

## **Original Research Article**

### **Study of effect of cowpea biscuits supplementation on nutritional and cognitive development of malnourished pre-school children**

#### **Abstract**

This study aimed to determine the effect of supplementation of cowpea biscuits on nutritional status and cognitive development of malnourished pre-school children. Pre-school children, aged 3-5 years, from Saraswati Shishu Mandir School, Pantnagar (Uttarakhand, India) were screened for low weight for age. Malnourished children (N=48), who volunteered, were divided equally into three groups viz. control I (no supplementation), control II (refined wheat flour biscuits) and experimental group (cowpea biscuits) and subjected to intervention for the period of three months. Parameters like height, weight, mid upper arm circumference (MUAC) and cognitive development was analyzed before and after supplementation in each month. No significant differences between groups were observed during follow-up concerning height, weight, MUAC, however differences tended to be in expected direction. Experimental group supplemented with cowpea biscuits outperformed significantly in all the domains of cognitive development as compared to control groups. The study concluded that cowpea supplementation is likely to be more effective in cognitive development of malnourished preschool children in short period of time.

**Keywords:** Supplementation, height, weight, legume, protein and malnutrition

#### **Introduction**

Nutritional status of children has a major effect on their cognitive development [1]. Indeed, there is no dispute over the importance of the study of child's nutritional status. Sufficient body of literature existing suggests malnutrition not only affects physical growth, physical activity, motor development but also hampers attention, memory, learning, thinking, perception and impairs intellectual functioning [2,3].

Malnutrition has been recognized to cause serious health, development and economic problem. As per the National Family Health Survey (NFHS)-4 (2015-16), 35.7 per cent children below five years are underweight, 38.4 per cent are stunted and 21 per cent are wasted in the

34 country [4]. Children who suffered from malnutrition of different grades exhibited significant  
35 insufficiency in intellectual and behaviour functioning [5]. Malnourished children typically were  
36 fatigued and uninterested in their social environment and they were less likely to establish  
37 relationships or explore and learn from their surroundings. This consequently affected their  
38 overall cognitive development. Malnutrition during preschool age resulted in poor school  
39 performance, working ability and physical growth later [6].

40 Protein energy malnutrition (PEM) occurs typically in preschool children under 5 years,  
41 whenever the diet is poor in protein and energy [7]. Shortage of cheap, easily digestible  
42 complementary foods, containing good quality protein, is one of the main causes of malnutrition  
43 in children [8]. Generally, the animal proteins foods are in short supply and expensive.  
44 Supplementation of low cost vegetable proteins such as legumes could be an important mode to  
45 alleviate the problem of PEM [9]. With a high protein content, along with energy values and the  
46 important vitamin and mineral content, legumes should be recognized for their nutritional  
47 importance. A combination of cereals with legumes would improve the protein and nutrient  
48 density of the subsequent food products [10]. A study on biological value (BV) of cowpea  
49 blended with rice and barley weaning foods in albino rats and found that highest BV (90.23%)  
50 was observed in diet prepared from autoclaved rice flour and malted cowpea flour [11].

51 The present study has been carried out with the objectives to develop the cowpea biscuits,  
52 to determine the sensory acceptability and nutritional composition of biscuits and to examine the  
53 effect of cowpea biscuits on nutritional status and cognitive development of malnourished  
54 children.

## 55 **2. Materials and Methods**

### 56 **2.1 Procurement of raw material**

57 Local variety of cowpea, refined wheat flour, castor sugar, vanilla essence, hydrogenated  
58 fat, sodium bicarbonate and baking powder were purchased from the local market of Pantnagar.

## 59 **2.2 Processing of grain**

60 Cowpea seeds were sun dried for one day and manually cleaned to remove stones, grit,  
61 chaff and other impurities. After sun drying, the seeds were oven roasted at 120°C for 2 hours in  
62 order to remove its anti-nutrients before milling [12]. The roasted seeds were then milled in flour  
63 mill to give the finer flour. Cowpea flour thus prepared was packed in air tight containers and  
64 was used for making biscuits in the *Phoolbagh* Bakery, Pantnagar.

