Original Article

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Comparative Study on Supplementation of Potato Flour Biscuits on the Nutritional and Cognitive Profile of the Selected Children

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Abstract

Objective: Nutrition of the early childhood is of paramount importance because the foundation for life time strength and intellectual vitality is laid during this period. The present study aims to evaluate the effect of weaning biscuits supplementation of the nutritional parameters and cognitive performance of the selected children.

Methods: Three Balwadies situated in Salem District, Tamilnadu, India were selected. A total number of 40 school children in Grade II malnutrition, 15 from Balwadi I, 14 from Balwadi II and 11 from Balwadi III comprised the study sample. All the 40 were selected for the experimental study. Home diet without any supplementation was followed by Group I (n=10, control group), potato flour biscuit was supplemented to Group II (n=10), Maize biscuits were given to Group III (n=10) and Green gram biscuits were given to Group IV (n=10) for the period of 3 months. Parameters like anthropometric measurements, hemoglobin content and clinical picture were analyzed before and after supplementation, cognitive performance of the supplemented children was assessed at the end of the study period.

Findings: There was significant difference in height, weight, blood hemoglobin and clinical picture after three months on their home diet in group I. In groups II, III and IV significant increase in all the above parameters was noticed. More increase was found in group II children supplemented with potato flour biscuits for a period of 3 months. About cognitive performance better results were obtained in Group II followed by group IV (supplemented with green gram biscuits) and group III (supplemented with maize biscuits). Least was obtained by control group children who were in their home diet.

Conclusion: All these observations evidence that if such weaning biscuits made with potato flour, maize and green gram can form a daily ingredient in their diets, it will bring out better all round development of the children.

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Key Words: Children; Potato; Maize; Green gram; Nutritional; Cognitive performance

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Introduction

In India, Protein Energy Malnutrition(PEM) among children under five years still constitutes a major public health problem, poor infant feeding and weaning practices are major contributory factors in malnutrition especially among the under fives. Weaning diets of the low income families are often cereal gruels or regular family diet with or without small quantities of pulses thus inadequate in both calories and proteins. As a result, prevalence of PEM along with other micronutrient deficiencies is the order of the day [1].

Potato (*solanum tuberosum* L) belongs to family solanaceae in one of the major tuber corps of the world and most important commercial vegetable vis-à-vis food crop grown in India. It is rich in good quality proteins and carbohydrates and is available in India round the year and is a good supplement to the cereal diets. Potato based products can be more well balanced in proteins, vitamins and calories/unit area/unit time than any other food [2].

Maize is a major source of starch, a major ingredient in home cooking and in many industrialized food products. Maize and maize flour constitutes a staple food in many regions of the world. Maize flour is also used as a replacement for wheat flour, to make various baked products. Green gram is one of the major pulses widely consumed next to black gram. It is grown in both Kharif and Rabi seasons. The crop was extensively cultivated in various districts of Tamilnadu which together accounted for 60.7% of the total area under this crop in the state during 05-06[3].

Soy being an excellent source of both calories and good quality protein along with other micronutrients can in a large measure help formulation of nutrient dense weaning and supplementary foods that can be recommended for consumption if mitigation of PEM is the concern [4]. The objectives of the study are to develop and standardize the weaning biscuits, to study background information, clinical history, nutritional status and dietary pattern, to evaluate the supplementary effect on anthropometric and cognitive development of the selected children.

Subjects and Methods

Three Balwadies situated in Kottagound-ampatti village belong to Omalur Taluk, Salem district, Tamilnadu, India were selected by purposive sampling method for the sample selection. A total of 40 children,15 from Balwadi-I, 14 from Balwadi-II and 11 from Balwadi-III comprised the sample, belonged to the age group of 2-3 years, were identified based on their height and weight measurements and all were selected for the study. Through a food weighment survey the calorie gap in their dietaries were estimated as 320 kilocalories.

Initially unmarketable small sized potatoes were taken washed, peeled, pre treated with 3% NaCl + 0.05% ascorbic acid, sliced, blanched, cooled and once again treated with 0.02% potassium meta bisulphate, drained, dried in sun and made into flour.

