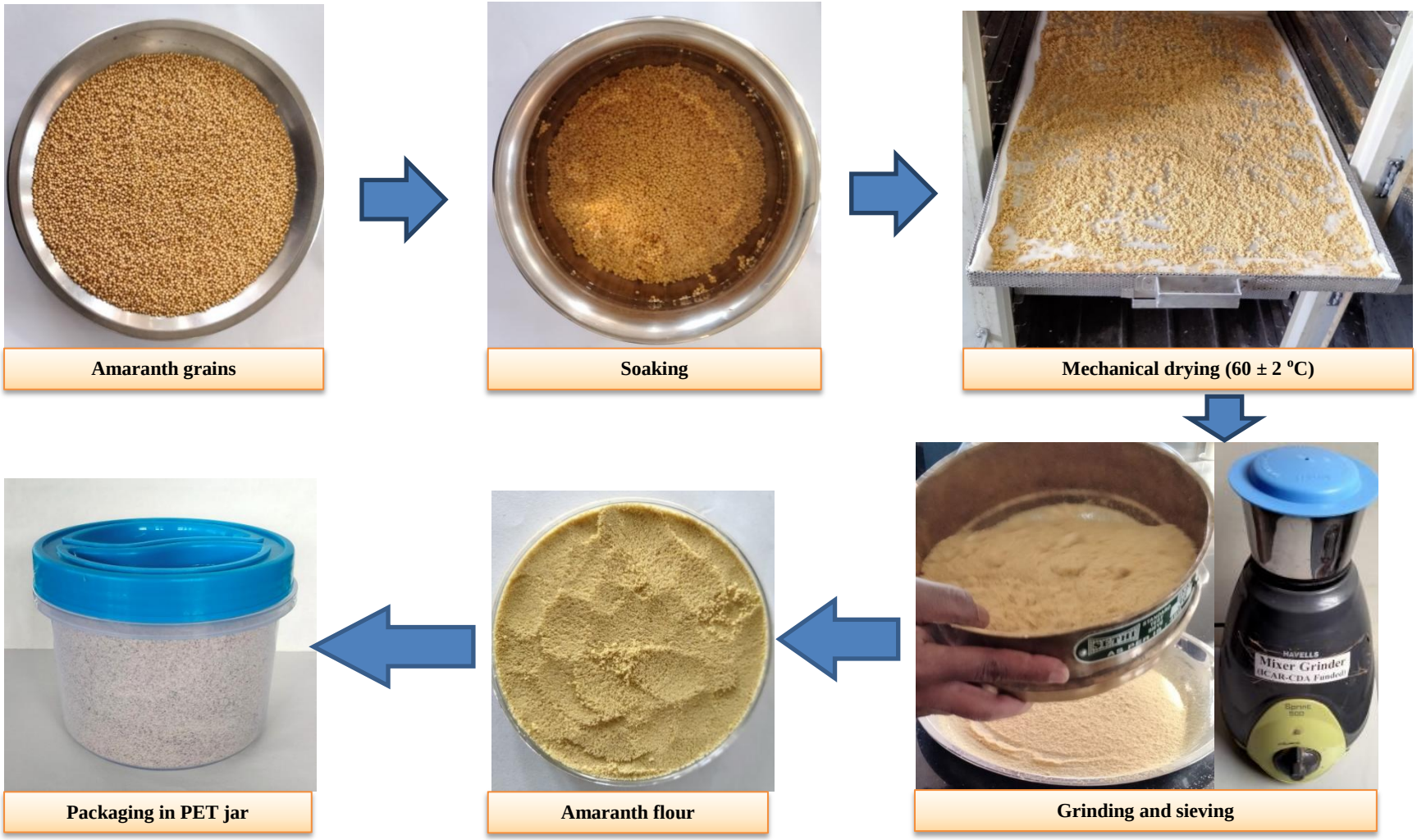

Plate 2: Unit operations for preparation of amaranth grain flour

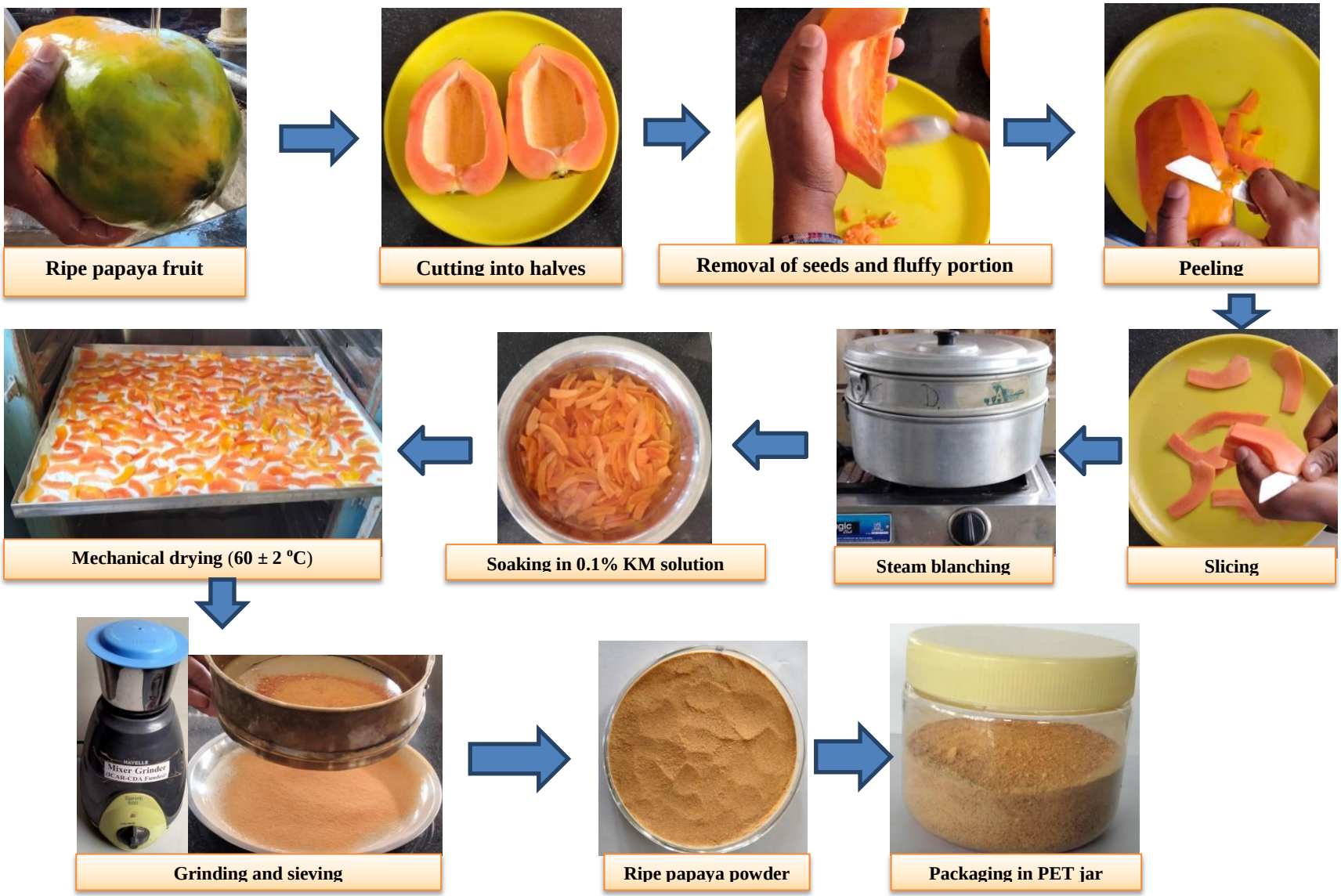

Plate 3: Unit operations for preparation of ripe papaya powder

Recipe 1: Protein Rich Instant Muffin Mix

Ingredients: Refined wheat flour (45 g), soybean flour (40 g), papaya powder (15 g), baking powder (10 g), baking soda (0.75 g), skimmed milk powder (45 g) and sugar powder (58 g) and refined oil (16 mL)

Nutrition composition of dried Protein Rich Instant Muffin Mix

Nutrients	Appropriate composition per 100 g
Moisture (%)	5.62
Protein (%)	26.69
Fat (%)	5.21
Fibre(%)	5.10
Carbohydrates	56.52
β-carotene (mg/100 g)	1.88
Ash (%)	5.96
Total energy value (Kcal/100 g)	359.33

Preparation procedure

A mix of 100 g was mixed with refined oil and 50 mL of water in a bowl with constant stirring to batter consistency. The batter was poured into muffin cups and baked in an oven at 150 ^{o}C for 50 minutes till light brown. The ready-to-save muffins were saved lukewarm to the children. This recipe is suitable for children in the age group of 1-5 years (Chuwa, 2022)

Recipe 2: Iron Rich Instant Muffin Mix

Ingredients: Refined wheat flour (45 g), amaranth grain flour (40 g), papaya powder (15 g), baking powder (10 g), baking soda (0.75 g), skimmed milk powder (45 g) and sugar powder (60 g) and refined oil (16 mL)

Nutrition composition of dried Iron Rich Instant Muffin Mix

Nutrients	Appropriate composition per 100 g
