



## **Effect of Bajra (*Pennisetum glaucum*) Based Supplementary Food on Anthropometric Parameters of School Children (5-6 Year Old)**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Aims:** To study the effect of bajra (*Pennisetum glaucum*) based supplementary food on anthropometric parameters of school going girl children.

**Methodology:** Two groups of 30 girl children in the age group of five to six year each were selected. Total number of children participated in the present study was 60. First group constituted non supplemented (control); the second group of children (experimental) was supplemented 100 g of bajra based supplementary food mix in the form of biscuits along with their home diet for a period of 100 days. The anthropometric parameters like height, weight, mid-upper arm circumference and waist hip ratio were measured before and after the administration of supplementary food. The data obtained from the study subjects were quantified, classified, tabulated and expressed in percentages. The paired 't' test was used for pre and post treatments comparison.

**Results:** Among the two groups studied, highest increment in weight was recorded by the children

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on experimental group (0.7 kg) followed by an increment of 0.62 kg in control. After the supplementation for a period of 100 days, the mean height of the experimental group children increased slightly by 0.34 cm, whereas in the control group the mean height increase was only 0.12 cm for the same period. The mean increment in mid upper arm circumference of the selected children was 0.1 cm (control group) and 0.21 cm (experimental group). The presence of moderate malnutrition grade was decreased from 63 to 53 per cent and 44 to 40 per cent in control and experimental group, respectively. Normal children in control and experimental group increased after intervention from 3.0 per cent to 7.0 per cent and 20 to 23 per cent, respectively.

**Conclusion:** Supplementation with bajra based supplementary food mix has improved the anthropometric and clinical symptoms of the selected children. Long term feeding trials with supplementary food mix could improve the nutritional status of the children.

**Keywords:** Supplementation; bajra; anthropometric; children; food mix.

## 1. INTRODUCTION

In developing countries like India various forms of malnutrition affect a large segment of population and both macro and micronutrient deficiencies are of major concerns. The school age period is nutritionally significant because this is the prime time to build up body stores of nutrients in preparation for rapid growth of adolescence [1]. Growth retardation is not only an important and objective manifestation of malnutrition, but also, perhaps, is the first response to nutritional deprivation. Measurement of growth, therefore, for long, has been considered a valuable tool for the assessment of nutritional status, particularly of children. It has now been generally accepted that nutritional anthropometry has a significant role in the direct assessment of nutritional status in communities, particularly in young children. The methods and measurements can vary greatly in number and complexity. One should select a minimum number of relatively simple methods that can give useful, if approximate, practical information on a community basis [2]. By the time children enter school, undernourished children already lag behind with regard to not just physical, but also cognitive, behavioural and emotional development [3]. Supplementary feeding programmes constitute the most promising and effective measures to overcome the nutritional problem among children and improve the quality of their performance in school. So there is an urgent need to promote healthy weaning practices and the consumption of nutritionally sound, low cost supplementary foods to prevent the development of nutritional deficiency among infants and young children in developing countries including South Asia. Supplementary foods provide those additional nutrients that are lacking in day to day meals. Bajra (*Pennisetum glaucum*) is one of the most widely grown millet in India. It is grown in about 7.6 million hectares

and yielding 9.1 million tons of grains per year. Bajra contains starch (61.78%), crude protein (10.96%), fat (5.43%), ash (1.37%) and dietary fiber (11.49%). The calcium, magnesium, phosphorus and iron content of pear millet are 27.35, 124.00 and 289.00, 6.42 mg, respectively [4]. Bajra is dense in essential nutrients and can be utilized along with pulses and oil seeds for the preparation of supplementary foods to improve the nutritional status of school children. Hence an attempt was undertaken to study the effect of bajra based nutrient supplementation on anthropometric parameters of school children.

## 2. METHODOLOGY

### 2.1 Preparation of Supplementary Food Mix

The supplementary food mix was prepared on the basis of a standardized supplementary food, 'Kuzhandai Amudhu' composition [5]. The bajra, Bengal gram, ground nut and jaggery are taken in the ratio of 30:20:10:20 and 5.0 per cent of carrot and araikeerai (*Amaranthus dubius*) powder were also incorporated.

### 2.2 Preparation of Biscuits

Supplementary food mix (100 g), baking powder (0.2 g) and cardamom powder (0.2 g) were mixed together, then sieved twice. Shortening (40 g) and powdered sugar (50 g) were creamed, blended with flour and made into dough. The dough was then rolled, biscuits were cut, baked at 160°C for 15 minutes, cooled and evaluated for its proximate composition.

### 2.3 Chemical Analysis

Protein, fat,  $\beta$ -carotene, calcium and iron content of the supplementary food mix and biscuits

prepared from supplementary food mix were determined by AOAC method [6].

