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Research Article

Millet Product Formulation and Effect of Supplementation on Malnourished School Going Children

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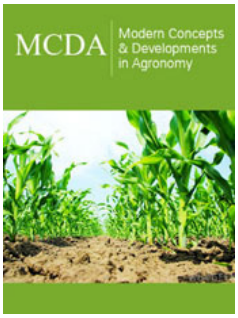

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Abstract

Primary school age is a dynamic period of physical and mental growth for the child. The major nutritional problem observed among school children is malnutrition. Diversification of food resources by incorporating millets with high macro and micronutrient density can combat malnutrition. Ragi is one of the best supplements for Nutraceutical assurance in changing climates. Thus, in the present study formulation and standardization of ragi laddoo was done according to standard method. Standardized formulation was analysed for its biochemical composition. 60 school going malnourished and anaemic children were selected for a 6-month supplementation study. After the ragi laddoo supplementation a significant improvement in anthropometry measurement (Height from 132.26±8.23cm to 136.7±2.52cm, and weight, from 31.27±2.61kg to 36.4±512 kg) and haemoglobin status (from 11.38g/dl. to 12.57g/dl) was observed in selected children, reduction in sign and symptoms related to vitamin and mineral deficiency was also recorded.

Keywords: Malnutrition; Anaemia; Millet; Value addition; Nutrition

Introduction

School age is the active growing phase of childhood. Primary school age is a dynamic period of physical and mental growth for the child. School age is important from a nutritional perspective because it is the best time for the body to accumulate in preparation for the growth spurt of adolescence [1]. The major nutritional problems observed among school children are malnutrition, which affects more than 900 million people worldwide. Malnutrition is a major cause of infant and child death (Martines et. al., 2011). Malnutrition refers to insufficient or excesses of one or more nutrients in body it may be due to hunger, lack of nutrient in diet, imbalance of essential nutrients or impaired nutrient utilization for longer time [2]. Under nutrition manifests in four broad forms: wasting, stunting, underweight, and micronutrient deficiencies resulting underdevelopment of the brain, which has long-term damaging effects on mental capacity and learning ability, school performance, and future risk of diet-related non-communicable diseases [3,4].

India accounts for 33.33 % of the world's stunted children under the age of 5. This undernutrition persists in school children and adolescents [5]. Undernutriotion problems are not only associated with macronutrients but also micronutrients as vitamins and minerals enable the body to produce enzymes, hormones, and other substances that are essential for proper growth and development. Micronutrients deficiency namely iron, vitamin A, iodine and zinc associated with an impairment of immune responses [6]. The major nutritional problems observed among the school children are protein energy malnutrition (PEM), Iodine Deficiency Disorder (IDD), Iron Deficiency Anaemia (IDA) and Vitamin A Deficiency (VAD).

These problems occurring more in developing country like India, where a large part of the population is suffering with hunger. Nutrition is a fundamental human need and a key

component of a healthy lifestyle. The quantity and quality of food intake and its ability to digest, absorb and utilize food greatly influence children's nutritional intake. Adequate nutrition at school age is important to eliminate deficiencies. Health and nutritional status of the population is largely determined by food consumption [7]. The developmental, economic, social, and medical impacts of the global burden of malnutrition are serious and lasting, for individuals and their families, for communities and for countries [4]. Thus, efforts to accelerate economic growth will not be successful unless the focus is on the growth and development of children [4].

Diversification of food resources by incorporating millets with high macro, micro and phytonutrient density can contribute to balanced diets, achieve nutritional security and combat life-threatening diseases [8]. The major limiting factors for the utilization of millet is poor availability of millet based ready-to-use value- added products. Therefore, development of nutrient rich, functional and value-added product from millet are required which can prevent malnutrition related problem. This is the perspective from which ragi consumption, and its promotion must be regarded in Jharkhand state suffering from disease and disorder related to nutrient deficiency [9]. Thus, the present study was aimed to assess and reduce the prevalence of malnutrition and anaemia from school going children through supplementation of formulated and standardised ragi laddoo.