The other ingredients like soya flour, maize flour, green gram flour and wheat flour were procured from the local market. Three varieties of weaning biscuits were developed using the proportion of potato flour (Variety I) maize flour (Variety II) green gram flour (Variety III) with soya flour and wheat flour in the ratio of 70:20:10 with the addition of sugar and fat. All the developed three varieties of biscuits were evaluated for their acceptability by a panel of 10 judges from Department of Food Science, Periyar University, and Salem. All the judges were asked to score the products for appearance, colour, flavor, taste, texture and over all acceptability using a score of a nine point hedonic scale [5]. The developed biscuits were analyzed for its nutritive value with reference to calories, protein, fat, carbohydrates, crude fiber and total ash using the standard procedures [6].

Forty grade II malnutrition children identified were divided into four groups with

ten subjects in each group and given the following weaning biscuits.

Group I: 10 children kept as control group; they are on home diet only.

Group II: 10 children supplemented with potato flour biscuits.

Group III: 10 children supplemented with maize biscuits.

Group IV: 10 children supplemented with green gram biscuits.

Each supplemented groups received six biscuits comprising the weight of 60 grams daily. Three biscuits were given in the mid morning and three biscuits in the evening.

Before starting the feeding trail one local Balwadi teacher from each school were selected to distribute and monitor the feeding for the selected children of their area. They were initially briefed about the importance of the study. The feeding trail was conducted for a period of 3 months and during the entire study period, all the experimental and control groups were supervised by the research staff.

The study was approved by the ethical committee members of the institution.

Background details such as age, sex, type of family, family size, birth order, level of income per month were elicited by interviewing the parents of the selected children using an interview schedule.

Anthropometric measurements like height and weight, blood hemoglobin levels, clinical picture were studied before and after supplementation with the help of a physician. Hemoglobin was analyzed using the cyanmethemoglobin method [7]. Apart from above data at the end of the study period certain perceptual development that measures cognition was assessed for the selected children using specially designed criteria [8].

The data was complied and analyzed by using statistical methods. Descriptive statistics ANOVA and paired comparison test are computed using statistical software SPSS version 15.0, Duncan's multiple range tests is applied to determine the significant differences between the supplemented biscuits. P. value less than 0.05 was significant.

Findings

Oganoleptic evaluation of the developed biscuits: The results on organoleptic parameters are given in Table1.

Among the three variation green gram biscuits has got highest score of 8.20 followed by the potato biscuits with the score of 8.13 and the least score 7.80 is obtained by maize biscuits for appearance. Regarding color attributes the highest score 8.33 is obtained by green gram biscuits followed by potato biscuits is 7.80 and the least score is 7.73 obtained by maize biscuits.

For the flavor attributes potato biscuits has got highest score of 8.26 followed by maize biscuits with the score 7.84 and the least score 7.73 is obtained by green gram biscuits. For the texture attributes the highest score 8.26 is obtained by maize biscuits followed by green gram biscuits with the score of 8.06 and the least score 8.00 is obtained by potato biscuits.

Table 1: Oganoleptic evaluation of the developed biscuits

Type of Variations	Appearance	Color	Flavor	Texture	Taste	Overall acceptability
Potato biscuits	8.13±0.83	7.80±0.86	8.26±0.70	8.00±0.75	8.53±0.63	8.60±0.50
Green gram biscuits	8.20±0.77	8.33±0.61	7.73±1.03	8.06 ±0.59	8.33±0.81	8.33 ± 0.72
Maize biscuits	7.80±1.08	7.73±0.79	7.84 ±0.95	8.26 ±0.96	8.06±0.70	8.46 ± 0.63
F-ratio	0.838	2.762	2.543	0.469	1.570	0.672
***P*-Value**	0.4^{ns}	0.07^{ns}	0.09^{ns}	0.6^{ns}	0.2^{ns}	0.5^{ns}

