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Assessment of supplementation with nutri-dense millet bar to combat iron deficiency Anemia in Adolescent girls of Wanaparthy district, Telangana

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Abstract

In India, millets are often referred to as "Siridhanya" or "miracle grains" due to their nutritional and health benefits. Food and Agriculture Organization and United Nations has recognized 2023 as International Year of Millets or IYM2023 for awareness about health and nutritional benefits of millets. Millets are indeed considered a nutrient-rich food and offer numerous health benefits. Among the various health and nutritional benefits of millets, its impact on hemoglobin concentration is important since anemia is a major public health issue in many countries. To evaluate the effect of nutritious millet bars on hemoglobin levels in adolescent girls, a systematic food-based intervention programme was conducted by YFA-Krishi Vigyan Kendra (ICAR), Mahbubnagar-I in Madanapuram, Wanaparthy district. 120 adolescent girls were involved in the study with 60 participants in the control group and 60 participants in the experimental group. Consumption of millet bar shows positive effect on hemoglobin levels with highly significant value ($p < 0.01$). In the experimental group, the participants with moderate anemia hemoglobin levels has increased significantly 9.33±0.88 g/dl to 10.01±0.76 g/dl from 0 to 90 days ($p < 0.01$) respectively. Results of this study showed a significant rise in the hemoglobin levels of participants with severe anemia in the experimental group from 6.8±0.09 g/dl at baseline to 8.14±0.96 g/dl after 30 days and further to 9.44±0.31 g/dl, showing the effectiveness of the nutri-dense millet bar in rising the hemoglobin levels and reducing anemia in adolescent girls. Many participants in the experimental group, has been progressed from mild anemia to normal. Increasing the consumption of iron from millets resulted a positive impact on hemoglobin levels of adolescent girls. By promoting millet consumption and developing innovative millet-based products, can address iron deficiency anemia and improve overall health outcomes, particularly in vulnerable populations.

Keywords: Anemia, experimental group, food based intervention, hemoglobin, and Nutridense millet bar

Introduction

Iron deficiency anemia (IDA) is a global public health issue that affects children and young women in particular. According to the World Health Organization (WHO) estimates for 2019, global anemia prevalence in women of reproductive age and children was 29.9 and 39.8%, respectively, accounting for half a billion women and 269 million children (WHO,2021). A deficit in dietary iron intake remains a significant challenge, exacerbated by the growing global consumption of refined and highly processed foods, leading to micronutrient deficiency in vulnerable populations. It especially impacts young children, adolescent girls and women who are pregnant or postpartum. WHO estimates that 40% of children 6-59 months of age, 37% of pregnant women and 30% of women 15-49 years of age worldwide are anemic.

In Wanaparthy district of Telangana, the situation is especially alarming, According to the District Nutritional profiles (DNPs) are based on data from the National Family Health Survey (NFHS)-(2015-2016) and NFHS-5(2019-2020). 75% of children under 5 years of age, 59% of non-pregnant women under 15-49 years and 63% of pregnant women are aneamic.

Numerous factors contribute to anemia in women, including rural residency, younger age, lower education, reduced women's empowerment, poorer economic conditions, lower nutritional status, and higher childbearing rates. South Asia has the highest prevalence of anemia, with in India reporting that 50 to 70 percent of reproductive-age women suffer from iron deficiency anemia. The consequences of anemia vary based on severity, social group, and living conditions. It impairs mental and psychomotor development, reduces individual work performance and increases maternal and child morbidity and mortality (Nowaji *et al.*,2000) [8].

A deficit in dietary iron intake remains a significant challenge, exacerbated by the growing global consumption of refined and highly processed foods, leading to micronutrient deficiency in vulnerable populations (Seetha *et al.*, 2024) [11]. Also report by the ICMR states, anaemia due to iron deficiency may cause an impaired immune system, resistant to fight against infection, reduced reproductive health and related problems such as Premature birth, low birth weight (LBW), delay Cognitive development etc.

