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Evaluation and Impact of Niger Seed Fortified Cookies on Hemoglobin Level of School Children

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Abstract
Nutritional micro-nutrient deficiency is a public health problem in children and pregnant women in developing countries. Micronutrients are also available in food and can provide through direct supplementation. In this study aims to investigate the hemoglobin level of school-going children (age 6-10 years) randomly selected for the study. The present study works on supplemented cookies made with roasted niger seed powder on twenty-five subjects for 90 days. The selected group was supplemented daily with four serving and 30% of niger seed cookies for 90 days. No other supplementation was given to the anemic subjects.
The mean hemoglobin was found in the experimental group on 0 days (9.78) to 90 days (10.6). A significant difference was found in the mean of hemoglobin, respectively. The developed cookies were found to acceptability and efficacy as an iron supplement in combating mild to moderate iron deficiency anemia, which is reflected in the results.
Keywords- Niger seed**,** Micronutrient, Iron, Fortified food, Cookies.

Introduction

Nutritional anemia is a public health problem in developing countries. Its primary factors are poverty, limited dietary diversity, lack of knowledge, and the agricultural revolution that resulted in animal foods rich in bioavailable iron being displaced by cereals, legumes, and plant-based diets. According to the NFHS-5 India reports, 67% of children had some degree of anemia (< 11.0 g/dl). 29% of children had mild anemia, and 2% had severe anemia. Micro deficiency is a significant contributor to childhood morbidity and mortality. Micronutrients are available in foods and can also be provided through direct supplementation—iron deficiency is mostly the primary cause of anemia, which has serious health consequences for women and children. Niger seed is the best source of protein (Abebeetal 1978, Mulatu Geleta 2011), energy (Rohini Jain 2015), fat, essential vitamins, and minerals (Mulatu Geleta, Rodomiro Oritz 2013, Thatte and Lakshmi 2012). Niger seed which is belongs to the same family of sunflowers. Niger seed is Ethiopia's most important oil crop and a minor crop in India. Anti-oxidant activity had a health benefit on niger seed (Dutta et al., 1994; Richadson, 1996; M. F. Ramadan & J. T. Morsel, 2002). According to the Deepika Baranwal (2013) study, seed processing reduced the anti-nutrient level and increased iron availability.

This research paper focuses on the hemoglobin level of school children, examining the experimental cookies consumed regularly for three months (90 days).

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Methods and material

This investigation study was carried out at the department of home science of Bundelkhand University, Jhansi, and Uttar Pradesh, India. The school-going students aged 6-10 years at the local NGO. The study was carried out from January to march 2022. All the study participants obtained an informed consent form before the study of 25 children screened for anemia. All selected students were vegetarians.

Intervention

Each child received two servings of niger seeds cookies for 90 days. They estimated Hemoglobin levels before 0 days and after 90 days of supplementation using the cynomethemoglobin method. Blood samples were collected from each child by pinprick method at 0 days, assessed 30 days, 60 days, and 90 days of the supplementation period, and the effect of supplementation by changing hemoglobin level.

Ingredients and Nutritional Analysis

Ingredients of niger seeds cookies were niger seeds, refined wheat flour, sugar, butter, baking powder, and vanilla essence purchased from local market, Jhansi. Prepared The cookies were with roasted niger seeds and refined wheat flour with different ratios (100gm for control, 15% for 85:15gm of niger seed flour, 30% for 70:30gm of niger seed, and 45% for 55:45 of niger seed (Indicated in table C= control, C1= for 15% of niger seed cookies, C2= for 30% of niger seed cookies, and C3= for 45% of niger seed cookies). The dry ingredients were weighed, mixed with shortening, prepared in different ratios of dough, and prepared dough rest for 15 min in the refrigerator. Take a small dough ball, place it in a greased baking tray, and bake for 20-25 min at 1600C in the Bajaj majesty OTG oven. Then after baked cookies, allow cooling and packed in zip lock bags for sensory analysis. Cookies were final based on nine points hedonic scale. The highly acceptable cookies sample was analyzed for its proximate composition with AOAC methods, the protein was calculated with Kjeldahl methods, fat was calculated by the soxhlet method, and carbohydrate content was calculated by difference. Iron and zinc were calculated by the AAS method.

