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Effect of Supplementation of Multigrain *Laddo* for Malnourished Children under 3–5 Years

Rosy Kumari[1], Deepak Bose[2]

Abstract

Malnutrition is one of the greatest single threats to the world's public health among children in developing countries according to the World Health Organization. It affects the child at the most crucial period, that is, stage of development, which can lead to permanent impairment in later life which includes reduced work capacity, growth retardation, and poor social and mental development. Half of all child deaths in India could be prevented if this one issue is tackled. Almost 11 million children die before they reach the age of five, four million of them in the 1st month of life. It is a significant public health problem described as a silent killer, silent emergency and invisible enemy affecting those who cannot express their voice and have to depend on others for their advocacy. The main objective of this study is to determine the effect of supplementation with the selected product on the nutritional status of the selected malnourished children. A baseline survey was conducted in four villages of Allahabad District, U.P. A total number of 382 respondents were selected (187 girls and 195 boys) for the present study. They belong to age group of 3–5 years. Four products were prepared with the help of incorporation composite flour. For each product, the basic recipes (control T_0) have three variations T_1, T_2, and T_3, respectively, were incorporated at different levels. The products such as *Laddo*, *Biscuit; Mathri,* and *Chakli* were developed. After supplementation, it is evident to note that there was a statistically significant improvement at 1% level and it was observed in the experimental and there was no increment in the weight of the selected subjects in the control group.

Keywords: Intervention, Nutrition, Supplementation

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Introduction

Protein Energy Malnutrition (PEM) affects children mainly under the age of 5 years. The first few years are most vital for a child's physical/mental/emotional health, for which proper nutrition is of utmost importance. Knowing the enormity of PEM, it is very important to diagnose the condition and prevent its complications at the earliest so as to avoid growth retardation and sickness. Malnutrition is the principal cause of child deaths. Half of all child deaths in India could be prevented if this one issue is tackled. Almost 11 million children die before they reach the age of 5, 4 million of them in the 1st month of life. It is a significant public health problem described as a silent killer, silent emergency and invisible enemy affecting those who cannot express their voice and have to depend on others for their advocacy.[1]

Despite India's remarkable economic growth over the last decade, many children still struggle to meet their basic needs, which include access to sufficient food and healthcare. In this context, it is important to get a more recent data on child's nutritional status.[2] Below the age of five, children comprise around 13% of the total population.[3] Faulty feeding practices are commonly observed and diets of most children are not adequate for calories and proteins as per Indian Council of Medical Research guidelines.

As India becomes more and more developed and we have greater means at our disposal, our response to our health challenges must reflect our changing health and socio-economic status. Under nutrition predisposes the child to infection and complements its effect in contributing to child mortality.[4] It is, therefore, logical to direct increasing attention to the quality of survivors. PEM and Micronutrient deficiencies are major contributors to higher mortality rates from illnesses and diseases such as pneumonia, malaria, diarrhea, and measles in the developing world. Stunting and wasting are significant effects of malnutrition.

[1]Department of Home Science, Patna Women's College, Patna University, Patna, Bihar, India

[2]Department of Agricultural Extension and Communication, Sam Higginbottom University of Agriculture Technology, and Sciences, Allahabad, Uttar Pradesh, India

Corresponding Author: Dr. Rosy Kumari, Department of Home Science, Patna Women's College, Patna University, Patna, Bihar, India. E-mail: angelrosy1991@gmail.com

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Objectives

The objectives are as follows:

1. To develop food products with the incorporation of the composite flour
2. To determine the effect of supplementation with the selected product on the nutritional status of the selected malnourished children.

Hypothesis

H_1: There was a significant difference in between the health status of the children Pre and Post treatment of *Laddo*.

Materials and Methods

The present investigation was carried out in the Nutritional Research Laboratory of the Department of Food Nutrition and Public Health, Ethelind College of Home Science, Sam

Higginbottom University of Agriculture, Technology and Sciences, Allahabad U.P. A descriptive cum experimental research design was followed to conduct the present study.

Descriptive research design is aimed at providing accurate description of variables relevant to the problem under consideration and is generally used for preliminary and exploratory study. On the other hand, in an experimental design, the researcher try to establish the causality between dependent and independent variable and taste a hypothesis. The respondents are randomly assigned to different condition and variables of interest are measured. Four villages (*Mahewa, Madoka, Amreha,* and *Bheeta*) under *Jasra* and *Chaka block* were selected purposively for the present study because the area are comparatively backward and such type a study was not done in previous year. The area selected for the pilot survey was prone to malnutrition.