Three major strategies are employed globally to control iron deficiency anemia (IDA), one among them is supplementation with iron and folic acid tablets, food fortification, and natural food-based are two strategies formulated. Despite the widespread implementation of the first two methods, IDA remains a serious malnutrition problem with an increasing trend globally. The third approach primarily focuses on dietary diversification and enriching diets with naturally iron-rich foods without the potential side effects of artificial additives. Staple cereals continue to dominate food consumption in developing countries, these mainly include refined wheat, rice, and maize, while other nutrient-rich crops such as millets are underutilized. In developing countries, a major portion (80%) of the diet consists of low-iron staple foods, achieving sufficient iron intake through the remaining 20% of the diet is challenging. Therefore, it is crucial to diversify the staple food by incorporating naturally iron-rich foods like millets (Anitha *et al*., 2021) [1]. Surveys conducted by National Nutritional Monitoring Bureau and other also conclude same that the Indian diets are qualitatively deficient in micronutrient deficiency (Ann Raeboline *et al*., 2019). Staple cereals continue to dominate food consumption in developing countries; these mainly include refined wheat, rice, and maize, while other nutrient-rich crops such as millets and sorghum are underutilized (Longvah *et.al* 2017, & Willett *et al.* 2019) [7, 19]. Studies in different parts of the world have shown that enhancing dietary diversity has resulted in improved hemoglobin levels (Shinde *et al*., 2021& Saaka *et al* 2017) [13, 10]. In this context, millets play an important role in promoting dietary diversity, which in turn ensures the consumption of a wide spectrum of essential vitamins, minerals, and other nutrients. Regions in which millets historically constituted a significant part of the diet have seen their prominence in the dietary landscape gradually diminish over time (Kane-Potaka *et al* 2019) [5]. Whole grain millets have advantages over refined cereals, as they have higher levels of nutrients.

Millets contain 2.3 to 4.0 times more dietary fiber (6.4 to 8.0 g/100g) compared to refined rice and wheat. This high fiber content supports beneficial gut microbiota and enhances gut health. Recognized as a smart food, millets are not only nutritious and health-promoting but also environmentally sustainable and resilient, which benefits both the planet and farmers. Additionally, millets and pseudocereals are considered excellent for improving nutritional health due to their high levels of dietary fiber and micronutrients. They offer significant nutraceutical and therapeutic benefits, including anti-diabetic, anti-hyperlipidemic, anti-allergic (for gluten-sensitive individuals), anti-carcinogenic, anti-inflammatory, anti-aging, and nephroprotective properties. They also aid in wound healing, strengthen the nervous system and boost hemoglobin levels (Chauhan and Sarita, 2018) [3].

Therefore, Millets have tremendous health benefits besides being a best option for supplementation that combat iron deficiency anemia. In this context, Krishi Vigyan Kendra (ICAR), Mahbubnagar-I in Madanapuram, Wanaparthy district organized a series of outreach activities from 2020-21 to 2023-2024. These programs focused on nutritional education, dietary diversity for nutritional security, millet production, their inclusion in diets through value addition and crop diversification and suitable agriculture practices. Additionally, an intervention through On Farm Trails (OFT) was conducted in order to assess the Nutri-dense millet bars on hemoglobin levels in Adolescent anemic girls with an objective to improve the Hemoglobin (Hb) and to access the dietary habits. During and after the trial, key strategies or potential approaches for promoting nutritious rich regular diets in rural households were explored.

Materials and Methods

A supplement trail framed under OFT, titled as assessment of supplementation of Nutri-dense millet bar on hemoglobin levels in Adolescent anemic girls over a 2 months (60-days) period. Subjects were selected based on anemia classification: Normal *(*hemoglobin ≥12.0 g/dL), mild (11.0-11.9 g/dL), moderate (8.0-10.9 g/dL) and severe (hemoglobin <8.0 g/dL*)*. From a baseline survey of 200 girls, 120 girls aged 13 to 15 years were chosen from schools in Kothakota, Madanapuram,and Wanaparthy mandals in Wanaparthy district. Each school contributed 40 girls, with 20 assigned to the control group and 20 to the experimental group. In total, 60 girls were placed in the control group and 60 in the experimental group.

The process of supplementary nutri-dense millet bar involves preparing a mixture of In puffed Pearl millets, sorghum and finger millet and then adding dates, almonds and groundnut. The mixture is then combined with jaggery syrup to create the final bar, aimimg for 40 g weight per bar. Here's mentioned flow chart in Fig.1.