Table 2: Nutritive value of the developed biscuits

Nutrients /100g of food	Potato biscuits	Maize biscuits	Green gram biscuits	RDA*
Calories (k.cal)	605.89	579.73	502.38	1240
Protein (g)	7.43	7.86	8.04	22
Fat (g)	38.77	37.41	29.10	25
Carbohydrate (g)	56.81	57.40	52.08	-
Crude fibre (g)	2.15	1.32	1.20	-
Total ash (mg)	1.35	1.09	1.34	

*Recommended daily allowances for 1-3 old children (ICMR 2000) [9]

Regarding the taste attributes the highest score 8.53 is obtained by potato biscuits followed by green gram with a score of 8.33 and the least score obtained by maize biscuits is 8.06. For the overall acceptability the highest score 8.60 is obtained by potato biscuits followed by maize biscuits with a score of 8.46 and least score is obtained by green gram biscuits with a score of 8.33.

Duncan's test reveals that there was no significant difference between the three biscuits for appearance, color, flavor, texture, taste and overall acceptability.

Nutritive value of the developed biscuits: The nutritive value of the biscuits as analyzed is given in table 2.

All the developed biscuits provide more than 500 kilo calories per 100g of food thus making it calorie rich providing one third of the day's requirement. The protein content of the biscuits is around 7-8g per 100g which is also one third of the Recommended Dietary Allowance (RDA) of children in the age group 1-3 years. Therefore, both calories and proteins provided by the biscuits can easily satisfy the day's requirement of children of 2-3 years of age. Presence of good amounts of fat and total ash made the biscuits rich in several macro and micronutrients.

Background information of the children: Among the 40 selected children 22 children belonged to the age group of 2 years and 18 children belonged to the age group of 3 years.

About the sex 25 were females and 15 were males. Fifty one percent of selected children belonged to nuclear family and rest were in joint families. In majority of the children families (68.1 percent) the family size was 3-4 and as a corollary 56.7 percent of the selected children were of first birth order. Seventy three percent of the selected children's mothers were illiterate and the rest were educated up to high school level. All the children selected were from the similar income bracket of about less than 2500 rupees per month.

Table 3: Mean increments in height of the selected children

Groups	Initial	Final	Height (cm) Difference	Initial vs Final 't' values	Significance
Group I	73.25±3.35	74.05± 4.21	0.80± 0.31	0.21	0.6^{ns}
Group II	74.21±3.21	76.37±4.21	2.16±1.12	0.03	0.02*
Group III	73.98±3.82	75.80±4.19	1.82±0.91	0.09	0.03*
Group IV	73.45±4.10	75.46±4.21	2.01±1.08	0.04	0.048*

Standard value (2-3 years) = 81.7 [NCHS standard for children (Seth et al, 1990) [10]] [*-5% level]

Table 4: Mean increments in weight of the selected children

Groups	Initial	Final	Height (cm) Difference	Initial vs Final 't' values	Significance
Group I	11.91±1.28	12.21±1.39	0.30±0.29	0.12	0.06^{ns}
Group II	11.61±1.98	13.40±1.89	1.80±0.38	0.07	0.04*
Group III	11.16±1.15	11.96±1.41	0.80±0.18	0.77	0.049*
Group IV	11.53±1.56	12.58±1.13	1.05±0.10	0.04	0.01*

Standard value (2-3 years) = 10.8 [NCHS standard for children (Seth et al, 1990)[10]] [*-5% level]

Changes in anthropometric parameters before and after biscuits supplementation

Improvements in height: Table 3 gives details regarding the mean increments in height of the children. Highest increment in height (2.16cm) was recorded by children in Group II given potato biscuits followed by an increment of 2.01cm recorded by children in Group IV given green gram biscuits. The increment observed in the control group (Group I) was only 0.80cm whereas the increment in Group III given the maize biscuits was 1.82cm. Statistical analysis revealed that these increments between all the groups except control group were significant at five percent level indicating that while green gram and maize biscuits had an edge over the control in promoting growth, incorporation of potato flour gave further increase in height which showed significantly higher increments with increase in quantity of the food.

Improvements in Weight: Mean increments in weight of the selected children are given in table 4.