## 65 **2.3 Biscuits preparation**

66 Biscuits were prepared using the basic recipe of Whitley [13, 14].

## 67 **2.4 Locale and period of study**

68 Out of the three primary schools located in Pantnagar, Saraswati Shishu Mandir had been  
69 randomly selected by lottery system. This school was used as a research base from where  
70 preschoolers were randomly drawn as respondents for the present study. The study was carried  
71 out for a period of three months from February 12, 2011 to May 12, 2011.

## 72 **2.5 Selection of subjects**

73 Firstly the principal of selected school was approached in the school itself and oriented  
74 about the goal of the study. Thereafter, written consent of him was obtained to make  
75 anthropometric assessments of children aged 3-5 years. Anthropometric measurement viz., height  
76 and weight of 86 subjects were recorded for selection of malnourished children before  
77 supplementation. Height measurement was done using a vertical anthropometric rod with the  
78 least count of 1.0 mm. Subjects were asked to stand erect and look straight in front with head,

79 shoulder blades, buttock and heels in vertical plane, touching the measuring rod. Footwear and  
80 headwear were taken off before taking measurement [15].

81 Weight was recorded in kilograms using digital weighing balance minimum division of  
82 0.5 Kg. Machine was placed on leveled surface and when it showed zero, subjects were asked to  
83 stand straight, erect, relaxed with minimum clothing and without footwear [15].

84 After preliminary survey, 48 preschool children were identified as malnourished  
85 according to weight for age criteria using Gomez classification [16]. The written consent was  
86 drawn from parents of the subjects before intervention and the procedure adopted in present  
87 investigation was explained to the parent or guardian. Before starting the supplementation,  
88 deworming process of three groups was done by using *Albandazole*. Out of total sampled  
89 children, three groups of each 20 children were randomly allocated namely control I, control II  
90 and experimental groups to whom no supplementation, refined wheat flour biscuits and 70 per  
91 cent cowpea incorporated biscuits were fed, respectively. Four subjects from each group were  
92 found to be irregular so they had been dropped out. Finally 16 subjects were present in the three  
93 groups.

94 **Control I Group:** 16 children kept on home diet only.

95 **Control II Group:** 16 children fed refined wheat flour biscuits.

96 **Experimental Group:** 16 children supplemented with 70 percent cowpea incorporated biscuits.

## 97 **2.6 Selection of biscuits**

98 Equi-calorie biscuits providing about 500 Kcal of energy/day/child were chosen for  
99 supplementation purposes in case of pre-school children. Each supplemented group received ten  
100 biscuits comprising the weight of 100g daily. Five biscuits were given in the morning at about 9  
101 O'clock and five biscuits in the mid morning at about 11 O'clock.

## 102 **2.7 Sensory evaluation of biscuits**

103 Both the biscuits were evaluated by a panel of 15 semi- trained judges comprising of post  
104 graduate students and faculty members from the Department of Foods & Nutrition, College of  
105 Home Science, Pantnagar. The products were attributed for color, texture, flavor, after taste and  
106 overall acceptability by score card method where 1= very poor, 2= poor, 3=fair, 4=good  
107 and 5=very good.

## 108 **2.8 Nutritional evaluation of biscuits**

109 The nutrient analysis of 70 per cent cowpea incorporated biscuit and 100 per cent refined  
110 wheat flour biscuits were done in triplicates for proximate composition and mineral content viz.  
111 iron and zinc [17].

## 112 **2.9 Measurement of cognitive development in children**

113 Hema Pandey's cognitive development test for pre-schoolers, a standardised test which  
114 measures the cognitive abilities of preschoolers (3 to 6 years), was administered orally in a room  
115 to ensure privacy of the administration of the test [18]. The child was given sufficient time to  
116 complete all the test items. The total score constitutes the "raw" scores. Each child was subjected  
117 to test the same day in forenoon. The test measured the cognition in children by verbal and non-  
118 verbal items and included six sub tests viz. concept skills; information; comprehension; visual  
119 perception; memory and object vocabulary.