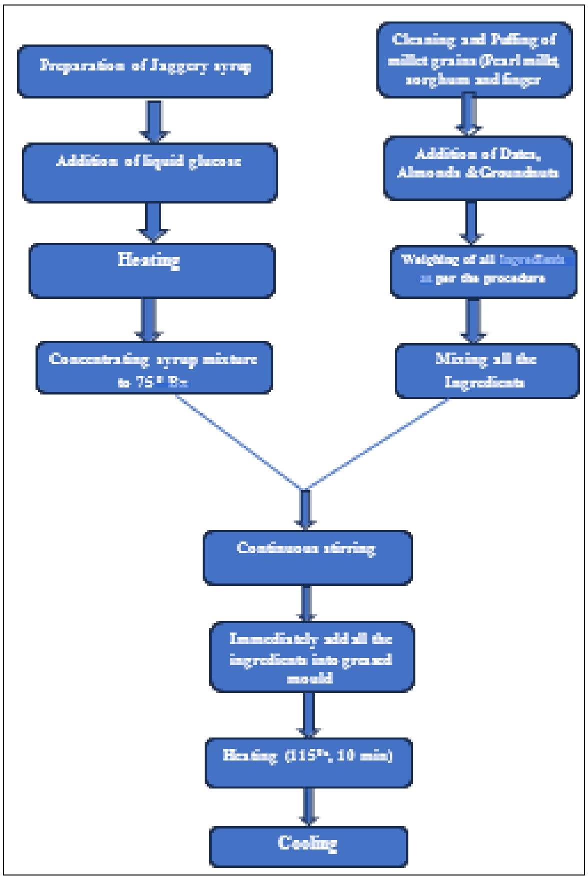

Fig 1: Flow chart of preparation of Nutri-dense millet bar

Hemoglobin study: Estimation of hemoglobin was done by the Haemometer on 0th, 30th and 60th days to study the effect of Nutri-dense millet bar supplementation on the blood hemoglobin levels.

Dietary assessment: A dietary assessment was performed on all 120 subjects to evaluate their general meal patterns and intake of iron-rich foods. This assessment utilized a food frequency schedule designed to collect information on meal patterns and the consumption of iron-rich foods, including their frequency.

Nutritional status: Nutritional status of the adolescent girls was assessed by Anthropometry measurement such as height and weight were taken on 0th, 30th and 60th day. Which were compared with standards method by Gibson R.S.(1990) [4].

Data analysis

Sensory evaluation differences were analyzed with Student's t-test and ANOVA (Snedecor and Cochran, 1969) [14]. Hemoglobin and BMI changes from baseline to 30th and 60th days were compared using a two-sample t-test. Dietary assessment data were summarized with frequency percentage.

Ethical consideration: Parent consent was obtained through District official (ICDS) team and School teachers and Parents. The purpose of the study were explained to the participants. The Ethical committee (ATARI Zone-X, Hyderabad and PJTAU, Hyderabad) was approved the study.

Results and discussion:

A systematic food-based intervention programme was conducted, to evaluate the effect of nutritious millet bars on hemoglobin levels in adolescent girls. 120 adolescent girls were involved in the study with 60 participants in the control group and 60 participants in the experimental group. The results are as follows.

Hemoglobin study

At baseline for the OFT supplementation trial, 200 girls aged 13-15 from Kothakota, Madanapuram, and Wanaparthy schools were screened for hemoglobin levels using a Haemometer. Based on the severity of their hemoglobin level, 120 girls with low hemoglobin were selected and divided into two groups: control (n=60) and experimental (n=60). According to WHO (2001) anemia classification, these girls were further categorized into Mild, Moderate, and Severe anemia subgroups.

In the survey, the experimental group comprised of 14 subjects with mild anemia, 26 with moderate anemia, and 20 with severe anemia. The control group included 12 subjects with mild anemia, 28 with moderate anemia, and 20 with severe anemia.

Effect of intervention on hemoglobin level

Supplementation involved in supply of 40 grams of a cereal-based bar daily to the control group (n=60) and 40 grams of a Nutri-dense millet bar daily to the experimental group (n=60) for a duration of 2 months (60 days), in addition to their regular diet. The nutri-dense millet bar was formulated using a blend of pearl millet, sorghum, finger millet, peanuts, almonds and dates. The cereal-based bar was prepared with puffed rice and Jaggery. Detailed results of the intervention are presented in Table 1.0.