Statistical Analysis

Data were entered in a Microsoft Excel spreadsheet and analyzed using IBM SPSS version 22; results were presented in tables. The Hemoglobin was statistically significantly different at ($p \leq 0.0001$). Post-hoc analyses with a Bonferroni adjustment revealed that all the pair-wise differences between time points were statistically significantly different ($p \leq 0.05$).

Results and Discussion

Table no.1 Acceptability scores of Niger seed cookies-

Sample	Color	Flavor	Taste	Texture	Overall acceptability
C	$6.85^{ab}\pm1.15$	$7.4^{a}\pm0.65$	$7.6^{a}\pm0.45$	$7.4^{a}\pm1.17$	$6.85^{ab}\pm1.97$
C1	$7.35^{ab}\pm0.47$	$6.45^{b}\pm0.64$	$7.0^{abc}\pm0.16$	$7.5^{a}\pm0.57$	$6.75^{ab}\pm0.70$

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C2	6.55^{ab}±0.83	7.55^{a}±0.14	7.25^{abc}±0.50	6.32^{a}±1.06	7.2^{a}±0.68
C3	7.4^{ab}±0.51	6.9^{ab}±0.39	6.6^{ab}±0.45	7.2^{a}±0.63	5.29^{b}±1.56

Nutritional composition of supplementary cookies

According to the nine points hedonic scale, overall acceptability was acceptable (7.2), higher than the control and other experimental cookies. Analyzed C2 cookie was for nutritional parameters showing that the C2 cookies samples contain 10.32gm protein, 32.97gm fat, 0.18gm fiber, 1.68gm ash, and 52.02gm carbohydrate. Also, 1.19ppm iron and 1.03ppm zinc.

Table no.2- Nutritional analysis of cookies.

Sample	Nutrients*						
	Protein (gm)	Fat (gm)	Fiber (gm)	Ash (gm)	CHO (gm)	Iron (ppm)	Zinc (ppm)
C2 (30%)	10.32±0.0	32.97±0.0	0.18±0.0	1.68±0.0	52.02±0.07	1.19±0.0	1.03±0.0

The age of the participant was 5-10 years, and they belonged to a low socio-economic group in an industrial area. After the intervention, the mean hemoglobin level was found to be significantly increased by (10.6), which is significantly increased compared to 0 days (9.78) table no 1. The Hemoglobin was statistically significantly different at the different time points during the diet, $F(3, 72) = 352.638$, $p < 0.0001$, eta2 [g] = 0.288.Post-hoc analyses with a Bonferroni adjustment revealed that all the pair-wise differences between time points were statistically significantly different ($p <= 0.05$).

A similar study conducted by Baranwal et al. reported that after supplementation of niger seed laddoo for 75 days among adolescent girls, a net change in mean hemoglobin values was observed (0.85 ± 0.10 and 1.57 ± 0.15 g/dl, $p< 0.001$) in the control and experimental subject respectively. Another study was found by Hazra et al., who confirmed that the niger seed chutney supplements (25gm) for 30 days significantly increased the hemoglobin level in women.

This study confirms the findings of earlier- mentioned studies that niger seed supplementation helps in increasing the hemoglobin level among children with low levels of hemoglobin. The developed supplementary food that is niger seed cookies, was found to be acceptable, and its efficacy as an iron supplement in combating mild to moderate iron deficiency anemia is reflected in the results.

This study has a limitation of the small sample size and no use of a control group. Community-based randomized control trial with large sample size and research on the bioavailability of iron from niger seed cookies is recommended.

