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# Energy Rich Composite Millet and Soybean based Malted Weaning Mix: A Complementary Food in Tribal Areas of Adilabad District, India

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**A B S T R A C T**

Prevalence of malnutrition among infants, young children and nursing mothers is common in tribal areas of Adilabad district of India, although district endowed with higher production of Soybean, Sorghum, wheat and millets that could be harnessed through processing to produce energy dense nutritious foods. Germination and milling of germinated grains into malt is a simple process that is widely used for making complementary nutritious weaning foods from locally grown cereals and pulses. The nutrient contents of energy rich complementary weaning foods (17.1±0.1%, 18.7±0.3 and 18.5±0.6 protein, and 367, 373 and 371, kcal/100 g for Sample-A, Sample-B and Sample-C, respectively fall in the category of protein-rich supplementary foods for children and mothers. The mean scores of sensory evaluation showed that all the energy rich complementary weaning food samples prepared from locally grown foods were within the acceptable range, while the energy rich complementary weaning food sample-B (Sorghum: Wheat: Ragi: Soybean: Green Gram in the ratio of 35:20:10:20:15) significantly had nutritionally superior quality with the acceptable sensory attributes. Further study also shows that the tribal families can prepare energy rich weaning mixes from their agriculture produce by simple malting and milling process.

## Introduction

Adilabad is one of the districts inhabited by highest number of tribal people in India with more than 75% rural population and among them 35% of people are tribes. Majority of the farmers are marginal and small accounting to 67.8% of total land holdings in the district. In total gross cropped area of the district, pulses, soybean and cotton occupy 18%, 12% and 77% area respectively (Directorate of Economic and Statistics, 2016-17). Soybean, Sorghum and wheat in *rabi* and other Millets, known as ragi and bajra are the main crops grown in tribal areas of Adilabad district of India. Millets have high nutritional value and resilient nature as compared to major cereals such as wheat and rice, which offer livelihood security for tribal farmers in rainfed regions of Telangana state of India. Currently

Telangana state is producing 2, 52,017 MT of soybean from an area of 0.24 million hectares (Directorate of Economics and Statistics-2017) and Adilabad district shares 39.6% area with the production 38.2% of total states' soybean production. Adilabad district also produces 19215 MT sorghum and millets per year from an area of 20030 ha and sharing 23.5% of state production.

Millets are nutritionally superior to major cereal grains. The additional health benefits of the millets like gluten-free proteins, high fibre content, low glycaemic index and richness in bioactive compounds made them a suitable health food (Kannan *et al.,* 2013). The average carbohydrates content of millets and sorghum varies from 56.88 to 72.97 g/100 g, protein content of 7.5 to 12.5% and lipid content ranges from 1.3 to 6 g/100 g and richest source of fibres, i.e. crude fibre as well as dietary fibre and also is rich in vitamins, minerals (Longvah *et al.,* 2017).

Soybeans are rich in protein and fat content, which accounts for about 60 % of dry soybeans by weight (Kuan-I Chen *et al.,* 2012). The high quality protein content in soybean makes soybean is an important and cheap source of complete protein (Henkel 2000) to control protein energy malnutrition in tribal areas of the district. A whole soybean has a Protein Digestibility Corrected Amino Acid Score (PDCAAS) of 96, soybean milk 91, and eggs 97 Kuan-I Chen *et al.,* 2012).

Protein Calorie Malnutrition (PCM)' is a major concern in Adilabad district especially in infants, young children and nursing mothers in tribal areas. About 35.8% children below 5 years under weight (weight for age), 38.3% children below 5 years under stunted (Height for age) and 67.8% children less than 5 years are suffering with anaemic problems (NFHS-4 data, 2015-16). Building awareness on preparation of composite soy and millet based foods and consumption can support the complementary diet, well-being, and livelihoods of tribal communities and farmers in Adilabad district of India, where malnutrition and anemia are common among infants, young children and nursing mothers.

However, the soybean, millets and sorghum consumption in tribal areas is in wane because of lack of awareness on nutritional importance, cultural changes towards polished rice consumption and gaps in processing and poor linkages to markets. Apart from their nutritional benefits, the health benefits of soybean, sorghum and millets such as control of diabetes, anaemia, cardiovascular, and celiac diseases are not properly exploited fully. Therefore to increase the consumption of locally grown foods such as soybean, sorghum and millets by tribal families an attempt was made to develop energy dense foods from composite blends of soybean and millets and sorghum. In recent years due to climate variations, mono cropping, high intensity of pests and diseases, non judicious use of chemicals are affecting the yields and increasing the cost of cultivation in the district and it leads paradigm shift in cultivation of sorghum and millets than cotton.