Mild Anemia

The mean hemoglobin level at baseline (0th day) for control group of mild anemia was 11.27±0.17 g/dl. The mean hemoglobin level were not significantly increased with the cereal-based bar from 30th day (11.13±0.17 g/dl) to 90th day (10.94±0.13 g/dl). The results showed no significant change in hemoglobin levels after three months of supplementation with a cereal-based bar for the control group.

The mean hemoglobin level at baseline (0th day) for experimental subjects for the mild anemia was 11.37±0.88 g/dl. After one month of supplementation (30th day), there was no significant increase in hemoglobin levels (11.44±0.23 g/dl). However, by the end of the 2nd month (60th day), the hemoglobin levels were increased to 11.46±0.24 g/dl. Despite this increase, it was not statistically significant ($^{*}p<0.05$) when compared to the baseline level (11.37±0.88 g/dl) and at the 60th day level (11.46±0.24 g/dl).

Moderate Anemia

In the moderate anemia control group, the mean hemoglobin level at baseline (0th day) was 9.55±0.81 g/dl, at 60th day, it was decreased to 9.25±0.89 g/dl, and by the end of 60th day, it further decreased to 9.12±0.93 g/dl. This decrease was not statistically significant. Overall, there was no significant change in hemoglobin levels from the 0th day (9.55±0.81 g/dl) to the 60th day (9.12±0.93 g/dl) in the moderate anemia control group.

The baseline mean hemoglobin level (0th day) moderate anemia experimental group was 9.33±0.88 g/dl. This increased significantly ($^{*}p<0.05$) to 9.66±0.81 g/dl after one month of millet bar supplementation (30th day). After 2nd month (60th day), the hemoglobin level was further rose to 10.01±0.76 g/dl. The increase in mean hemoglobin levels from the 0th day to the 300th day was not statistically significant. However, the overall increase from the 0th day (9.33±0.88 g/dl) to the 60th day (10.01±0.76 g/dl) was significant ($p<0.01$), indicating a notable improvement in hemoglobin levels with the consumption of the Nutri-dense millet bar.

Severe Anemia

The control group with severe anemia showed slight decrease in hemoglobin levels from 7.08±0.50 g/dl at baseline to 6.90±0.47 g/dl at 30 days, and 6.87±0.45 g/dl at 60th days, which was not statistically significant.

The results of severe anemic subjects as mentioned in detailed in Table 1.0. The experimental group showed a significant increase ($^{**}p<0.01$) in mean hemoglobin levels from 6.8±0.09 g/dl at baseline to 8.14±0.96 g/dl at 30th day and further to 9.44±0.31 g/dl at 60th day, demonstrating that the nutri-dense millet bar significantly improves hemoglobin levels and helps to reduce anemia.

Seetha *et al*., 2024 [11] who reviewed 19 studies and found that regular consumption of millets led to a significant increase in hemoglobin levels (13.2%) among anemic individuals, compared to just 2.7% with standard diets. Sushree Sangita Choudhury and Gitanjali Chaudhary (2024) [15] reported that after 45 days of consuming millet biscuits, 26.67% of severely anemic subjects improved to a moderate anemia status, 43.33% of moderate anemia subjects progressed to mild anemia, and 30% remained in the moderate category but showed increased hemoglobin levels.

Supplementation with Nutri-dense millet bars in experimental group resulted in a significant increase in hemoglobin levels ($^{**}p<0.01$) in both moderate and severe anemic subjects over 3 months, with the most substantial gains occurring after the first month. These findings collectively demonstrate that millet-based interventions are effective in improving hemoglobin levels and managing anemia, with notable benefits for individuals with moderate and severe anemia.

Table 1: change in hemoglobin (g/dl) status between baseline and supplementation of nutridense millet bar 60 days to adolescent girls.