Materials and Methods

Sample selection

The children in the age group of 7-9 years from primary schools located in rural area of Ranchi district were targeted for this study. Sample was selected in two stages, first stage was based on the inclusion process using a simple random sampling, the second stage consisted anthropometric measurements and biochemical analysis for that, a health checkup was conducted and blood haemoglobin of all the randomly selected children was analysed with a help of a physician using the cyanmet haemoglobin method as per the procedure by Varley [10]. Children were also examined for clinical signs and symptoms of malnutrition and anaemia to select a sample of 60 children suffering from PEM and IDA. Selected children were divided into two groups namely experimental and control group (30 in each).

Formulation and Standardization of Ragi Laddoo

Procurement of raw material

Ragi grain was procured from the farmer's field. Gram flour sugar, ghee and dry fruits, was procured from the local market of Ranchi.

Formulation of ragi laddoo

Formulation of ragi laddoo was done using the method outlined by Singh & Mehra [11] at food processing unit of KVK, Ranchi. Ragi grain was processed into ragi flour by destoning, cleaning, followed by drying, milling and storage. Development of nutrient dense Ragi laddoo was done by blending ragi (finger millet) with other ingredients such as sugar, ghee, and nuts (optional) into various combining to obtain 3 test samples namely TS1, TS2, and TS3 as shown in Table 1.

Table 1: Formulation of ragi laddoo.

Samples	Ratio of Different Ingredient used for the Formulation of Ragi Laddoo				
	Ragi flour	Gram flour	Sugar	Ghee	Dry fruits
TS1	1	1	1	1	0
TS2	1	1	1	0.8	0.2
TS3	1	1	0.8	1.1	0.1

Standardization of Ragi laddoo through sensory evaluation

For the standardization of the product, 3 test samples of ragi laddoo were evaluated by the sensory evaluation technique with the selected panel members using the method of Iwe MO [12]. The five-point hedonic scale was used for the development of score cards forvarious sensory characteristic like appearance, taste, color, texture, flavor and overall acceptability. Product with higher score was consider as the most desirable to consume, and its formulation accepted as the standardized formulation for preparation nutrient dense ragi laddoo.

Biochemical Analysis of Ragi laddoo

Moisture, crude protein, fat, ash, crude fibre, iron and calcium were determined by the method of AOAC [13]. The carbohydrate content was determined by the calculated difference method and energy value was determined by multiplying the proportion of protein, fat and carbohydrate by their respective physiological energy values and taking the sum of the products [14].

Supplementation study

Formulated ragi laddoo weighing 30g each were served to 60 selected children for one time in a day for five days in a week. Data in terms of Height weight, and haemoglobin level was recorded at the interval of 2 months.

Result and Discussion

Sensory evaluations of ragi laddoo

After the sensory evaluation of all three formulated taste samples, it was found that the TS 1 and TS2 had good taste but the appearance and the color for the product were not good, and product was not acceptable whereas TS 3 was good in all sensory attributes. Thus, TS3 with higher score was considered as the most desirable to consume, and its formulation accepted as the standardized formulation for preparation ragi laddoo (Table 2).

Table 2: Sensory evaluations of ragi laddoo.

Samples	Appearance	Colour	Taste	Texture	Flavour	Overall Scores
TS1	2	1.5	3	3	4.5	13.5
TS2	3.5	3	4	4	4	18.5
TS3	4	4	4.5	4.5	4	21

Biochemical composition

In the present study Biochemical composition of standardized ragi laddo at per 100g was similar with Tabssum et al. [15], who reported 67.39g/100gms of carbohydrate, 20.21g/100gms of total Fats, 1.19g/100gms of Ash in 100gm of ragi laddoo. According to Avadhut et. al. [16] the carbohydrate content present in Ragi Laddu were 67.45g/100g, protein content of 10.5g/100g, Ash content of 1.8g/100grams. In 2017 Kazi & Auti [17] examine the calcium content in different millet based standardised recipe and marketed product, and found the calcium range from 45.5mg/100g to 59.34mg/100g which was in agreement of present study (Table 3).

Table 3: Biochemical compositions of Standardized ragi laddo at per 100g.

Protein (g/100g)	Fat (g/100g)	CHO (g/100g)	Dietary Fibre (g/100g)	Energy (k cal)	Calcium (mg/100g)	Iron (mg/100g)	Total Mineral(g/100g)
8.86	24.83	64.92	8.15	514.54	77.72	5.58	1.22

Supplementation study

Effect of 6-month supplementation of ragi laddoo on height (in centimetres) and weight (in kilogram) of school going malnourished children are shows in Table 4. Figure 1 shows the effect of 6-month supplementation on nutritional status of selected children according to category given by Indian Academy Paediatrics (IAP). In Table 5 supplementation impact on haemoglobin level of malnourished school going children is given whereas figure 2 shows the status of iron deficiency anaemia of selected children according to category given by world health organization in 2007, Table 6 depicted the clinical sign symptoms of malnourished children before and after supplementation of ragi laddoo.