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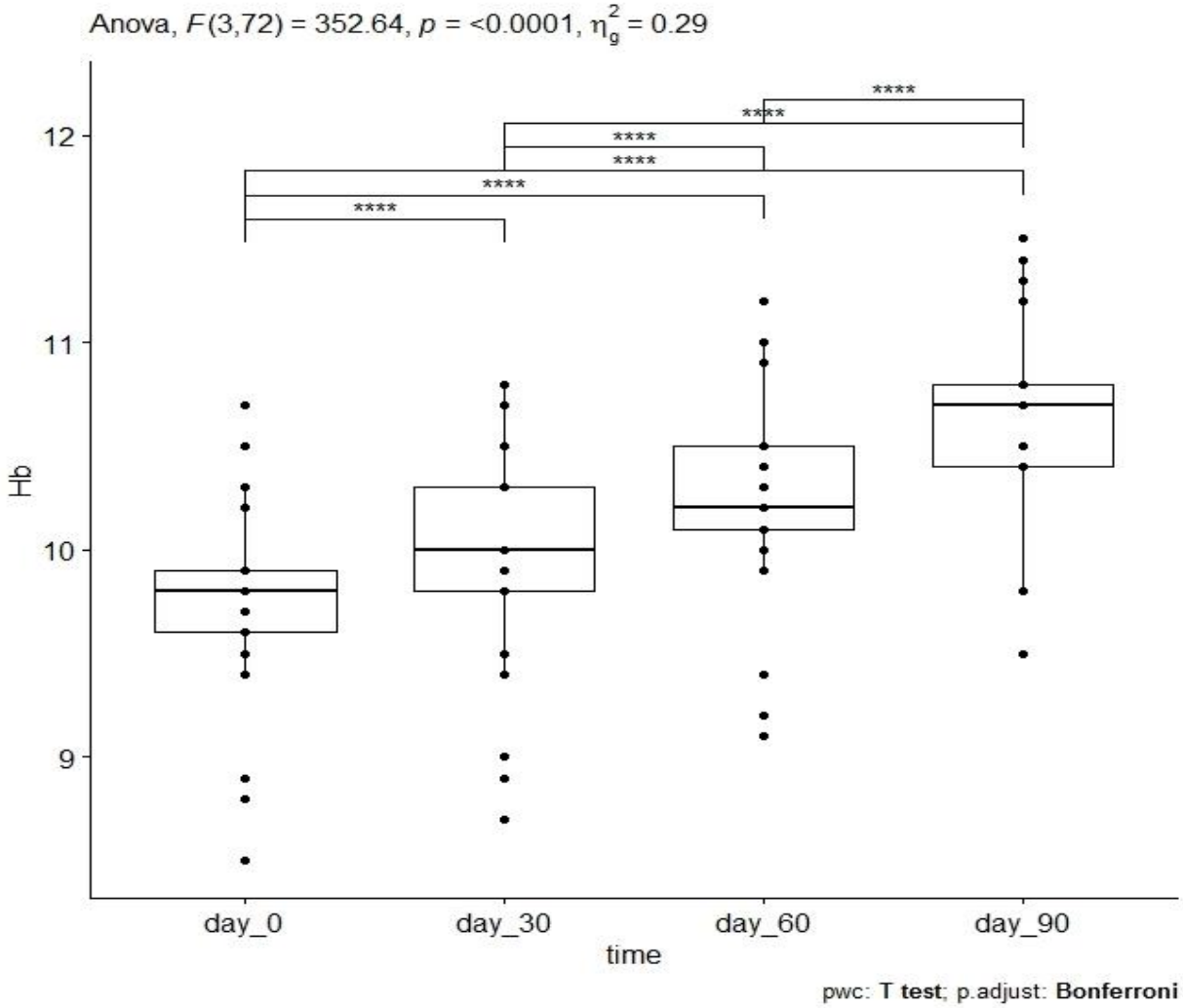
Table No. 3- Comparison of hemoglobin level at Baseline 0 days, 30 days, 60 days, to after 90 days among study Participant.

Days	0 day	30 days	60 days	90 days	p-value
Experimental group	9.78±0.53	9.94±0.54	10.2±0.51	10.6±0.51	5.96E-43*

Figure no. 1.



Conclusion

The results above show that all samples were prepared using different ingredients with pre-defined compositions. All designed niger seed sample cookies were finalized compared to the control sample, and based on sensory analysis (9 points hedonic sale), sample C2 (30% of niger seed) was finalized with overall acceptability. The finalized sample was stored with food-grade zip lock polyethylene and preserved at ambient temperature. Experimental sample cookies intake to 06-10 year child with both age groups, this observation continues in 90 days

(3 months). After 90 days of observation, results reflect that hemoglobin of every child was simultaneously increasing with increasing day-by-day observation, 9.7-10.6 g/dl, approximately 0.9 g/dl during 90 days under observation. Therefore during 90 days (3 months), approximately 0.9 g/dl hemoglobin level increases, so the C2 sample increases hemoglobin level. This finalized fortified Niger seed cookies (C2) sample is suitable for anemic patent and malnutrition. Niger seeds also have different antioxidants that prevent different diseases. Experimental cookies increase iron content concerning hemoglobin in the human body.

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