Day	Category	Mild Anaemia Hb=11.0 to 11.9g/dl		Moderate Anaemia Hb=8.0 to 10.9g/dl		Severe Anaemia Hb=< 8.0 g/dl	
		Control (n=12)	Experimental (n=14)	Control (n=28)	Experimental (N=26)	Control (n=20)	Experimental (n=20)
Baseline (0th day)	Mean ±SD	11.27±0.17	11.37±0.88	9.55±0.81	9.33±0.88	7.086±0. 50	6.8±0.09
	Sig.2 tailed	0.008	0.5	0.17	0.5	0.33	0.02
Ist month (30th Day)	Mean ±SD	11.13±0.17	11.44±0.23	9.25±0.89	9.66±0.81	6.90±0. 47	8.14±0.96
	Sig.2 tailed	0.11	0.26	0.77	0.07	0.89	0.003
2nd month (60th Day)	Mean ±SD	10.9±0.186	11.46±0.244	9.12±0.93	10.01±0.76	6.87±0. 45	9.442±0.31
	Sig.2 tailed	0.24	0.42	0.81	0.058	0.006	0.052

Note: *Significant at $^{*}p<0.05$, **Significant at $^{**}p<0.01$, C=Control Group, E=Experiment

Dietary assessment

A dietary assessment was conducted for the 120 anemic adolescent girls under supplementation trial. The selected participants were divided into an experimental group (n=60) and a control group (n=60), a food frequency questionnaire prepared to assess their intake of iron-rich foods. The results for the food frequency intake of iron-rich cereal grains are presented in Table 2.0. It was observed that none of the subjects either in the experimental or control group never consumed maize or rice bran.

Pearl millet and Foxtail millet was rarely consumed by the subjects 38.3% and 48.3% respectively in the experimental group and 33.3% and 23.3% respectively in the control group. The remaining 61.7% and 51.6 in the experimental group and 66.6% and 76.6 in the control group never consumed pearl millet and foxtail millet.

Finger millet was consumed twice a week by 21.6% of the subjects in the experimental group and 31.6% in the control group. It was rarely consumed by 33.3% of the subjects in the experimental group and 28.3% in the control group. Ragi was never consumed by 15% of the subjects in the control group and by 23.3% in the experimental group.

Sorghum was consumed daily by 16.6% of the subjects in the experimental group and 20% in the control group; thrice a week by 53.3% in the experimental group and by 46.6% in the control group; and twice a week by 30% in the experimental group and by 18.3% in the control group. Additionally, 15% of the subjects in the control group consumed sorghum once a week.

Seetha *et al.*, 2021 [12] reported that the consumption of iron-rich pearl millet with 8.3 mg/100 g of iron levels contributed more than 50% of iron to the entire meal with 14.1 ± 9 mg of iron and improved the iron bioavailability with bioavailable iron of 1 ± 0.4 mg/day, compared with the consumption of a low iron pearl millet (< 3 mg/100 g) meal.

Table 2: Frequency (%) intake of Iron rich cereal grains:

Cereal Grains	Daily (%)		Thrice a Week (%)		Twice a week (%)		Once a Week (%)		Rarely (%)		Never (%)	
	C	E	C	E	C	E	C	E	C	E	C	E
Pearl millet	0	0	0	0	0	0	0	0	20 (33.3)	23 (38.3)	40 (66.6)	37 (61.6)
Foxtail Millet	0	0	0	0	0	0	0	0	14 (23.3)	29 (48.3)	46 (76.6)	31 (51.6)
Finger millet	0	0	0	0	19 (31.6)	13 (21.6)	15 (25)	13 (21.6)	17 (28.3)	20 (33.3)	9 (15)	14 (23.3)
Sorghum	12 (20%)	10 (16.6%)	28 (46.6%)	32 (53.3)	11 (18.3)	18 (30)	9 (15)	0	0	0	0	0
Maize, tender	0	0	0	0	0	0	0	0	36	28	24	32
Maize, dry	0	0	0	0	0	0	0	0	0	0	0	0
Rice, bran	0	0	0	0	0	0	0	0	0	0	0	0

Food frequency questionnaire was prepared based on the locally available food items in the region and foods rich in iron, in reference to the standard literature, so locally available green leafy vegetables were included (Table 2.1)

Results observed that amaranthus leaves were consumed twice a week by 23.3% of the subjects in the experimental group and by 30% in the control group. Meanwhile, 31.6% of the experimental group and 20% of the control group consumed amaranthus once a week. Amaranthus was rarely consumed by 35% of the subjects in the experimental group and by 36.6% in the control group. Moreover, 10% of the experimental group and 13.3% of the control group never consumed amaranthus.