In view of the above advantages, this study is undertaken to design energy dense and highly nutritious complementary food from soybean, sorghum and millets using malting technology and conducted a supplementation study through ANGANWADI centres in Tribal areas.

## Materials and Methods

Freshly harvested Sorghum, Pearl millet, Wheat, Green gram and Soybean were obtained from Krishi Vigyan Kendra, Adilabad. Sugar and milk powder were collected from local markets. All other reagents were of analytical grade. Experiment

was carried out at Krishi Vigyan Kendra, Adilabad and ANGANWADI centres in Tribal areas.

## Sample preparation

The Sorghum, Pearl millet, Wheat, Green gram and Soybean were sorted in order to remove foreign materials, mouldy or broken and damaged grains (which may affect the taste and keeping quality of the product) and washed under running water.

## Production of composite malted flour

The cleaned Sorghum, Pearl millet, Wheat, Green gram and Soybeans were malted separately following the method described by Anigo *et al.*, 2010 and Adelekan and Oyewole (2010) with slight modification. The Sorghum, Pearl millet, Wheat, Green gram and soybeans were soaked in potable water at ambient temperature for 12 hr. At the end of the soaking period, the moisture content of the grains had increased to 40- 45%. The hydrated grains were spread separately on a moist cotton cloth (which had been previously sterilized by boiling in water bath for 30 mins) placed on a tray and kept in a cabinet. The grains were allowed to germinate for 1-3 days depending on the nature of the grains. The grains were watered twice daily and non-germinated ones removed. The sprouted grains were dried in a cabinet drier (60°C) until a moisture content of 12-15% was reached. Then the sprouted grains were roasted in separately on roasting pan and the malted grain flours were blended to formulate complementary energy rich foods (Table 1). Then the blend was milled in hammer mill (SVS, Portable Multipurpose flour mill) and were mixed thoroughly in ribbon blender into smooth homogenous powder and then stored in airtight containers at room temperature (25 - 30°C) until used. Ready-to-eat weaning mix of each formulated complementary foods was made by mixing flour in cold water at concentrations of 20% and then poured into boiling water (200 ml) with the addition of 20 g of flour, stirred and allowed to remain heated for 5 min to form thick porridge, after which samples were taken for analyses.

## Nutritional composition

The samples obtained from the different blends of complementary malted weaning mixes were analyzed for moisture, protein (N* 6.25), ash, crude fibre and crude fat (AOAC, 2012). Carbohydrate was determined by difference. Selected mineral contents (calcium and Iron) of malted weaning mixes were determined by using atomic absorption spectrophotometer (AAS) method (AOAC, 2000).

## Sensory evaluation

Sensory evaluation of Ready-to-eat weaning mix of each formulated complementary foods was carried out on sensory attributes like taste, appearance, aroma, texture, colour and overall acceptability by a 6 semi-trained adult panelists which includes mothers with children age 6 to 48 months and 30 untrained children's age group 4 to 5 years. The acceptability of sensory assessments was conducted in 6 ANGANWADI centres at Tribal Areas of Adilabad. Balamrutham (wearing food weaning supplied through ANGANWADI centres to provide improved supplementary nutrition to children between 7 months to 3 years in Telangana state of India), energy rich complementary weaning food samples (A, B and C) were used in the evaluation. Samples were coded using random three-digit numbers and served with the order of presentation counter-balanced. Panelists were provided with a glass of water and, instructed to rinse and swallow water between samples.

They were given written instructions and asked to evaluate the products for acceptability based on its flavour, texture, taste, color and overall acceptability using nine-point hedonic scale (1 = dislike extremely to 9 = like extremely; Meilgaard *et al.,* 1999 ). The range method of statistical analysis was applied for the test of the significance to find the preferences.

## Statistical analysis

Results were expressed as mean ± standard deviation. The difference between groups of each parameter was determined using the t-test and statistical significance was claimed at $P < 0.05$.