Moisture (%)	3.27
Protein (%)	25.25
Fat (%)	4.63
Fibre(%)	4.76
Carbohydrates	62.17
β-carotene (mg/100 g)	2.46
Iron (mg/ 100 g)	11.35
Ash (%)	4.68
Total energy value (Kcal/100 g)	372.31

Preparation procedure

A mix of 100 g was mixed with refined oil and 50 mL of water in a bowl with constant stirring to batter consistency. The batter was poured into muffin cups and baked in an oven at 150 ^{o}C for 50 minutes till light brown. The ready-to-save muffins were saved lukewarm to the children. This recipe is suitable for children in the age group of 1-5 years (Chuwa, 2022)

CONCLUSION

The main food ingredients used in these recipes are rich sources of protein (soybean), iron (amaranth grain) and β-carotene (papaya). Therefore, the products formulated (muffin mix for serving) are the richest source of nutrients, especially protein content (25.25 %) and iron (11.35 %) which can solve the problem of macro and micronutrient deficiency, especially Protein Energy Malnutrition (PEM) and Iron Deficiency (ID). Soaking and germination help to remove antinutritional factors, soaking papaya in KMS solution help to prevent enzymatic browning and roasting of amaranth grain and soybean flours help to improve taste and remove beany flavour for good quality of the final products. The authors recommended the recipes to the Government of India and different agencies to eradicate malnutrition in young children.

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