A total of 382 respondents were selected by random sampling method. A total of 382 children (age 3–5 years) were selected purposively for the study. Out of the total children selected, 191 children were selected as sub- sample by stratified random sampling procedure. For the intervention study, 114 children were further selected and they were divided into two groups, experimental and control groups, having 57 malnourished children in each group.

Procurement of Raw Materials

Raw materials such as *Ragi flour*, *whole wheat flour*, Soya flour, *Moong dal flour,* and groundnut flour obtained from local market of Allahabad for the development of the various food products.

Preparation of Flour

Preparation of Wheat Flour and *Ragi* Flour

Wheat grains and *Ragi* were thoroughly cleaned to remove dirt, dust, insect excreta/feathers, and admixture of other food grains and dried directly in the sun for 3–4 days till the material was completely dried having 6–8% moisture content. The clean graded materials were ground in the electric grinder to make fine flour and sieved by 80–100 mesh sieves. The flour samples obtained were kept in airtight container before use.

Preparation of Soya Flour

Soy grains were thoroughly cleaned to remove the dust and other foreign materials. The clean grains were soaked in water for 4–6 h and then autoclaved for 5 min in a pressure cooker. They were removed and dried directly in the sun for 3–4 days till the material was completely dried having 6–8% moisture content. Soy was then ground to make fine flour and sieved through 80–100 mesh sieves. The flour samples obtained were kept in airtight container before use.

Preparation of *Green Gram* Dal Flour

Green gram dal was thoroughly cleaned to remove the dust and other foreign materials. The clean dal was soaked in water for 4–6 h. They were removed and dried directly in the sun for 3–4 days till the material was completely dried having 6–8% moisture content. Green gram dal was then ground to make fine flour and sieved through 80–100 mesh sieves. The flour samples obtained were kept in airtight container before use.

Preparation of Groundnut Flour

Groundnuts were thoroughly cleaned to remove, dust, insect excreta/feathers and admixture of other food grains. They were removed and roasted for till the groundnut become brown. The clean graded materials were ground in the electric grinder to make fine flour. The flour samples obtained were kept in airtight container before use.

Treatments and Replication of the Product

Main ingredient was replaced on the trial basis to ascertain the level of acceptability. The percentage of ingredients used to develop the low-cost energy and protein-rich products is shown in Table 1. All control and treatments were replicated 3 times.

Replications

Control and each of the treatments for each product were replicated 3 times. *Ragi flour, Moong dal flour*, Groundnut flour is in constant and the variations between *Whole wheat flour* and Soya flour were selected because it is rich in energy and protein, rich in mineral content, easily affordable at reasonable price which can be easily procured by the poorest of the poor.

Deworming

Soil-transmitted worms, including roundworms, hookworms, and whipworms are common in tropical and subtropical areas and particularly affect children in low-income areas where there is inadequate sanitation. Heavy worm infection is associated with malnutrition, poor growth, and anemia in children. Both the experimental and the control groups were given a medicine of deworming at baseline. This medicine (MemendaZol Syrup) was given to the children as per recommendations of the doctors. Deworming being

Table 1: Percentage of ingredients use to developed the low cost energy and protein rich products

Ingredient / *Treatments*	*Ragi flour (%)*	*Moong dal flour (%)*	*Soya flour (%)*	*Whole wheat flour (%)*	*Groundnut flour (%)*
T1	5	15	25	45	10
T2	5	15	30	40	10
T3	5	15	35	35	10

Figure 1: Deworming being conducted by the researcher

conducted by the researcher is shown in Figure 1. Deworming was done to ensure that there were no worms competing for the malnutrition and that the intestinal tract was as clear for absorption of the malnutrition.

Dietary Intervention and Post Intervention Data Collection

An informed parental consent was obtained for all the under 3–5 years old children enrolled in the study. The investigator first visited the Anganwadi centers in the selected villages, where the information regarding children (3–5 years) was provided by the Anganwadi workers. Data were collected by house-to-house visit using a predesigned scheduled method administered in the local language to obtain information regarding socio-demographic information, child feeding practices, anthropometry, nutritional deficiencies and others were involved in taking care of the child, were interviewed. PEM deficient children were divided into control and experimental groups. Nutritional status of the subjects was assessed prior to intervention.