## 2.4 Selection of Study Area

It was planned to conduct the study in semi-rural area. For the present study Loosi Bery Noble special girl's school, at Moonrumavadi in Madurai district, Tamilnadu was selected, since this school served the community characterized by low socio-economic status. The school was located within 2.0 km from MGR (Mattuthavani) bus stand of central Madurai. Before starting the study, relevant information were collected to confirm that there were no noteworthy differences in characteristics between the children in the selected school or their environment that might cause confounding. The children in selected school represented a socio-economically homogenous population from lower income.

## 2.5 Study Design

To study the impact of intervention, two groups of 30 girl children in the age group of five to six year each were selected. Total number of children participated in the present study was 60. First group constituted non supplemented (control); the second group of children (experimental) was supplemented 100 g of bajra based supplementary food mix in the form of biscuits along with their home diet for a period of 100 days. The biscuits were distributed twice daily (5 biscuits for each serving) except Saturday and Sunday. To maximize the bioavailability of biscuits it was given without other foods between 11.00 AM and 12.00 Noon and 3.00 and 4.00 PM at a time intervals of two hours after breakfast and two hour before lunch and also two hours after lunch. Both control and experimental group of children were given mebendazole (500 mg) before the supplementation.

## 2.6 Inclusion Criteria and Exclusion Criteria

Inclusion criteria were children of age 5-6 years, those children whose parents were willing to participate in study. Exclusion criteria were children aged less than 5 years and more than 6 years, those Children with congenital diseases, history of metabolic diseases, chronic diseases, physical and mental impairment that could influence their growth. Children who were too

agitated and unwilling for anthropometric measurements were excluded from the study.

## 2.7 Anthropometric Measurements

The anthropometric parameters like height, weight, mid-upper arm circumference and waist hip ratio were measured before and after the administration of supplementary food [7].

## 2.8 Comparison of Height and Weight with Standards

On the basis of weight and height measurements, the relative body weight (weight as percentage of standard weight for age) as a criterion of current nutrition status and the relative body height (percentage of standard height for age) as a criterion of growth performance were calculated. Relative body weight and relative body height were calculated using the WHO reference standard [8]. The weight for age, height for age and weight for height index helps in assessing the stage of malnutrition.

## 2.9 Clinical Examination

Number of physical signs, some specific and others non-specific, known to be associated with the status of malnutrition were observed in the selected school going children. Medical officer has examined the children. After examining the children, the prevalence of any deficiency signs were recorded [9,10].

## 2.10 Statistical Analysis

The general information of study subjects were quantified, classified, tabulated and expressed in percentages. The paired 't' test was used for pre and post treatments comparison [11].

## 3. RESULTS AND DISCUSSION

### 3.1 Chemical Composition of Food Mix and Biscuits

The protein, fat, calcium, iron and  $\beta$ -carotene ( $\mu\text{g}$ ) content of bajra based supplementary food mix were 15.85 g, 9.85 g, 490.20 mg, 9.13 mg and 8,048  $\mu\text{g}$  per 100 gram and the corresponding value of biscuits prepared from supplementary food mix were 15.71 g, 30.14 g, 490.20 mg, 9.11 mg and 8,021  $\mu\text{g}$ , respectively (Table 1).

**Table 1. Chemical composition of supplementary food mix and biscuits**

Nutrients	Supplementary food mix	Biscuits (prepared from supplementary food mix)
Protein (%)	15.85±0.24	15.71±0.39
Fat (%)	9.85±0.17	30.14±0.62
Calcium (mg)	490.20±4.67	490.20±5.34
Iron (mg)	9.13±0.19	9.11±0.27
β-carotene (μg)	8,048±109.51	8,021±49.11

**Table 2. Baseline anthropometric measurements of the selected children**

Anthropometric measurements	Groups (mean + SD)		
	Control	Experimental	't' value
Weight (kg)	14.30 ± 2.32	13.50 ± 1.58	1.23884 NS
Height (cm)	105.86 ± 4.84	106.30 ± 5.53	1.00811 NS
Mid upper arm circumference (cm)	14.60 ± 1.06	15.39 ± 1.12	3.05354**
Waist hip ratio	0.76 ± 0.04	0.79 ± 0.04	0.72724 NS
Weight for age (% of standards)	73.13 ± 8.90	77.45 ± 10.21	1.67751 NS
Height for age (% of standards)	96.74 ± 6.82	90.42 ± 4.33	1.04905 NS
Weight / height index	0.134 ± 0.02	0.128 ± 0.012	1.44838 NS