## 120 **2.10 Statistical analysis**

121 Least significant difference was used to analyze significant difference in sensory  
122 attributes of 70 per cent cowpea incorporated biscuits and refined wheat flour biscuits. Nutritive  
123 value of both biscuits were analyzed by paired comparison test 't-test'. The data was analyzed

124 for percentage and ANOVA to find difference in nutritional status and cognitive development  
 125 between the groups during pre and post supplementation.

### 126 3. Results and Discussion

#### 127 3.1 Sensory evaluation

128 Among the two variation mean score for the colour (4.2), appearance (4.0), flavor (4.2),  
 129 taste (4.4), texture (4.40), aftertaste (4.47) and overall acceptability (4.3) of the refined wheat  
 130 flour biscuit was high as compared to cowpea biscuits as they have mean score of 3.47 for  
 131 colour, 3.67 for appearance, 3.6 for score, 3.53 for taste and texture, 3.13 for aftertaste and 3.7  
 132 for overall acceptability. The reasons of low mean score of cowpea biscuits are colour of biscuit  
 133 changed from creamy to light brown, texture became slightly rough and also it contained little  
 134 amount of beany flavour. However, there was non-significant difference in the colour,  
 135 appearance, flavour taste, texture, aftertaste and overall acceptability of both the biscuits.

136 **Table. 1 Sensory evaluation of biscuits (n=15)**

Biscuits	Cowpea biscuit (70 per cent)	Refined Wheat Flour biscuit	LSD
<b>Colour</b>	3.47	4.20	1.34 <sup>ns</sup>
<b>Appearance</b>	3.67	4.00	1.33 <sup>ns</sup>
<b>Flavour</b>	3.60	4.20	1.60 <sup>ns</sup>
<b>Taste</b>	3.53	4.40	1.61 <sup>ns</sup>
<b>Texture</b>	3.53	4.40	1.07 <sup>ns</sup>
<b>Aftertaste</b>	3.13	4.47	2.12 <sup>ns</sup>
<b>Overall acceptability</b>	3.73	4.33	1.26 <sup>ns</sup>

137 LSD- Least Significant Difference ns- non significant difference

#### 138 3.2 Nutritional composition of biscuits

139 All the developed biscuits provide one third of the day's requirement. The protein content  
 140 of the biscuits is around 15.2 g per 100 g. Therefore, both calories and proteins provided by the  
 141 biscuits could easily satisfy the day's requirement of children of 3-5 years of age. Presence of  
 142 good amounts of fat and total ash made the biscuits rich in several macro- and micronutrients.

143 **Table.2 Nutritional composition of biscuits on as is basis (n=3)**

Components	Refined Wheat Flour Biscuit	Cowpea Biscuit
Moisture (g%)	4.5±0.1	3.2±0.2* (-1.3)
Ash (g%)	0.6±0.1	1.3±0.0* (+0.70)
Crude protein (g%)	12.2±0.5 (	15.2±0.1* (+7.0)
Crude fat (g%)	24.8±0.3	24.4±0.2 <sup>ns</sup> (-0.4)
Crude fiber (g%)	1.5±0.1	4.4±0.2* (+2.9)
Carbohydrate by difference (g%)	68.5±0.1	66.8±0.4* (-1.7)
Energy (Kcal/100g)	546±3.8	547±2.7 <sup>ns</sup> (+1.0)
Iron (mg/100g)	3.1±0.1	4.3 ±0.3 <sup>ns</sup> (+1.2)
Zinc (mg/100g)	0.1±0.1	3.1 ±0.2* (+2.0)

144 \*significant at 5%      ns-non significant      Mean ± S.D.

145 The values are mean of triplicate estimations/observations

146 Values in the parenthesis shows the mean difference between the nutrient content of biscuits.

147

148 **3.3 Changes in anthropometric parameters before and after supplementation of biscuits**149 **Height, Weight and MUAC:**

150 From Table 3 it is clear that the mean increment in weight, height and MUAC of children  
 151 between the groups did not differ significantly. Observations indicate mean increment in weight,  
 152 height and MUAC was independent of supplement of cowpea and refined wheat flour biscuits.