Experimental group was fed with the selected protein energy rich developed food product, that is, *Laddo*, while the control group was not given any product or supplementation. During this intervention the protein energy rich standardized recipe was supplemented for a period of 4 months. The two *laddo* (each of 50 g) was supplemented and fulfill the 1/4th of RDA and the total amount of *laddo* was 100 g. The effects of feeding were determined after four months by analyzing the difference in malnutrition status before and after intervention in both the groups. Supplementation given by the researcher is shown in Figure 2. Dietary intakes, clinical assessment, and anthropometric measurements were also collected before, and after the feeding experiment for both the groups at identical time period.

Nutritional Intervention

Selection of respondents

Out of the surveyed 382 preschool children, 57 children were selected for the supplements. On the basic of degree of malnourishment 57 of them were selected form four distinct villages (*Mahewa, Madoka, Amreha,* and *Bheeta*) under *Jasra* and *Chaka block*.

Selection of the supplemented food product

On the basis of the organoleptic evaluation and nutritional composition the prepared product ""*Laddo*" was selected for the supplementation. It was found rich in energy (367 kcal/d), protein (16 g/d), calcium (67 mg/d), and iron (16 mg/d).

Nutritional Intervention

Comparison of Mean Height (cm.) of Respondents with NCHS Standard

Table 2 shows that the mean levels of the details of regarding the height of the selected subjects in the experimental groups. The mean height of the selected male subjects aged between 3 and 5 years ranged from 80.02 ± 0.9, 88.7 ± 1.21, and 99.4 ± 2.0, respectively, and the mean height of the selected female subjects aged between 3 and 5 years ranged from 85.75 ± 6.95, 92.38 ± 1.21, and 101.06 ± 1.33, respectively There was the significant difference between the observed mean value and NCHS standard at $P \leq 0.05$ and $P \leq 0.01$.

Comparison of Mean Weight (kg.) of Respondents with NCHS Standard

Table 3 shows that the mean levels of the details of regarding the weight of the selected subjects in the experimental groups. The mean weight of the selected male subjects aged between 3 and 5 years ranged from 11.6 ± 2.94, 12.89 ± 2.64, and 15.11 ± 1.66, respectively, and the mean weight of the selected female subjects aged between 3 and 5 years ranged from 11.8 ± 3.01, 12.74 ± 3.21, and 14.6 ± 3.12, respectively There was the significant difference between the observed mean value and NCHS standard at $P \leq 0.05$ and $P \leq 0.01$.

Comparison of Mean MUAC (cm.) of Respondents with NCHS Standard

Table 4 shows that the mean levels of the details of regarding the MUAC of the selected subjects in the experimental groups. The mean MUAC of the selected male subjects aged between 3 and 5 years ranged from 14.9 ± 0.3, 15.7 ± 0.1, and 16.5 ± 0.4, respectively, and the mean height of the selected female subjects

Figure 2: Supplementation given by researcher

Table 2: Comparison of mean height (cm.) of respondents with 50th NCHS standard

Age (Years)	*Gender*	*Experimental group n=57*					*Control group n=57*				
		No. of respondents	*Mean±S.E.*	*NCHS Standard*	*t-value*	*Difference*	*No. of respondents*	*Mean±S.E.*	*NCHS Standard*	*t-value*	*Difference*
3 Years	Female	7	85.75±6.95	93.9	13.01**	-8.15	6	88.29±4.12	93.9	16.12**	-5.61
	Male	7	80.02±0.9	94.9	15.24**	-8.15	5	73.3±2.4	94.9	9.67**	-21.6
4 Years	Female	17	92.38±1.21	101.6	32.32**	-9.22	15	74.27±1.21	101.6	21.24**	-27.33
	Male	10	88.7±1.21	102.9	18.23**	-9.22	10	87.5±5.4	102.9	18.05**	-28.63
5 Years	Female	9	101.06±1.33	108.4	17.33**	-7.34	11	98.56±2.15	108.4	13.17**	-9.84
	Male	7	99.4±2.0	109.9	17.81**	-7.34	10	92.6±1.4	109.9	14.82**	11.34

±: S.E, *Significant, $P \leq 0.05$, **Significant, $P \leq 0.01$, Source: Srilakshmi, 2014, NCHS: National Centre for Health Statistics