## Results and Discussion

Germination and milling of germinated grains into malt is a simple process that is widely used for making complementary nutritious weaning foods from cereals and pulses. Table 2 showed result of nutritional composition of the formulated complementary weaning foods. Sample-C had significantly ($p < 0.05$) lower mineral content (2.4±0.1%) while comparable higher values of carbohydrates were recorded for Sample-A (64.2±0.6%). Fat contents of Sample-B (5.5±0.5%) and Sample-A (5.4±0.1%) were significantly ($p < 0.05$) higher while Sample-A (17.1±0.1%) significantly lower ($p < 0.05$) in protein content. Mineral element concentrations showed that Sample-C which had significantly ($p < 0.05$) higher calcium and Iron content then other samples. All the mixes were nutritional rich over the Balamrutham (wearing food weaning supplied through ANGANWADI centres to provide improved supplementary nutrition to children between 7 months to 3 years in Telangana state of India). The nutrient contents of Energy Rich Complementary Weanining Foods (17.1±0.1%, 18.7±0.3 and 18.5±0.6 protein, and 367, 373 and 371, kcal/100 g for Sample-A, Sample-B and Sample-C, respectively) fall in line with the guidelines of the Bureau of Indian Standards for protein-rich supplementary foods for children and mothers (Indian Standards Institution 1973). These nutritional compositions indicate that the energy rich complementary weaning foods have fairly balanced proteins and other nutrients. Similar findings were quoted by Sumathi *et al.,* (2007) in scientific literature. Sensory quality of energy rich complementary weaning food sample-B compare to the regular supplemented food (Balamrutham) in ANGANWADI centers of the Telangana state was both liked moderately on the hedonic scale (Table 3).

**Table.1** Different Energy Rich Complementary Weanining Mixes

| S.No | Ingredients in (%) | Formulation- A | Formulation- B | Formulation- C |
|---|---|---|---|---|
| 1 | Sorghum | 35 | 35 | 35 |
| 2 | Wheat | 30 | 20 | 15 |
| 3 | Ragi | 5 | 10 | 15 |
| 4 | Soybean | 15 | 20 | 20 |
| 5 | Green Gram | 15 | 15 | 15 |
| Total | | 100 | 100 | 100 |