153

154 **Table 3: Mean increment in anthropometric measurements after 90 days supplementation**  
 155 **of biscuits**

Groups	Weight (kg)				Height (cm)				MUAC (cm)			
	Initial	Final	Difference	Result	Initial	Final	Difference	Result	Initial	Final	Difference	Result
<sup>1</sup> Control- I	13.5 ± 1.1	13.8 ± 1.1	0.3	1 Vs 2-ns 1 Vs 3-ns 2 Vs 3-ns	98.5 ± 4.4	99.4 ± 4.3	0.9	1 Vs 2-ns 1 Vs 3-ns 2 Vs 3-ns	14.8 ± 0.9	14.8 ± 0.9	0	1 Vs 2-ns 1 Vs 3-ns 2 Vs 3-ns
<sup>2</sup> Control- II	13.3 ± 1.3	13.9 ± 1.4	0.6		98.8 ± 4	100.0 ± 4	1.2		14.8 ± 0.8	14.9 ± 0.7	0.1	
<sup>3</sup> Experimental	13.4 ± 1.1	14.2 ± 1.1	0.8		100.7 ± 5.2	102.2 ± 5.6	1.5		14.9 ± 0.9	15.1 ± 0.8	0.2	

156 Values are Mean±S.D.

157 ns = non- significant (p>0.05),

158 Values in parentheses shows mean increment in anthropometric measurements

159 1= Control- I, 2= Control- II and 3= Experimental group

160

### 161 3.4 Effect of supplementation on shift in malnutrition grades in the study groups:

162 Initially 6.25% subjects of experimental group were in grade III malnutrition. There were  
 163 12.5 % subjects in control- I, 6.25% subjects in control- II and also in experimental group in  
 164 grade II malnutrition. Whereas 87.5% subjects in control- I and experimental group and 93.75%  
 165 subjects were in grade I malnutrition.

166 At the end of the study period, 18.75% of subjects in control- I and control- II moved  
 167 from grade II and grade I to normal. Only 75% and 6.25% in control- I, were still in grade- I and  
 168 grade- II respectively. In control- II, 68.75 % and 12.5% were still in grade I and grade II. In  
 169 experimental group, 12.5% of subjects moved from grade II and grade I to normal and only  
 170 81.25% and 6.25% were in grade I and grade II respectively. However, results of shift in



171 malnutrition grades showed non-significant difference within as well between the groups during  
 172 supplementation period.

173 **Table 4: Shift in malnutrition grades**

<b>GROUPS</b>		<b>0 day</b>	<b>30 day</b>	<b>60 day</b>	<b>90 day</b>	<b>Chi square</b>
<b>C-I (No biscuits)</b>	<b>Grade I (mild)</b>	87.5 (14)	87.5 (14)	81.25 (13)	75 (12)	3.68 <sup>ns</sup>
	<b>Grade II (moderate)</b>	12.5 (2)	6.25 (1)	6.25 (1)	6.25 (1)	
	<b>Grade III (severe)</b>	0	0	0	0	
	<b>Normal</b>	0	6.25 (1)	12.5 (2)	18.75 (3)	
<b>C-II (Refined wheat flour biscuits)</b>	<b>Grade I (mild)</b>	93.75 (15)	75 (12)	81.25 (13)	68.75 (11)	4.12 <sup>ns</sup>
	<b>Grade II (moderate)</b>	6.25 (1)	18.75 (3)	12.5 (2)	12.5 (2)	
	<b>Grade III (severe)</b>	0	0	0	0	
	<b>Normal</b>	0	6.25 (1)	6.25 (1)	18.75 (3)	
<b>Experimental group (Cowpea biscuit)</b>	<b>Grade I (mild)</b>	87.5 (14)	81.25 (13)	81.25 (13)	81.25 (13)	2.13 <sup>ns</sup>
	<b>Grade II (moderate)</b>	6.25 (1)	12.5 (2)	12.5 (2)	6.25 (1)	
	<b>Grade III (severe)</b>	6.25 (1)	0	0	0	
	<b>Normal</b>	0	6.25 (1)	6.25 (1)	12.5 (2)	
<b>Chi square</b>	<b>0.06<sup>ns</sup></b>					