Table 3: Comparison of mean weight (kg.) of respondents with 50th NCHS Standard

Age (3-5 Years)	Gender	Experimental group n=57					Control group n=57				
		No. of respondents	Mean±S.E	NCHS Standard	t-value	Difference	No. of respondents	Mean±S.E.	NCHS Standard	t-value	Difference
3 Years	Female	7	11.8±3.01	14.1	6.5**	−2.3	6	12.12±2.32	14.1	17.5**	−1.98
	Male	7	11.6±2.94	14.1	6.58**	−1.5	5	12.17±1.17	14.1	17.59**	−1.93
4 Years	Female	17	12.74±3.21	16	13.9**	−3.26	15	14.27±1.13	16	19.4**	−1.73
	Male	10	12.89±2.64	16	13.91**	−3.11	10	13.24±3.76	16	19.41**	−2.76
5 Years	Female	9	14.6±3.12	17.7	15.8**	−3.1	11	13.56±1.25	17.7	15.71**	−4.14
	Male	7	15.11±1.66	17.7	15.82**	−2.59	10	14.32±1.39	17.7	15.71**	−3.38

±: S.E, *Significant, $P \leq 0.05$, **Significant, $P \leq 0.01$, Source: Srilakshmi, 2014, NCHS: National Centre for Health Statistics

Table 4: Comparison of Mean MUAC (cm.) of respondents with 50th NCHS Standard

Age (3–5 Years)	Gender	Experimental group n=57					Control group n=57				
		No. of respondents	Mean±S.E	NCHS Standard	t-value	Difference	No. of respondents	Mean±S.E	NCHS Standard	t-value	Difference
3 Years	Female	7	10.92±0.3	15.9	5.27**	−4.98	6	9.21±0.5	15.9	4.53**	−6.69
	Male	7	14.9±0.3	16.2	5.61**	−1.3	5	12.8±0.23	16.2	7.42**	−3.4
4 Years	Female	17	11.62±0.1	16.9	5.13**	−5.28	15	13.24±0.5	16.9	3.21**	−3.66
	Male	10	15.7±0.1	16.9	5.25**	−1.2	10	12.9±0.4	16.9	7.76**	−4
5 Years	Female	9	14.23±0.4	16.9	3.83**	−2.67	11	15.7±0.1	16.9	3.95**	−1.2
	Male	7	16.5±0.4	17.1	7.52**	−0.6	10	11.9±0.2	17.1	9.73**	−5.2

±: S.E, *Significant, $P \leq 0.05$, **Significant, $P \leq 0.01$, Source: Srilakshmi, 2014, NCHS: National Centre for Health Statistics

Table 5: Comparison of Mean Chest Circumference (cm.) of respondents with 50th NCHS Standard

Age (Years)	Gender	Experimental group n=57					Control group n=57				
		No. of respondents	Mean±S.E	NCHS Standard	t-value	Difference	No. of respondents	Mean±S.E.	NCHS Standard	t-value	Difference
3 Years	Female	7	44.57±0.16	47.4	2.65*	−2.83	6	45.6±0.8	47.4	5.36**	−1.8
	Male	7	47.9±0.12	49	2.83**	−1.1	5	41.12±0.6	49	3.22**	−7.88
4 Years	Female	17	44.59±0.31	48.6	2.53*	−4.01	15	49.14±0.32	48.6	3.97**	−0.54
	Male	10	55.1±0.22	50	3.42**	−5.1	10	45.11±0.6	50	5.34**	−4.89
5 Years	Female	9	45.18±0.12	50.9	3.96**	−5.72	11	46.35±0.17	50.9	4.23**	−4.55
	Male	7	42.7±0.6	51.3	3.91**	−8.6	10	44.01±1.3	51.3	4.51**	−7.29

±: S.E, *Significant, $P \leq 0.05$, **Significant, $P \leq 0.01$, Source: Srilakshmi, 2014, NCHS: National Centre for Health Statistics

Table 6: Comparison of mean head circumference (cm.) of respondents with 50th NCHS standard

