Plant Archives Vol. 26, No. 1, 2026 pp. 975-978 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.1.133

EFFECTIVENESS OF IRON-RICH MILLET-BASED NUTRITIOUS *LADOO* AS A DIETARY INTERVENTION TO ALLEVIATE ANEMIA AMONG ADOLESCENT GIRLS IN CHITRAKOOT DISTRICT (U.P.), INDIA

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(Date of Receiving-05-12-2025; Date of Revision-25-01-2026; Date of Acceptance-19-02-2026)

ABSTRACT

The study was carried out under On Farm Trial (OFT) at Krishi Vigyan Kendra, Ganivan, Chitrakoot to see the impact of millet based nutritious *ladoo*, made out locally available materials on hemoglobin level of adolescent girls aged between 14-19 years from Pahari block at Chitrakoot district. The hemoglobin level of selected 20 girls aged between 14-19 years from Pahari block was carefully examined before intervention study. Experimental adolescent girls who fell in the hb level range of < 8 to 11.9 g/dl were intervened with 100g millet based *ladoo* for a period of 45 days in order to complement at least 1/3rd of the regular need of iron for adolescent girls. The results showed that the mean increase in hemoglobin level after intervention was found to be 1.24 g/dl in experimental girls, which indicated the positive impact of millet based *ladoo* on hematological health of adolescent girls. The present work will be complementary contribution towards alleviating anemia among adolescent girls

Key words : Anemia, Chitrakoot, Girls, Hemoglobin, Ladoo.

Introduction

Iron deficiency anemia is the most common type of nutritional anemia which affects people globally; adolescent period symbolizes the initiation of menstrual period in girls hence they are at a larger risk of nutritional anemia. Supplementation, fortification and dietary diversification are the three initiatives for alleviating anemia (Choudhury *et al.*, 2024). The prevalence of iron deficiency anemia (IDA) is notably high among adolescent girls, particularly during menarche when iron requirements increase. Therefore, comprehensive educational initiatives and awareness programs are essential for the prevention, early detection, and effective management of anemia in this population (Anwar *et al.*, 2025). Adolescence, defined as the age range of 10–19 years, is characterized by rapid physical growth, physiological maturation, and increased physical activity. Adolescents constitute nearly one-fifth of the global population; however, a substantial proportion of this group continues to suffer from under nutrition (Yadav *et al.*, 2017). Especially, adolescent girls form a crucial segment of the population and constitute as it were the vital “bridge” between the present generation and the forth coming generation. At present the frequency of anemia among adolescent girls is on the hike in India mainly due to low economic status and poor access of the health-care services. Anemia refers to a hematological disorder marked by diminished oxygen transport resulting from reduced healthy red blood cell mass or hemoglobin concentration. Iron deficiency anemia (IDA) is the most common nutritional anemia globally, with adolescent girls being especially vulnerable due to the commencement of menstruation. According to the World Health Organization (2019), anemia affects 29.9% of women aged 15–49 years globally. In India, the prevalence is substantially

higher, with 59.1% of adolescent girls aged 15–19 years reported to be anemic. In Uttar Pradesh, anemia prevalence among females in this age group is 65%, with a slightly higher rate observed in rural areas (65.4 per cent). Furthermore, the prevalence of anemia among adolescent girls aged 15–19 years in Chitrakoot district was reported to be 65.9% (NFHS, 2019-20). Supplementation, fortification and dietary diversification are the three initiatives for alleviating anemia. As a result, it is critical that locally accessible affordable but high nutritional value material should be employed as a catalyst to enhance the nutritional condition of teenage females. Millets and pseudo cereals are considered as the best option to improve nutritional health due to abundance of dietary fibre and micronutrients present in them. Millets have been known for their significant neutraceutical and therapeutical properties like anti-diabetic, anti-hyperlipidemic, anti- allergic for gluten sensitive persons, anti –carcinogenic, anti- inflammatory, anti- ageing, nephroprotective etc. It also helps in wound healing, strengthening the nervous system and increasing hemoglobin level (Chauhan and Sarita, 2018). Along with millets, pseudo cereals have gained considerable nutritional importance in the present scenario due to their rich content of proteins, phenolic acids, minerals, vitamins, essential amino acids, dietary fiber and unsaturated fatty acids, all of which contribute positively to human health.(Przadah and Malik, 2020). Although, millets and pseudo cereals possess high nutritional value, they also contain ant nutritional compounds like phytates and tannins that can be effectively minimized through processing methods such as soaking and germination.As very few studies conducted on nutritional importance of coarse grains to prevent anemia in Chitrakoot district of Uttar Pradesh, this present investigation was undertaken with the objective to study the impact of millet based ladoo on hemoglobin level of adolescent girls of Chitrakoot district in U.P.

Materials and Methods

The study was conducted during the period of December 2024 to February2025. Total twenty adolescent girls aged between 14- 17 years were purposively selected from two villages of Pahari block in Chitrakoot district.