174 Values in parentheses indicate number of preschool children ns = non- significant

175

176 **3.5 Cognitive development of children:**

177 A close perusal of Table 5 illustrates that 43.8%, 56.3% and 43.8% of children from  
 178 Control I, Control II and Experimental Group, respectively were conceptually low and only  
 179 6.2%, 12.5% and 6.2% were conceptually high, respectively before intervention. However, after  
 180 90 days a tremendous gain in conceptual skills was observed. Only 6.2%, 12.5% and 0% of

181 children from Control I, Control II and Experimental Group respectively were conceptually low.  
182 After 90 days 31.3%, 43.8% and 68.8% of children from three groups respectively were  
183 conceptually high.

184 Information characteristics reflecting cognition in 3-5 years old children showed that  
185 before supplementation 56.2%, 31.3% and 31.2% children were at low level from Control I,  
186 Control II and Experimental Group, respectively and 0% children from Control I as well as from  
187 Experimental group and 12.4% children from Control II group were at high level. However, after  
188 90 days only 6.2%, 0% and 0% of children from Control I, Control II and Experimental Group  
189 respectively were at low level and 25%, 18.8% and 68.8% of children from three groups  
190 respectively were at high level.

191 Comprehension skill shows that in Control I, Control II and Experimental group 12.5%,  
192 31.2% and 12.5% children were in low level and no one was in high level. After 90 days, 0%  
193 children in Control I and Experimental group, 6.2% children in Control II group, respectively,  
194 were in low level; however, 18.8 % children of Control I and Control II group and 56.2 %  
195 children of Experimental group were in high level.

196 In visual perception, 31.2% children of Control I, Control II and Experimental Group,  
197 respectively, were at low level and 0% children of Control I as well as of Control II group and  
198 12.4% children of Experimental Group were in high level. After 90 days, 18.8 % children of  
199 Control I & Control II group were in low level while it is interesting to note that from  
200 Experimental group no one was found in low level. However, 6.2% children from Control I  
201 group, 18.8% children from Control II group and 87.5% children from Experimental group were  
202 in high level, respectively after intervention.

203           Regarding memory, results of the study showed that, 87.5%, 81.2% and 56.2% of  
204 children from Control I, Control II and Experimental Group, respectively were in low level and  
205 none of the three groups, respectively, were in high, before intervention. However, after 90 days  
206 43.8%, 25.0% and 0% of children from Control I, Control II and Experimental Group  
207 respectively were in low level and 6.2%, 0% and 31.2% of children from Control I, Control II  
208 and Experimental Group respectively were at high level.

209           In Object vocabulary, 12.5% children of Control I were in low as well as in high level, in  
210 Control II group 18.8% children were in low and 25% children were in high level and in  
211 Experimental group, 0% children were in low level and 31.2% children were in high level .  
212 However, after 90 days it was observed that none of the children from either group was in low  
213 level while 87.5%, 68.8% and 100% of children from Control I, Control II and Experimental  
214 Group, respectively were at high level.

215           The overall score reveal that 43.8%, 31.3% and 12.5% of children from Control I,  
216 Control II and Experimental Group respectively were at low level and only 0%, 12.4%, 6.2% of  
217 children from Control I, Control II and Experimental Group, respectively were at high level  
218 before intervention. After three months of supplementation it was observed that none of the child  
219 from either group was at low level but 31.2%, 25.0% and 81.2% of children from Control I,  
220 Control II and Experimental Group respectively were at high level.

221           The rise in cognitive development after 90 days was more in the children from  
222 experimental group than those from Control I & Control II group. The reason for it may be  
223 attributed to supplementing cowpea biscuits in the diet of experimental group.