Spinach leaves were consumed twice a week by 18.3% of the subjects in the experimental group and by 26.6% in the control group, while 35% of the experimental group and 28.3% of the control group consumed spinach once a week. Spinach was rarely consumed by 31.6% of the subjects in the experimental group and by 36.6% in the control group. Furthermore, 15% of the subjects in the experimental group and 8.3% in the control group never consumed spinach.

None of the subjects in either the experimental or control group not consumed carrot leaves, which are rich in iron. Gogu was consumed twice a week by 25% of the subjects in the experimental group and by 28.3% in the control group, while 33.3% of the experimental group and 23.3% of the control group consumed gogu once a week. Gogu was rarely consumed by 23.3% of the subjects in the experimental group and by 41.6% in the control group. Additionally, 18.3% of the experimental group and 6.6% of the control group never consumed gogu. Mint was rarely consumed by 100% of the subjects in the experimental group and by 70% in the control group. The remaining 30% of the control group never consumed mint. Ambati chukka was rarely consumed by 25% of the subjects in the experimental group and by 41.6% in the control group and 75% of the subjects in the experimental group, 30% of the control group never consumed.

Table 2.1: Frequency (%) intake of Iron rich Green leafy vegetables:

2.leafy vegetables	Daily (%)		Thrice a Week (%)		Twice a week (%)		Once a Week (%)		Rarely (%)		Never (%)	
	C	E	C	E	C	E	C	E	C	E	C	E
Amaranthus	0	0	0	0	18 (30)	14 (23.3)	12 (20)	19 (31.6)	22 (36.6)	21 (35)	8 (13.3)	6 (10)
Spinach	0	0	0	0	16 (26.6)	11 (18.3)	17 (28.3)	21 (35)	22 (36.6)	19 (31.6)	5 (8.3)	9 (15)
Gogu	0	0	0	0	17 (28.3)	15 (25)	14 (23.3)	20 (33.3)	25 (41.6)	14 (23.3)	4 (6.6)	11 (18.3)
Mint	0	0	0	0	0	0	0	0	60 (100)	42 (70)	0	18 (30)
Carrot leaves	0	0	0	0	0	0	0	0	0	0	0	0
Ambati chukka	0	0	0	0	0	0	0	0	25 (41.6)	15 (25)	35 (58.3)	45 (75)

The results from food frequency data (Table 2.2) show that 31.6% of the experimental group and 41.6% of the control group consumed fish once a week. In both groups, 20% reported rarely consuming fish, while 48.3% of the experimental group and 38.3% of the control group never consumed fish. 20% of the experimental group and 13.3% of the control group consumed egg hen thrice a week. 35% of the experimental group and 30% of the control group consumed egg hen twice a week. 45% of the experimental group and 56.6% of the control group consumed egg hen once a week. Moreover, 10% of the subjects of experimental group and control group never consumed dry fish, liver goat and liver meat.

Table 2.2: Frequency (%) intake of Iron rich Fish and meat product:

Fish and meat products	Daily (%)		Thrice a Week (%)		Twice a week (%)		Once a Week (%)		Rarely (%)		Never (%)	
	C	E	C	E	C	E	C	E	C	E	C	E
Fish	0	0	0	0	0	0	25 (41.6)	19 (31.6)	12 (20)	12 (20)	23 (38.3)	29 (48.3)
Dry fish	0	0	0	0	0	0	0	0	0	0	60 (100)	60(100)
Prawn	0	0	0	0	0	0	0	0	0	0	60 (100)	60 (100)
Egg hen	0	0	8 (13.3)	12 (20)	18 (30)	21 (35)	34 (56.6)	27 (45)	0	0	0	0
Chicken	0	0	0	0	0	0	60 (100)	60 (100)	0	0	0	0
Liver goat	0	0	0	0	0	0	0	0	0	0	60 (100)	60 (100)
Liver Meat	0	0	0	0	0	0	0	0	0	0	60 (100)	60 (100)

The analysis of food frequency data revealed a low consumption of iron-rich foods among participants, including heme iron sources like millet and iron absorption enhancers such as amla and lemon, indicating poor iron absorption. As noted by (Zijp *et al*., 2000) [20], ascorbic acid, along with meat, fish, and poultry, enhances iron absorption, while polyphenols, phytates, and calcium found in vegetables, tea, and coffee inhibit it. In this trial, it was observed that consuming ascorbic acid, meat, fish, and poultry together can help counteract these inhibitors. Recommendations include drinking tea between meals rather than with meals, and consuming iron absorption enhancers simultaneously to improve iron uptake. The general meal patterns showed that most participants drank tea with breakfast, which may further hinder iron absorption