\*\* At 1 % level of significance

**Table 3. Clinical examination of selected children for nutritional deficiency symptoms**

Clinical signs	Control group		Experimental group	
	Initial	Final	Initial	Final
<b>General appearance</b>				
Active	25 (83.0)	26 (87.0)	26 (87.0)	30 (100.0)
Dull	5 (17.0)	4 (13.0)	4 (13.0)	-
<b>Hair</b>				
Normal	27 (90.0)	27 (90.0)	13 (43.0)	20 (67.0)
Loss of luster	3 (10.0)	3 (10.0)	12 (40.0)	10 (33.0)
Discoloured and dry	-	-	5 (17.0)	-
<b>Teeth</b>				
Normal	17 (56.0)	17 (56.0)	14 (47.0)	14 (47.0)
Chalky teeth	8 (27.0)	8 (27.0)	1 (3.0)	1 (3.0)
Pitting of teeth	5 (17.0)	5 (17.0)	15(50.0)	15(50.0)
<b>Skin</b>				
Normal	28 (93.0)	28 (93.0)	27 (90.0)	30 (100)
Loss of luster	2 (7.0)	2 (7.0)	3 (10.0)	-

Figures in parentheses represent percentage to total

### 3.2 Baseline Anthropometric Measurements of Children

Anthropometric measurements is the important tools to picturize the nutritional status of the individual. Anthropometric parameters of the selected children are presented in the Table 2. From the table it is inferred that initial anthropometric parameters of the children in both the group was lower than the normal level. The mean weight and height of the children in experimental were 13.50 kg and 106.30 cm and

the corresponding value of the control were 14.30 kg and 105.86 cm, respectively.

The mean mid-upper arm circumference was 14.60 to 15.39 cm in control and experimental group. Bhan and Kaur [12] noted that the mean value of mid-upper arm circumference was 15.0 cm and 16.3 cm in the age group of 5 and 6 respectively. Similar trend was noted in the present study too. The height for age was higher in both control and experimental group than the weight for age.

The weight / height index of all the children in both groups were less than the normal standard value (0.15). The weight / height index of control group was 0.134, which was higher than the experimental group (0.128). The waist hip ratio of the selected children was normal in both control and experimental group of children. From the results it was concluded that the central obesity was not present in the selected children (both control and experimental group). Sachithananthan and Chandrasekhar [13] revealed that the height / weight index of the different age groups of the male and female population, studied was below the standard of 0.15 (ranged from 0.13 to 0.14). Similar observation was noted in the present study also.

### 3.3 Effect of Supplementation on the Clinical Symptoms of the Selected Children

Table 3 shows the details about the clinical examination of selected children for nutritional deficiency symptoms before and after supplementation. Majority of the children (83% and 87%) in control and experimental group were active. The percentage of dull children in control (17% and 13%) and experimental group (13% and zero per cent) was decreased after supplementation. However, there was no change in the percentage of chalky teeth and pitting of teeth at the end of study completion. None of the children in all the groups have vitamin A and iron deficiency. Dry skin and dry hair showed a slight decrease after the study completion (only in experimental group).

Chandrasekhar and Rani [14] estimated the effect of supplementation of Soy Protein Isolate (SPI) based food mix on 1-2 year old malnourished children. The results showed that the reduction in all the clinical symptoms of nutritional disorders was observed in SPI based food based food mix supplemented groups than in the other two groups.

### 3.4 Effect of Supplementation on Anthropometric Status

The effect of supplementation on increment in weight, height, Weight / Height ratio, Mid upper arm circumference (cm) is given in the Table 4.

#### 3.4.1 Mean increment in weight of the selected children

Among the two groups studied, highest increment in weight was recorded by the children on experimental group (0.70 kg) followed by an

increment of 0.62 kg in control. Even their final values in both groups did not reach the standard value. The increments found in both the groups were significantly different.

#### 3.4.2 Mean increment in height of the selected children

Initially the height of both control and experimental group of all the children were below the standard height. After the supplementation for a period of 100 days, the mean height of the experimental group children increased slightly by 0.34 cm, whereas in the control group the mean height increase was only 0.12 cm for the same period. The increase in height may be due to the protein content of supplementary food supplied during the intervention period. The increments in height increased very marginally but distinctly. Vuong et al. [15] reported that there was no change in height at the end of supplementation.

#### 3.4.3 Weight / height index of the selected children

The mean weight / height index for each of children was calculated from the individual weight and height of the children. This index was chosen to be calculated because weight / height ratio is more sensitive index to assess the degree of malnutrition among all other indices for children and was found to be independent of age and sex even in longitudinal studies. The highest value for this ratio was registered by control group (0.134), followed by experimental group (0.129) at the study entry and it was increased to 0.136 and 0.131, respectively at the final. The results are in line with the results of Chandrasekhar and Rani and Rahman et al. [14,16].