224           An overview of Table 5 elucidates that all the domains of cognitive development shows  
225 that after three months of supplementation period there is a marked shift of all the three groups

226 (Control I, Control II and Experimental group) from low to high level of cognitive development  
 227 which may be due to maturation. But highest shift from low level to high level of cognitive  
 228 development was noted among preschoolers of experimental group which clearly indicate the  
 229 effect of fortification of protein and energy dense foods in the form of weaning biscuits.

230 **Table 5. Percentage distribution of preschool children on different domains of cognitive**  
 231 **development over the period of supplementation**

Domain of cognitive development	Level	Control I (n=16)		Control II (n=16)		Experimental (n=16)	
		B	A	B	A	B	A
Conceptual skill	Low	43.8	6.2	56.3	12.4	43.8	-
	Medium	50.0	62.5	31.2	43.8	50.0	31.2
	High	06.2	31.3	12.5	43.8	6.2	68.8
Information	Low	56.2	6.2	31.3	-	31.2	-
	Medium	43.8	68.8	56.3	81.2	68.8	31.2
	High	-	25.0	12.4	18.8	-	68.8
Comprehension	Low	12.5	-	31.2	6.2	12.5	-
	Medium	87.5	81.2	68.8	75.0	87.5	43.8
	High	-	18.8	-	18.8	-	56.2
Visual Perception	Low	31.2	18.8	31.2	18.8	31.3	-
	Medium	68.8	75.0	68.8	62.4	56.3	12.5
	High	-	06.2	-	18.8	12.4	87.5
Memory	Low	87.5	43.8	81.2	25.0	56.2	-
	Medium	12.5	50.0	18.8	75.0	43.8	68.8
	High	-	06.2	-	-	-	31.2
Object Vocabulary	Low	12.5	-	18.8	-	-	-
	Medium	75.0	12.5	56.2	31.2	68.8	-
	High	12.5	87.5	25.0	68.8	31.2	100.0
Overall Score	Low	43.8	-	31.3	-	12.5	-
	Medium	56.2	68.8	56.3	75.0	81.3	18.8
	High	-	31.2	12.4	25.0	06.2	81.2

232 Low: 0-9 score Medium: 10-18 score High: 19-27 score n=no. of children

233 B:Before supplementation A: After supplementation

234

235 **3.6 Mean score in various domains of cognitive development**

236 It can be well seen from the Table 6 that after 90 days of supplementation period, in  
 237 Conceptual skill there was significant difference found between experimental (20.3) and Control  
 238 I group (16.0). In case of Information there was significant difference between Experimental  
 239 group (6.1) with Control I (4.6) and Control II (4.4) group. Similarly in Comprehension, Visual  
 240 Perception, Memory, Object Vocabulary and Overall Score significant difference was observed  
 241 between experimental group with control I group and also with control II group. These results  
 242 are indicative of the better cognitive development of experimental group ( supplemented with 70  
 243 percent cowpea incorporated biscuits) followed by control II (fed refined wheat flour biscuits)  
 244 and control I ( home diet) bringing out the importance of cowpea.

245 **Table.6 Mean score in the domain of cognitive development**

Domain of cognitive development	Groups	Mean score	
		0 Day	90 Day
Conceptual skill	Control I (1)	10.7	16.0 <sup>b</sup>
	Control II (2)	11.6	17.6
	Experimental (3)	11.4	20.3 <sup>a</sup>
	<b>C.D. at 5 %</b>		
	1 v. 2	Ns	Ns
	1 v. 3	Ns	2.9
	2 v. 3	Ns	Ns
	Information	Control I (1)	2.4
Control II (2)		2.9	4.4 <sup>b</sup>
Experimental (3)		3.1	6.1 <sup>a</sup>
<b>C.D. at 5 %</b>			
1 v. 2		Ns	Ns
1 v. 3		Ns	0.8