Nutritional status

The nutritional status of subjects in the supplementation trial under OFT was assessed through anthropometry (height and weight) and dietary evaluation. BMI was calculated on days 0^{th}, 30^{th} and 60^{th} day. The results BMI showed no significant changes throughout the supplementation period, indicating that the Nutri-dense millet bar did not affect height, weight, or BMI. This lack of change may be due to the short duration of the study (60-day). Extending the supplementation period beyond six months might reveal positive effects on weight and BMI.

Key Strategies or potential approaches to optimize Nutrient-Rich millet bar and combat Anaemia

During the study, the following strategies/approaches were framed to enhance the effectiveness of a nutrient-rich millet bar and, consequently, combat Anaemia

1. **Conduct Nutrition education campaign:** Organize nutrition awareness campaigns in collaboration with ICDS, schools, and SERP to address the growing issue of anemia in rural areas. These campaigns should focus on educating communities about the causes and symptoms of anemia and the critical role of iron and millets in its prevention and management particularly for adolescent girls, pregnant women, and lactating mothers. Include method demonstrations on the preparation of Nutri-dense millet bars during these campaigns to encourage adoption. Additionally, distribute IEC (Information, Education & Communication) materials in local languages,

highlighting the health benefits and preparation process of millet bars to enhance understanding and community engagement.

2. **Development of Partnerships and Collaborations:** Establish strategic partnerships with the District Health Department (DHO) and Integrated Child Development Services (ICDS) to integrate Nutri-dense millet bars into regular health and nutrition camps conducted at the village and mandal levels. Collaborate to incorporate millet bars as part of food-based supplementation strategies under key government programs such as ICDS, the Midday Meal Scheme, and Poshan Abhiyaan. These collaborations will ensure consistent distribution and consumption of millet bars among target groups like adolescent girls, pregnant and lactating women, and children's ultimately helping to reduce anemia and improve overall nutritional outcomes in the district.
3. **Empower Community Groups:** Community groups, including women farmers organized into Self-Help Groups (SHGs), Farmer Interest Groups (FIGs), and Farmer Producer Organizations (FPOs), play a vital role in strengthening rural food systems. To promote millet-based nutritional interventions, Krishi Vigyan Kendra's (KVKs) can provide technical backstopping to these groups through demonstrations on the preparation and processing of nutri-dense millet bars. Capacity building in branding, labeling, and value addition should be integrated to enhance marketability. Additionally, facilitating access to microcredit and linking these groups with food safety certification agencies such as FSSAI will ensure quality assurance and support them in developing millet bar enterprises as a sustainable livelihood option.
4. **Leverage various Media for promotion nutri-dense millet bar:** Utilize a combination of print media, social media, and ICT platforms to widely disseminate information about nutri-dense millets and the benefits of millet bars. Share success stories, recipe demonstrations, and testimonials from beneficiaries to build trust and create awareness. Educational videos, infographics, community radio, and WhatsApp groups can be used to influence dietary behavior, especially among rural women and adolescents. These efforts can play a critical role in improving nutrition literacy, encouraging healthy food choices, and fostering a positive perception of millet-based products as a tool to combat anemia and enhance overall health.

Conclusion
The results indicated no significant change in hemoglobin levels among the control group subjects. However, in the experimental group, the hemoglobin levels of subjects with moderate and severe anemia increased significantly ($^{**}p<0.01$) from the 30th day to the 60th day. Adolescent girls are encouraged to boost their intake of vitamin C-rich fruits and vegetables for better iron absorption. Food frequency data showed that overall poor iron absorption is due to poor intake of iron absorption enhancers like lemon and amla and also due to less consumption of iron rich foods. To address this, strategic partnerships with the District Health Department and ICDS are being fostered to incorporate nutri-dense millet bars into regular health and nutrition camps. Millet bars are also being proposed as a component of food-based supplementation strategies under ICDS, the Midday Meal Scheme, and Poshan Abhiyaan. Therefore, through this intervention KVK aims to enhance women empowerment and improve nutrition security in Wanaparthy dist. of Telangana.