Age (Years)	Gender	Experimental group n=57					Control group n=57				
		No. of respondents	Mean±S.E	NCHS Standard	t-value	Difference	No. of respondents	Mean±S.E.	NCHS Standard	t-value	Difference
3 Years	Female	7	44.85±0.2	46.7	5.0**	−1.85	6	45.7±1.6	46.7	4.11**	−1
	Male	7	49.3±0.3	48.2	4.62**	−1.1	5	35.4±1.8	48.2	4.5**	−12.8
4 Years	Female	17	45.37±0.2	47.5	4.62**	−2.13	15	43.7±1.3	47.5	4.32**	−3.8
	Male	10	43.6±1.1	49	4.1**	−5.4	10	40.7±0.5	49	2.9**	−8.3
5 Years	Female	9	46.58±1.42	48.6	5.54**	−2.02	11	35.31±1.5	48.6	5.34**	−13.29
	Male	7	44.0±0.6	49.2	8.5**	−5.2	10	41.9±0.4	49.2	4.1**	−7.3

±: S.E, *Significant, $P \leq 0.05$, **Significant, $P \leq 0.01$, Source: Srilakshmi, 2014, NCHS: National Centre for Health Statistics

Table 7: Effect of developed product "laddo" on various forms of malnutrition

Particulars	Ranges	Experimental Group (n=57)				Control group (n=57)			
		Pre-intervention		Post–intervention		Pre-intervention		Post–intervention	
		n	%	n	%	n	%	n	%
Weight-for-age									
Normal	(>80)	-	-	-	-	-	-	-	-
Mild	(71–80)	24	42.10	32	56.14	4	7.01	4	7.01
Moderate	(61–70)	29	50.08	23	40.35	52	91.22	52	91.22
Severe	(51–60)	4	7.01	2	3.50	1	1.75	1	1.75
Very Severe	(>50)	-	-	-	-	-	-	-	-

aged between 3 and 5 years ranged from 10.92 ± 0.3, 11.62 ± 0.1, and 14.23 ± 0.4, respectively There was the significant difference between the observed mean value and NCHS standard at $P \leq 0.05$ and $P \leq 0.01$.

Table 8: Height of the selected subjects in the study groups (before and after supplementation)

Age (Years)	Experimental Group (n=57)				Control group (n=57)			
	Mean±SD		Mean Difference	Calculated "t" value	Mean±SD		Mean Difference	Calculated "t" value
	Initial (pre)	Final (post)			Initial (pre)	Final (post)		
3	101.08±2.67	103.96±2.97	2.88	23.7359*	92.56±2.16	92.78±2.74	0.22	3.6921^{NS}
4	106.22±4.13	107.32±4.17	1.1	15.6732*	98.96±3.48	98.76±3.98	0.2	2.6342^{NS}
5	109.67±1.16	111.66±1.76	1.99	8.9264*	108.45±1.33	108.76±2.63	0.31	2.3113^{NS}

*: Significant at 5% level, NS: Non-significant

Table 9: Weight of the selected subjects in the study groups (before and after supplementation)

Age (Years)	Experimental Group (n=57)				Control group (n=57)			
	Mean±SD		Mean Difference	Calculated "t" value	Mean±SD		Mean Difference	Calculated "t" value
	Initial (pre)	Final (post)			Initial (pre)	Final (post)		
3	11.61±1.22	13.11±1.87	1.5	25.56*	10.32±1.22	10.92±2.01	0.6	2.6127^{NS}
4	14.62±2.26	16.29±2.12	1.67	13.26*	12.27±2.26	12.68±2.33	0.41	2.1962^{NS}
5	18.62±2.21	20.21±4.12	1.59	7.69*	1s4.19±2.21	14.58±1.60	0.39	2.3694^{NS}

*: Significant at 5% level, NS: Non-significant

Comparison of Mean Chest Circumference (cm.) of Respondents with NCHS Standard

Table 5 shows that the mean levels of the details of regarding the Chest Circumference of the selected subjects in the experimental groups. The mean Chest Circumference of the selected male subjects aged between 3 and 5 years ranged from 47.9 ± 0.12, 55.1 ± 0.22, and 42.7 ± 0.6, respectively, and the mean height of the selected female subjects aged between 3 and 5 years ranged from 44.57 ± 0.16, 44.59 ± 0.31, and 45.18 ± 0.12, respectively There was the significant difference between the observed mean value and NCHS standard at $P \leq 0.05$ and $P \leq 0.01$.