	<b>2 v. 3</b>	Ns	0.8
<b>Comprehension</b>	<b>Control I (1)</b>	3.1	4.6 <sup>b</sup>
	<b>Control II (2)</b>	3.2	4.9 <sup>b</sup>
	<b>Experimental (3)</b>	3.7	5.6 <sup>a</sup>
	<b>C.D. at 5 %</b>		
	<b>1 v. 2</b>	Ns	Ns
	<b>1 v. 3</b>	Ns	0.6
	<b>2 v. 3</b>	Ns	0.6
<b>Visual Perception</b>	<b>Control I (1)</b>	2.9	4.1 <sup>b</sup>
	<b>Control II (2)</b>	2.9	4.2 <sup>b</sup>
	<b>Experimental (3)</b>	3.7	6.2 <sup>a</sup>
	<b>C.D. at 5 %</b>		
	<b>1 v. 2</b>	Ns	Ns
	<b>1 v. 3</b>	Ns	0.9
	<b>2 v. 3</b>	Ns	0.9
<b>Memory</b>	<b>Control I (1)</b>	1.3 <sup>b</sup>	4.3 <sup>b</sup>
	<b>Control II (2)</b>	2.2	4.5 <sup>b</sup>
	<b>Experimental (3)</b>	2.9 <sup>a</sup>	6.5 <sup>a</sup>
	<b>C.D. at 5 %</b>		
	<b>1 v. 2</b>	Ns	Ns
	<b>1 v. 3</b>	1.2	1.2
	<b>2 v. 3</b>	Ns	1.2
<b>Object vocabulary</b>	<b>Control I (1)</b>	3.7	5.1
	<b>Control II (2)</b>	3.6	5.1 <sup>b</sup>
	<b>Experimental (3)</b>	4.2	5.6 <sup>a</sup>
	<b>C.D. at 5 %</b>		
	<b>1 v. 2</b>	Ns	Ns
	<b>1 v. 3</b>	Ns	Ns
	<b>2 v. 3</b>	Ns	0.5
<b>Overall score</b>	<b>Control I (1)</b>	24.2	38.7 <sup>b</sup>
	<b>Control II (2)</b>	26.5	40.8 <sup>b</sup>
	<b>Experimental (3)</b>	29.1	50.3 <sup>a</sup>
	<b>C.D. at 5 %</b>		
	<b>1 v. 2</b>	Ns	Ns

	<b>1 v. 3</b>	Ns	5.5
	<b>2 v. 3</b>	Ns	5.5

246 Control I (no supplementation), Control II (fed refined wheat flour biscuits), Experimental (supplemented with 70

247 per cent cowpea incorporated biscuits) ,ns- non significant difference

248 Values with dissimilar letters in superscript are significantly different (p<0.05)

249

250 The findings of present study showed that there was no significant effect of the  
 251 intervention for the anthropometric outcomes viz. height, weight and MUAC between the  
 252 groups. Several factors probably contributed to the absence of a statistically significant effect on  
 253 growth. First, significant number of children was in the category of mild and moderate  
 254 malnutrition at baseline. Second, the intervention was of a relatively short duration, especially  
 255 given the age of our participants and hence their slower growth rate relative to preschoolers [19].

256 The interesting finding in the present study was that after 3 months of providing cowpea  
 257 supplemented biscuits to the children from experimental group, they improved significantly on  
 258 all the domains of cognitive development in comparison to those for control II and control I  
 259 group. The findings of the present study are in line with that of Nazni *et al.*, who reported that  
 260 after three months supplementation of potato flour biscuits, cognitive performance was good in  
 261 the supplemented group children as compared to the control group [20]. Similarly,  
 262 supplementation of multiple-micronutrient-fortified fruit powder beverage for 16 weeks showed  
 263 significant improvements in cognitive performance [21]. In another study supplementation of  
 264 beta-carotene fortified biscuits significantly improved the cognitive functions of the children  
 265 [22]. The limitation of present study is that biochemical method to assess protein energy  
 266 malnutrition status should have been adopted to see the immediate effect of supplementation.

267 **4. Conclusion**

268 It can be concluded that experimental group (supplemented with cowpea incorporated  
269 biscuits), control II group (supplemented with refined wheat flour biscuits) and control I (no  
270 supplementation) differed on components of cognitive ability. The high scores on cognitive  
271 development among experimental group may be attributed to the effectiveness of supplementary  
272 nutrition provided at school.

273

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