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References
1. Anitha S, Kane-Potaka J, Botha R, Givens DI, Sulaiman NLB, Upadhyay S, *et al*. Millets can have a major impact on improving iron status, hemoglobin level, and in reducing iron deficiency anemia-A systematic review and meta-analysis. Front Nutr. 2021;8:725529.
2. Liney ENAR, Kavitha R, Usha A. The impact of the Green Revolution on indigenous crops of India. J Ethn Foods. 2019;6:8.
3. Chauhan ES, Sarita. Exploration of gluten-free baked food products incorporated by germinated finger (*Eleusine coracana*) and pearl (*Pennisetum glaucum*) millet: A therapeutic approach. Int J Health Sci Res. 2018;8(3):232-42.
4. Gibson RS. Principles of nutritional assessment. Oxford (UK): Oxford University Press; 1990.
5. Kane-Potaka J, Kumar P. Smart food - food that is good for you, the planet and the farmer. In: State of India's Livelihoods Report 2019. New Delhi: Access Development Services; p. 71-82. Available from: https://smartfood.org
6. Lazarus R, Louise B, Webb K, Blyth F. Body mass index in screening for adiposity in children and adolescents: systematic evaluation using receiver operating characteristic curves. Am J Clin Nutr. 1996;63:500-6.
7. Longvah T, Ananthan R, Bhaskarachary K, Venkaiah K. Indian food composition table. Hyderabad (India): National Institute of Nutrition; Indian Council of Medical Research; 2017. p. 1-578.
8. Nowaj S, Bhaswati D, Asraful A. Prevalence of anemia among reproductive women in different social groups in India: Cross-sectional study using nationally representative data. Natl Libr Med. 2023;eCollection.
9. Press Information Bureau (PIB). India's foodgrains production touched a record 315.7 million tonnes in 2021-22 [Internet]. 2021 [cited 2025 May 24]. Available from: https://pib.gov.in/PressReleasePage.aspx?PRID=1894899
10. Saaka M, Galaa SZ. How is dietary diversity related to haematological status of preschool children in Ghana? Food Nutr Res. 2017;61:1333389.
11. Seetha A, Takuji W, Tsusaka D, Givens BI, Nur Liana

BS, Vetriventhan M, *et al*. Does millet consumption contribute to raising blood hemoglobin levels compared to regular refined staples: a systematic review and meta-analysis. Natl Libr Med. 2024;eCollection.
12. Seetha A, Takuji W, Tsusaka D, Givens BI, Nur Liana BS, Vetriventhan M, *et al*. Millets can have a major impact on improving iron status, hemoglobin level, and in reducing iron deficiency anemia-A systematic review and meta-analysis. Front Nutr. 2021;8:1-14.
13. Shinde S, Madzorera I, Fawzi WW. Association of iron supplementation and dietary diversity with nutritional status and learning outcomes among adolescents: results from a longitudinal study in Uttar Pradesh and Bihar, India. J Glob Health. 2021;11:04037.
14. Snedecor GW, Cochran G. Statistical methods. 6th ed. Ames (USA): The Iowa State University Press; 1969. p. 59-234.
15. Sangita SC, Gitanjali C. Impact of iron rich millet biscuits in alleviating anaemia among adolescent girls of Samastipur district. Asian J Dairy Food Res. 2024;43(1):111-5.
16. The Hindu. 74.1% of Indians unable to afford a healthy diet: FAO Report [Internet]. 2023 [cited 2025 May 24]. Available from: https://www.thehindu.com/sci-tech/health/741-of-indians-unable-to-afford-a-healthy-diet-fao-report/article67631605.ece
17. Vaidyanathan G. Healthy diets for people and the planet. Nature. 2021;600:22-5. doi:10.1038/d41586-021-03565-5
18. World Health Organization (WHO). Global anaemia estimates 2021 [Internet]. Available from: https://www.who.int/data/gho/data/themes/topics/anaemia_in_women_and_children
19. Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S, *et al*. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. Lancet. 2019;393:447-92. doi:10.1016/S0140-6736(18)31788-4
20. Zijp IM, Korver O, Tijburg LBM. Effect of tea and other dietary factors on iron absorption. Crit Rev Food Sci Nutr. 2000;40(5):371-93.