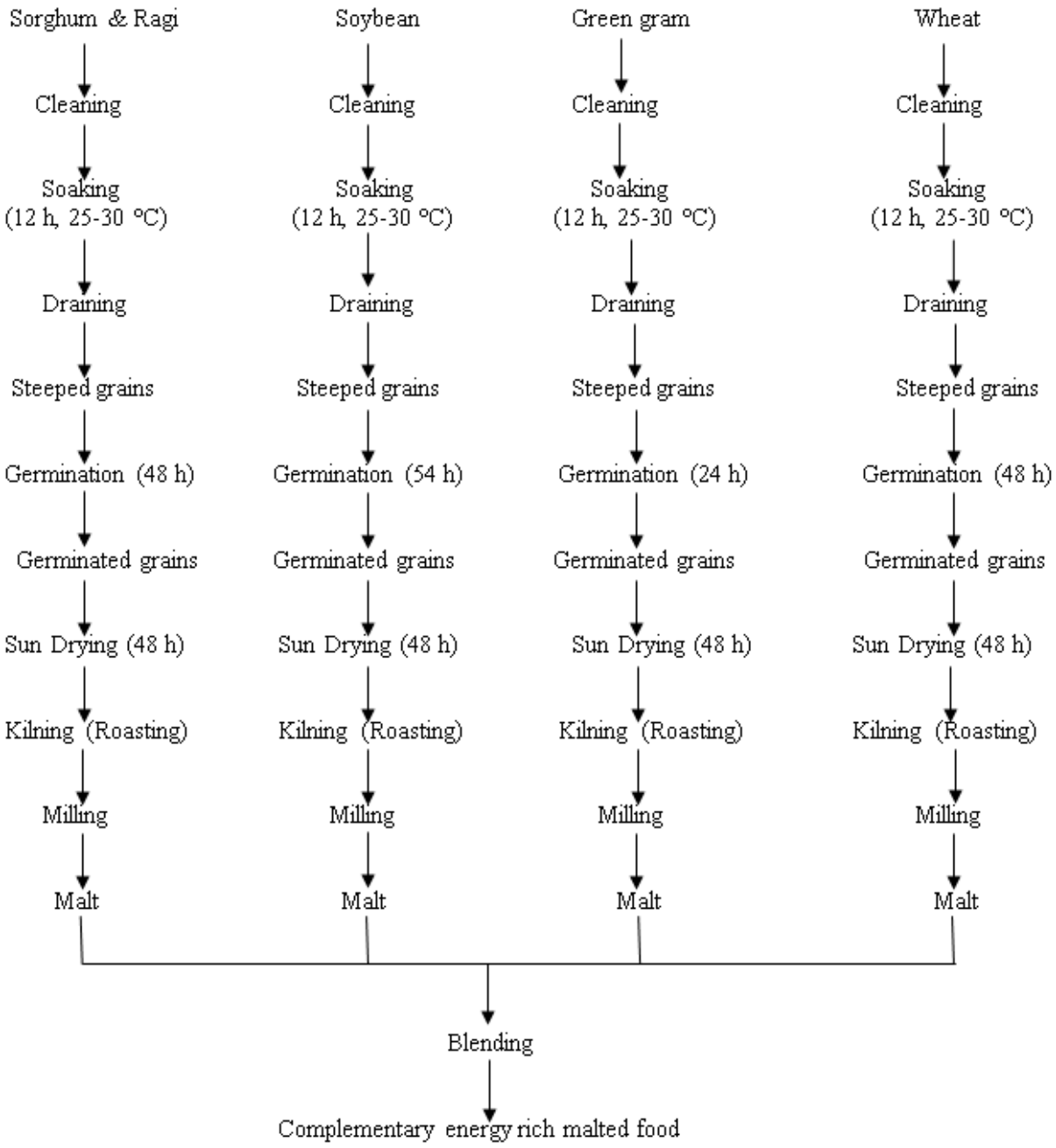


**Figure1. Flow chart for preparation of energy rich complementary malted weaning food mixes**

**Table.2** Nutrient composition of Energy Rich Complementary Weaning Foods for 100g*

| | Balamrutham | Formulation- A | Formulation- B | Formulation- C |
|---|---|---|---|---|
| Calories (kcal) | 414 | 367±0.3 | 373.0±0.5 | 371±0.2 |
| Protein(g) | 11.0 | 17.1±0.1 | 18.7±0.3 | 18.5±0.6 |
| Fat(g) | | 4.7±0.2 | 5.5±0.5 | 5.4±0.1 |
| Carbohydrates (g) | | 64.2±0.6 | 62.2±0.4 | 62.2±0.3 |
| Dietary Fiber (g) | | 7.5±0.1 | 7.2±0.2 | 6.9±0.2 |
| Total Minerals | - | 2.2±0.2 | 2.4±0.3 | 2.4±0.1 |
| Calcium (mg) | 167 | 97.5±0.5 | 125.0±0.6 | 140.7±0.8 |
| Iron (mg) | 3.1 | 6.1±0.2 | 6.7±0.5 | 6.7±0.4 |
| Values presented as the average of triplicate determinations and are expressed on a dry weight basis.<br>Balamrutham" is the weaning food introduced under ICDS to provide improved supplementary nutrition to children between 7 months to 3 years. | | | | |

*All the values in Triplicate of analysis and presented as means ± standard error

**Table.3** Sensory evaluation of Energy Rich Complementary Weaning Foods**

| Samples | Appearance | Colour | Flavour | Texture | Taste | Overall acceptability |
|---|---|---|---|---|---|---|
| control | 8.3±0.21 | 8.6±0.23 | 8.4±0.31 | 8.8±0.32 | 8.6±0.36 | 8.9±0.28 |
| A | 8.1±0.13 | 8.4±0.18 | 8.1±0.23 | 8.3±0.19 | 8.1±0.27 | 8.2±0.27 |
| B | 8.4±0.17 | 8.7±0.19 | 8.4±0.30 | 8.9±0.11 | 8.7±0.23 | 8.6±0.13 |
| C | 8.2±0.26 | 8.4±0.33 | 8.2±0.17 | 8.1±0.33 | 8.4±0.33 | 8.1±0.10 |

** All the values in Triplicate of analysis and presented as means ± standard error

The mean scores of sensory evaluation showed that all the energy rich complementary weaning food samples prepared from locally grown foods were within the acceptable range, while the energy rich complementary weaning food sample-B prepared from malted Sorghum: Wheat: Ragi: Soybean: Green Gram in the ratio of 35:20:10:20:15 had significantly better appearance (8.4±0.17), color (8.7±0.19), flavour (8.4±0.30), texture (8.9±0.11), taste (8.7±0.23) and overall acceptability (8.6±0.13).

Feeding infants with improved complementary malted foods prepared from locally available food crops as that formulated in this study for children in the state may cause improvement in their growth (Anigo *et al.*, 2010).

The present study revealed that, energy rich complementary weaning food sample-B (Sorghum: Wheat: Ragi: Soybean: Green Gram in the ratios of 35:20:10:20:15) be used to produce nutritionally superior quality malted weaning food with the acceptable sensory properties. Further study also shows that the tribal families can prepare energy rich weaning mixes from their agriculture produce by simple malting and milling process. The millet proteins complement well with the soy

as well as legume proteins, and the supplementary foods may be suitable for nutrition intervention programmes.

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