Comparison of Mean Head Circumference (cm.) of Respondents with NCHS Standard

Table 6 shows that the mean levels of the details of regarding the chest circumference of the selected subjects in the experimental groups. The mean chest circumference of the selected male subjects aged between 3 and 5 years ranged from 49.3 ± 0.3, 43.6 ± 1.1, and 44.0 ± 0.6, respectively, and the mean height of the selected female subjects aged between 3 and 5 years ranged from 44.85 ± 0.2, 45.37 ± 0.2, and 46.58 ± 1.42, respectively There was the significant difference between the observed mean value and NCHS standard at $P \leq 0.05$ and $P \leq 0.01$.

Table 7 shows the distribution of selected subjects according to their malnutrition level before and after intervention in experimental and control groups. Varying degrees of malnutrition was prevalent among preschool children in both the groups.

For wasted (Weight-for age), there are no any children under normal stage. In experimental group at pre-intervention stage 7.01% subjects were severely malnourished, 50.08% moderate, and 42.10% subject's mild malnutrition. In experimental group, there was slight improve in malnutrition after intervention the changes were observed 3.50% subjects were severely malnourished, 40.35% moderate, and 56.14% subjects mild malnutrition. In control group, 1.75% subjects were found severely malnourished, 91.22% moderate, and 7.01% subjects mild malnutrition and no change was observed after intervention.

NCHS-National Centre for Health Statistics (2002)

The mean height of selected subject in both experimental and control group was below the NCHS standard values. Table 8 shows that the mean before and after intervention study. Levels of the details of regarding the height of the selected subjects in the study groups. The mean height of the selected subjects aged 3–5 was 101.08, 106.22, and 109.67, respectively, before supplementation. After supplementation, it is evident to note that there was a statistically significant improvement at one per cent level and it was observed in the experimental and there was no increment in the height of the selected subjects in the control group. By conclusion, It is evident that after supplementation of multigrain "*laddo*" providing 369 kcal energy, 17.43 g protein, and 15.74 mg iron per day for a period of 4 months, there was significant rise in level of experimental group ($P < 0.05$) whereas, the change in level of control group was found non-significant at 5% probability level ($P < 0.05$).

NCHS-National Centre for Health Statistics (2002)

The mean weight of selected subject in both experimental and control group was below the NCHS standard values.

Table 9 shows that the mean levels of the details of regarding the weight of the selected subjects in the study groups before and after intervention study. The mean height of the selected subjects aged 3–5 was 11.61, 14.62, and 18.62, respectively, before supplementation. After supplementation, 13.11, 16.29, and 20.21, respectively, it is evident to note that there was a statistically significant improvement at 1% level and it was observed in the experimental and there was no increment in the weight of the selected subjects in the control group. By conclusion, it is evident that after supplementation of multi grains "*laddo*" providing 15–19 mg/day iron for a period of 4 months, there was significant rise in level of experimental group ($P < 0.05$) whereas, the change in level of control group was found non-significant at 5% probability level ($P < 0.05$).

Summary and Conclusion

A baseline survey was conducted in four villages of Allahabad District, U.P. A total number of 382 respondents were selected (187 girls and 195 boys) for the present study. They belong to age group of 3–5 years. After selection of respondents, pre intervention data were collected through a pre tested survey schedule and each respondents were interviewed personally. The survey schedule

contained question related to general profile, anthropometric measurement, clinical assessment, dietary information, personal hygiene, and other information. Pre-intervention knowledge level of respondents was measured using knowledge test schedule which include nutrition related questions.

Four products were prepared with the help of incorporation composite flour. For each product, the basic recipes (control T_0) have three variations T_1, T_2, and T_3, respectively, were incorporated at different levels. The products like *Laddo*, *Biscuit; Mathri* and *Chakli* were developed. The observations were recorded, tabulated, and statistically analyzed by the following analysis of variance technique and critical difference. The organoleptic evaluation of the products was done by "9 Point Hedonic Scale" and their proximate composition and minerals were analyzed with the use of standardized methods.

The mean height of the selected subjects aged 3–5 was 101.08, 106.22, and 109.67, respectively, before supplementation. After supplementation, it is evident to note that there was a statistically significant improvement at 1% level and it was observed in the experimental and there was no increment in the height of the selected subjects in the control group. The mean height of the selected subjects aged 3–5 was 11.61, 14.62, and 18.62, respectively, before supplementation. After supplementation, 13.11, 16.29, and 20.21, respectively, it is evident to note that there was a statistically significant improvement at 1% level and it was observed in the experimental and there was no increment in the weight of the selected subjects in the control group.

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