Table 4: Pre and post supplementation impact of ragi laddoo on anthropometric parameters of malnourished school going children.

Particular	Initial	2nd Month	t-value	4th Month	t-value	6th Month	t-value
Height (CM)	132.26±8.23	132.98±9.68	11****	134.38±9.44	11.25****	136.7±2.52	8.2****
Weight (KG)	31.27±2.61	32.6±1.14	6.67****	35.66±2.99	8.4****	36.4±512	5.57****

Note: ****indicate significance at p<0.001.

Table 5: Pre and post supplementation impact of ragi laddoo on haemoglobin level of malnourished school going children.

Initial Hb Level (g/dl)	2nd Month Hb Level (g/dl)	t-value	4th Month Hb Level (g/dl)	t-value	6th Month Hb Level (g/dl)	t-value
11.38±0.74	11.79±0.74	21****	12.17±0.73	19****	12.57±0.71	10****

Note: ****indicate significance at p<0.001.

Table 6: Status clinical signs and symptoms before and after supplementation of ragi laddoo.

S.No	Clinical Signs & Symptoms	Before Supplementation (%)	After Supplementation (%)		
			2nd month	4th month	6th month
1	Pale eye	80	32	10	6
2	Pale skin	80	40	10	5
3	Cheilosis	10	10	8	0
5	Discoloured hair	50	45	30	15
6	Loss of appetite	50	20	16	0
7	Fatigue	100	30	9	0

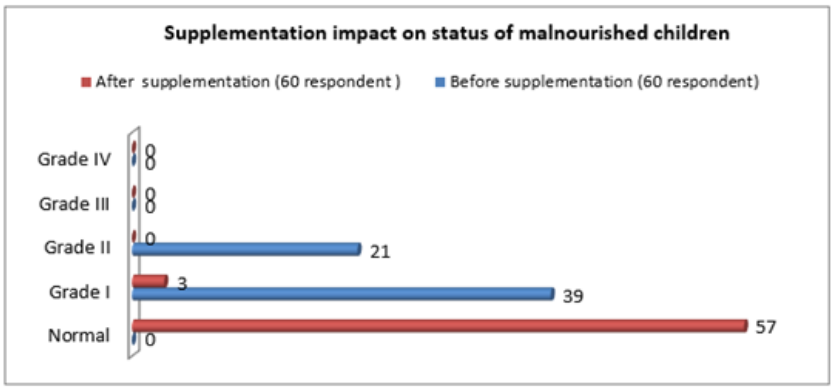

Figure 1: Pre and post supplementation impact of ragi laddoo on status of malnourished children.

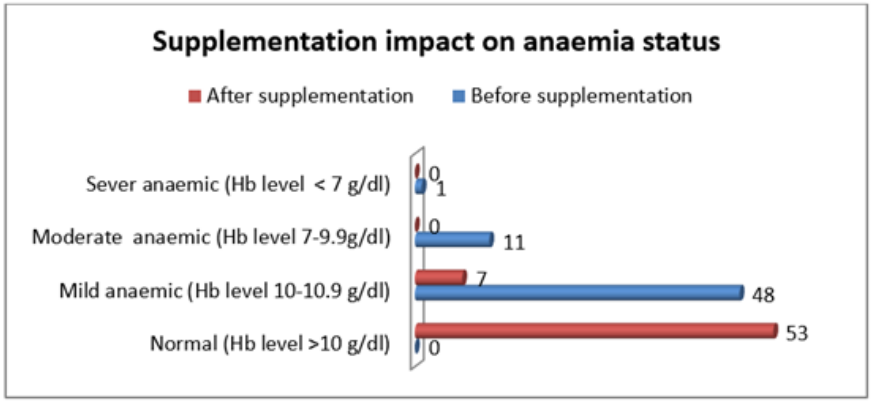

Figure 2: Pre and post supplementation impact of ragi laddoo on anaemia level of malnourished school going children.