Background information

Before intervention, a systematic interview schedule was structured to know about their general and socio economic information, nutritional knowledge regarding millets and their value added products and knowledge about anemia including its deficiency symptoms. Apart fromthis assessment of their nutritional status was also carried out, which included dietary assessment, anthropometric measurement, bio chemical evaluation respectively.

Selection of raw materials

The raw materials like puffed rajgeera, jaggery, rice flakes, groundnut were procured from locally available market “Karwi” in Chitrakoot district while bajra, bengal gram, lentil, sesame seeds were procured from Krishi Vigyan Kendra (KVK) Farm and Farmers field.

Processing of selected ingredients

The processing of selected raw materials step by step is given below in Fig. 1.

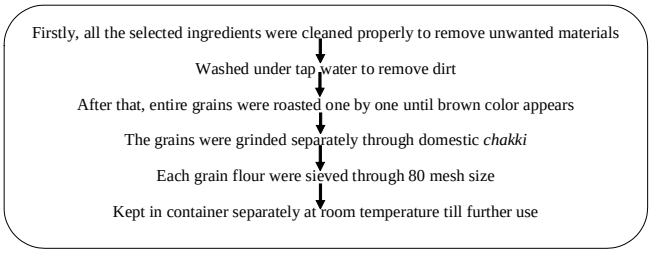

Fig. 1 : Processing or raw materials.

Formulation of Nutritious ladoo

Pearl millet and Amaranthus seed flour are more beneficial with reference to micro nutrients content when included in making value added products. So, it was planned to incorporate both to develop *ladoo* in order to eliminate our complete reliance on wheat. The millet grains viz. pearl millet, amaranthus seeds, bengal gram, lentil, ground nut, and sesame and rice flakes each 4.5 kg were used to develop value added product i.e. *ladoo* in bulk amount. In addition to these ingredients jaggery and *desi* ghee were used to develop *ladoo*. These ingredients were used because they were locally available and affordable whereas jaggery was preferred due to its high iron content. Selected food ingredients with various proportions and their nutritional content, iron, foliate and protein level are given in Table 1.

The nutritious *ladoo* that comprised proportion of 1:1:1:1:1:1:1:3 of puffed pearl millet, roasted lentil, roasted chickpea, roasted groundnut, puffed sesame, puffed amaranthus, rice flakes and jaggery achieved higher values of nutrition.

Results and Discussion

The on farm trial (OFT) was conducted by Krishi Vigyan Kendra, Ganivan, Chitrakoot (Uttar Pradesh) to see the impact of iron rich supplementation of nutritious ladoo, made up of locally available foods materials on hemoglobin level of adolescent girls. The hemoglobin content of 40 adolescent girls between the age group of

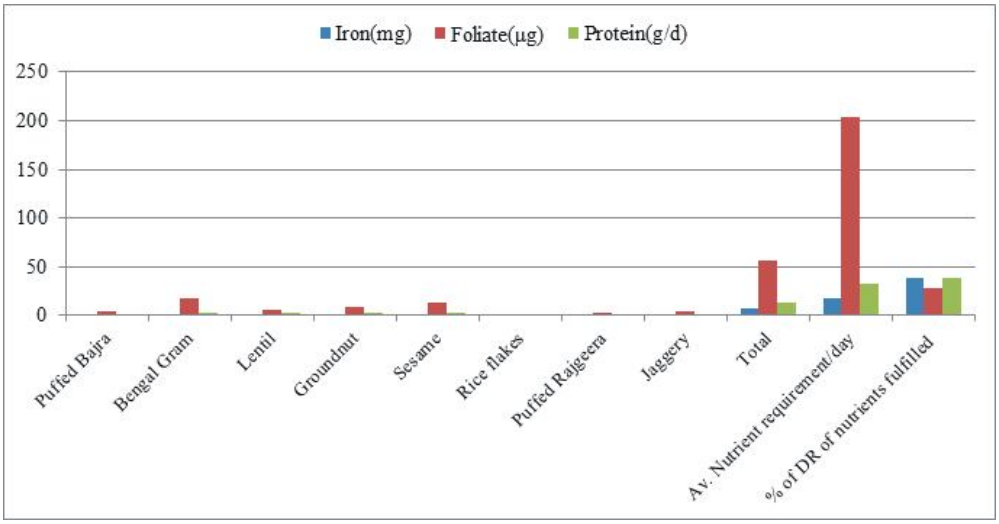

Fig. 2 : Nutrients quantity of ladoo.

Table 1 : Formulation of nutritious *Ladoo*.

Ingredients	Amount(g)
Puffed Bajra	10
Bengal Gram	10
Lentil	10
Groundnut	10
Sesame	10
Rice flakes	10
Puffed Rajgeera	10
Jaggery	30
Total	100

Table 2 : Average requirement and nutrient fulfilled by nutritious *ladoo*.