#### 3.4.4 Mid upper arm circumference

The mean increment in mid upper arm circumference of the selected children was 0.10 cm (control group) and 0.21 cm (experimental group). The mean increment in mid upper arm circumference was high in experimental group than the control group. This mean increment in mid upper arm circumference of the children was significant at one per cent level.

Chandrasekhar and Rani stated that the mean increment in mid upper arm circumference of grade III children was 0.30 cm with the initial and final values of 11.70 cm and 12.0 cm respectively [14]. Similar trend was observed in the present investigation too.

**Table 4. Effect of supplementation on anthropometric status**

Groups	Anthropometric parameters			
	Initial	Final	Difference	't' value
<b>Weight (kg)</b>				
Control	14.30 ± 2.32	14.92 ± 2.39	0.62	4.04867**
Experimental	13.50 ± 1.58	14.20 ± 1.65	0.70	5.2668**
<b>Height (cm)</b>				
Control	105.86 ± 4.84	105.98 ± 4.16	0.12	9.80958**
Experimental	106.30 ± 5.53	106.64 ± 5.10	0.34	13.4524**
<b>Weight / Height ratio</b>				
Control	0.134 ± 0.02	0.136 ± 0.02	0.002	1.00007 NS
Experimental	0.129 ± 0.01	0.131 ± 0.01	0.002	1.42094 NS
<b>Mid upper arm circumference (cm)</b>				
Control	14.60 ± 1.06	14.70 ± 1.08	0.10	0.26655 NS
Experimental	15.39 ± 1.12	15.60 ± 1.21	0.21	0.305354**

\*\* At 1 % level of significance

**Table 5. Changes in nutritional status of children on the basis of weight-for-age**

Degree of malnutrition	Control group		Experimental group	
	Initial	Final	Initial	Final
Normal (> 90)	1 (3.0)	2 (7.0)	6(20.0)	7 (23.0)
Mild (75 – 90)	8 (27.0)	11 (37.0)	10 (33.0)	10 (34.0)
Moderate (60 -75)	19 (63.0)	16 (53.0)	13 (44.0)	12 (40.0)
Severe (< 60)	2 (7.0)	1 (3.0)	1 (3.0)	1 (3.0)
Total	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)

Figures in parentheses represent percentage to total

**Table 6. Changes in nutritional status of children on the basis of height-for-age**

Degree of malnutrition	Control group		Experimental group	
	Initial	Final	Initial	Final
Normal (> 90)	27 (90.0)	27 (90.0)	26(87.0)	27 (90.0)
Mild (75 – 90)	3 (10.0)	3 (10.0)	4 (13.0)	3 (10.0)
Moderate (60 -75)	-	-	-	-
Severe (< 60)	-	-	-	-
Total	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)

Figures in parentheses represent percentage to total

### 3.5 Changes in Nutritional Status of Children on the Basis of Weight for Age

Table 5 shows the changes in weight for age at the end of dietary intervention. The presence of moderate malnutrition grade was decreased from 63 to 53 per cent and 44 to 40 per cent in control and experimental group, respectively. Normal children in control and experimental group increased after intervention from 3.0 per cent to 7.0 per cent and 20 to 23 per cent, respectively.

Jayakumar et al. [17] investigated the effect of red palm oil, retinol palmitate and groundnut oil on preschool children in Ramanathapuram

District of Tamilnadu for a period of 7 month which did not reveal any change in weight for age in majority of the children. Similar result was noted in the present study too.

### 3.6 Changes in Nutritional Status of Children on the Basis of Height for Age

Table 6 represents the details of changes in height for age. Control group maintained their height for age at the end of dietary intervention. In the experimental group 87 per cent of normal stage was increased to 90 per cent at the end of the study period. The shift in malnutrition grades was found to be minimum. This may be due to

shorter period of supplementation. Similar results were also given by Abrams et al. [18] and Nirmala and Varalakshmi [19].

#### 4. CONCLUSION

The ingredients used in the preparation of supplementary food mix such as bajra, roasted Bengal gram, ground nut are good source of energy, protein, vitamin, minerals and fiber. The carrot powder, araikeerai (*Amaranthus dubius*) powder incorporated in the supplementary mix are rich source of  $\beta$ - carotene and iron. Initially the weight, height and mid arm circumference of both control and experimental group of children were below the standard level. After the supplementation for a period of 100 days, the anthropometric status of the experimental group children increased significantly. Supplementation with bajra based supplementary food mix has improved the anthropometric profiles and clinical symptoms of the selected children. Long term feeding trials with supplementary food mix could improve the nutritional status of the children.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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