After the 6-month supplementation of ragi laddoo a gradually and significantly ($p<0.001$) improvement in height from 132.26±8.23cm (at initial) to 136.7±2.52cm (at the end of 6 month) and in weight, from 31.27±2.61kg (at initial) to 36.4±512 kg (at the end of 6 month) was observed. Same as the present study in 2022 Jahan A et al. [18] concluded a 90days supplementation study of millet bar on school going girl in Telangana state, and they found that there was a significant increase in height from 148.7cm to 148.9cm and weight from 30.7kg to 33.23kg. Thirumani Devi et al. [19] reported a significant improvement in height from 111.31 to 112.6cm, weight from 15.21 to 16.14kg at $p<0.001$ and hemoglobin from 11.42 to 12.58g/dl, after 120 days' supplementation of multi-nutrient value added product on schoolgirls of Coimbatore. Similarly, another study had demonstrated that after the 6-month intervention of ragi based different value-added product among school going girl, a significant improvement in weight was noticed from 26.77±1.4kg to 26.92±2.1kg by Devulapalli & Gokhale [20].

In the present research it was found that before supplementation all children were malnourished where 39 (65%) children were Grade I malnourished, remaining 21 (35%) were Grade-II malnourished, no children were found at Grade-III and IV level malnourished. After the 6-month supplementation of ragi laddoo a significant($p>0.15$) improvement was recorded where57 (95%) malnourished children from Grade-I and Grade-II shifted in normal category, and remaining3 (5%) children from Grade-II shifted in Grade-I category as shows in Figure 1.

Durairaj et al. [21] develop multi-millet health mix and supplemented to school going children and found The mean height of the children increased by 2.82cm (from the baseline mean height 106.124 ± 7.51 to final mean height 108.944 ± 5.62) similarly in weight increased by 2.64kg (from the baseline mean weight 15.88 ± 2.82 to final mean weight 18.52 ± 3.14), they concluded that millet could significantly improve the anthropometry measurement and reduce the number of malnourished children in school. Before supplementation, the mean haemoglobin level of experimental group was 11.38g/dl. There was significant ($p<0.001$) improvement observed by food supplementation in 2nd month (11.79g/dl), in 4th month (12.17g/dl) and in 6th month (12.57g/dl).

Similarly, Durairaj et al. [21] reported the positive impact of supplementation of multi-millet health mix on anaemic school going children and found the improvement in haemoglobin content from 8.71 ± 0.72 to 9.25 ± 0.82 at the end of the supplementation. Devulapalli & Gokhale [20] observed a significant improvement in haemoglobin level of anaemic school children from 8.40±0.9 to 8.45±0.6, after the intervention of millet-based product. In 2016 Prasad et Al. [22] also found a significant improvement in hemoglobin status and serum ferritin level after sorghum supplementation in school going children of southern India.

In the present research it was found that before supplementation all children were anemic where 48 (80%) children were mild anemic, 11 (18.33%) were moderate anemic and remaining 1 (1.6%) was sever anemic. After the 6-month supplementation of ragi laddoo a significant ($p>0.15$) improvement was recorded where 53 (88.33%) children from mild and moderate anemic category shifted in normal category and remaining 7 (11.66%) children from moderate category shifted in mild anemic category as shows in Figure 2. These findings are similar to other studies showing that millet supplementation has a positive effect on heme levels and reduces the incidence of anaemia [23,24].

After the assessment of clinical sign and symptoms, it was found that before supplementation of ragi laddoo all malnourished children had vitamin and mineral deficiency. In which 80% children had pale eye and skin, 10% had Cheilosis, 50% had discoloured hair and loss of appetite, and all (100%) selected student felt fatigue. This state was gradually reduced after the 6 months of supplementation of ragi laddoo, as shown in Table 6.

Arokiamary et al. [25] demonstrated a reduction in clinical signs and symptoms of micronutrient deficiency in school going children after the supplementation of millet-based food. They stated that millet based supplementary foods provide those additional nutrients that are lacking in day-to-day meals. This study concluded that millet-based product like ragi laddoo contain good amount of essential nutrient such as carbohydrate, protein, fat, dietary fibre, calcium, iron etc. supplementation of ragi laddo weighing 30gm each for one time in a days and 5 days in a week, had a significant

effect on height, weight, and haemoglobin level of malnourished children. Thus, this value-added product is able to reduce the prevalence of undernutrition, anaemia and other deficiencies.

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