Nutrients	Average nutrient requirement of 12 -18 year age girls	% of DR of nutrient fulfilled by nutritious *ladoo*
Iron (mg/d)	17	38.7
Folate (µ/d)	204	27.75
Protein (g/d)	33	38.91

Source: ICMR- Indian Food Composition Table (IFCT), 2017

Table 3 : Nutrient profile of nutritious *Ladoo*.

Ingredients	Amount (g)	Iron (mg)	Foliate (µg)	Protein (g/d)
Puffed Bajra	10	0.642	3.611	1.096
Bengal Gram	10	0.678	18.2	2.155
Lentil	10	0.706	4.99	2.435
Groundnut	10	0.344	9.087	2.365
Sesame	10	1.54	13.1	2.17
Rice flakes	10	0.46	0.846	0.74
Puffed Rajgeera	10	0.82	2.465	1.327
Jaggery	30	1.389	4.32	0.555
Total	100	6.579	56.618	12.843
Av. Nutrient requirement per day		17	204	33
% of DR of nutrients fulfilled by nutritious *ladoo*		38.7	27.75	38.91

Source: ICMR- Indian Food Composition Table (IFCT), 2017

12 to 19 were tested. On the basis of blood test report 20 adolescent girls whose hemoglobin level was found to be lower than the normal standard values were selected for the study. The selected girls were divided into two groups (A&B), 10 in each group. Group A as a control group with the mean hemoglobin status of 9.93 g/dl received no iron rich supplementation food. Group B is another group of 10 girls with mean hemoglobin status of 9.89 g/dl, were administered 100g nutritious ladoo daily; which provided 17 mg of iron, supporting 38.7% of day requirement of an adolescent girls, along with daily routine diet for about 45 days. The nutritious ladoo was made with ingredients high in iron rich grains, Puffed bajra (10 g) + Bengal gram (10g) + Lentil (10g) + Groundnut (10g) + sesame (10g) + rice flakes (10g) + puff rajgeera (10g) + Jaggery (30g). The intervention programme was scheduled for 45 days and hemoglobin estimation was exercised after 45 days of intervention of both the groups enabling us to determine the impact of iron rich supplementation food on increasing the hemoglobin level of adolescent girls. According to Kumari *et al.* (2019) there is increase in hemoglobin level after supplementation of iron rich supplements among both pregnant women and adolescent girls. The results after 45 days of intervention depicted that mean hemoglobin status of group B hiked to 10.73 g/

Table 4 : Effect of iron rich supplementation food (Nutritious *ladoo*) on hemoglobin level of adolescent girls.

Technology Option	No. of trials	Pre- test Hb (g/dl)	Post- test Hb (g/dl)	Increase in Hemoglobin level(g/dl)	Pre-test body weight(kg)	Post-test body weight (kg)	Increase in body weight (g)
T_1 : Control group (General daily diet)	10 in each group	9.93	9.96	0.03(0.3%)	42.14	42.21	0.07(0.17%)
T_2:T_1 + Nutritious *ladoo*		9.89	10.73	0.84(7.83%)	41.98	42.28	0.29(0.7%)

dl, showed an increase of 0.84 g/dl, whilst the mean hemoglobin status of controlled group rendered as 9.96 g/dl. Improvement in the Hb levels clearly indicated the positive effect of nutritional intervention (Arunjyothi *et al*., 2021). Pearl millet based *ladoo* could be an efficient and promiscuous vehicle for reducing the prevalence of anemia in adolescent girls. A food-based intervention using pearl millet–based *ladoo* may be effectively employed to improve hemoglobin levels among adolescent girls, demonstrating efficacy comparable to elemental iron supplementation (Singh *et al*., 2014).

The present investigations reported that the mean hemoglobin levels after 45 days of intervention showed an increase of 0.84 g/dl (7.83 per cent) increased from 9.89 to 10.73 g/dl (0.3 per cent). Whilst the mean hemoglobin level of controlled group increased by 0.03 g/dl after 45 days. Supplementation with iron rich millet based *ladoo* also resulted in positive impact on gain in body weight showing an averageincrease of 0.290 g as compared to controlled group which showed an increase of 70 g only over the same period.

Conclusion

The OFT (on farm trial) conducted to know the impact of millet based iron rich nutritious *ladoo* among adolescent girls by KVK, Ganivan, Chitrakoot. Experimental adolescent girls were supplemented with 100 g of a millet-based ladoo for 45 days to meet approximately one-third of their daily iron requirement. Result showed that the mean hemoglobin levelof adolescent girls after 45 days of intervention showed an increase in value. Therefore, there is increase in hemoglobin level after intervention was found to be 1.24 g/dl in experimental girls, which indicated the positive impact of millet based *ladoo* on hematological health of adolescent girls. Improvement in the Hb levels clearly indicated the positive effect of dietary intervention among adolescent girls. The positive outcomes of the nutrition intervention highlight the immediate necessity for strengthening nutrition education among adolescents as a strategy for ensuring a healthier future population.

Acknowledgement

The authors are very thankful to the Deendayal Research Institute (DRI) for providing facilities and fund for conducting OFT in Ganivan (Chitrakoot), U.P.

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