The increments in weight in Group II children given potato flour biscuits was higher (1.80kg) compared to the other three groups followed by Group IV with the mean increment of 1.05kg. Group III registered a mean increment of 0.8kg and Group I (control group) registered the least increment of 0.30kg. When statistically analyzed the difference between the initial and final values of the different groups of children were highly significant (P<0.05) except control group which showed no significant difference in weight gain.

Hemoglobin levels of children: Table 5 gives the mean increments in blood hemoglobin levels of the selected children over the supplementation period.

The increment in blood hemoglobin levels in group II fed with potato biscuits was found to be the maximum (1.01g/dl) followed by group IV (0.98g/dl) fed with green gram biscuits. Group III Children showed an increment of 0.73g/dl whereas the least increment was registered by Group I (control group) given home diet alone (0.2g/dl). These increments in hemoglobin levels between the groups when compared statistically showed a significant difference as five percent level.

Table 5: Mean increments in blood hemoglobin levels

Groups	Initial	Final	Difference	Initial vs Final 't' value	Significance
Group I	6.32±0.21	6.52±0.18	0.2±0.01	0.14	0.08^{ns}
Group II	6.59±0.34	7.6±0.20	1.01±0.21	0.06	0.03*
Group III	6.82±0.31	7.55±0.92	0.73±0.18	0.82	0.04*
Group IV	6.49±0.29	7.47±0.27	0.98±0.22	0.54	0.01*

Standard value (2-3 years) = 11.0 [NCHS standard for children (Seth et.al, 1990) [10]] [*-5% level]

Clinical picture of children: Clinical examinations of the children were carried out initially and finally with the help of the medical practitioner. Initial symptoms like pot belly, edema, dry skin, dry hair, brittle and spoon shaped nails were prevalent in all the four groups. Supplementation with potato biscuits, maize and green gram biscuits had wiped out the symptoms of pot belly and edema (symptoms related to PEM) whereas in control group (Group I) there symptoms still existed.

Reduction in anemia related symptoms of brittle and spoon shaped nails were notable in Group II, as against the other groups and this may be a reflection of the increased hemoglobin level exhibited by Group II. In general, reduction in all the clinical symptoms of nutritional disorders was observed in supplemented groups than in the control group.

Cognitive development of the selected children: Certain developmental characteristics reflecting cognition in 2-3 years old children was studied at the end of the study period and the data is presented in Table 6.

Majority of children (90-100%) in Group II given potato flour biscuits showed good cognition with respect to all the criteria studied, except string beads, folding paper horizontally and building tower. A comparatively better picture for cognition was identified in Group IV (82-90% children responding) given green gram biscuits as against group III with 70-88 percent responding and group I with 51-68 percent responding. While 48 percent of the children in group II could easily string the beads followed by group IV (40%) and group III (35%) and in Group I they could do so only with great effort (taking more than a minute).

While 42 percent of the children in Group II could fold a paper horizontally only 32, 29 and 12 percent of children could do so in group IV, III and I respectively. These results are indicative of the development of better cognition in group II children given potato flour biscuits followed by group IV children given green gram biscuits than by group III given maize biscuits as against the control group again bringing out the importance of potato flour in the total development of children.

Table 6: Cognitive development of the selected children

Criteria	Percentage of children			
	Group I	Group II	Group III	Group IV
Knows full name and sex	62	100	88	90
Uses short sentences (3-4 words)	65	100	80	88
Recognizes some shapes and colors	61	100	82	89
Arranges 3 cubes	64	98	80	82
Follows a short series of direction	52	92	85	88
Reproduces a circle	51	90	82	85
Sting heads of large holes with no effort	21	48	35	40
Understands in, on under	58	98	70	83
Loves to listen to stories	68	92	72	84
Develops speech using 'I' and 'Me'	60	90	80	86
Imitates animal sounds	61	92	88	86
Identifies objects as same	57	94	88	90
Folds a paper horizontally	12	42	29	32

Discussion

The findings of the present study showed importance of mother's education in the nutritional status of the children and the same was acknowledged by various research studies [11-14].

The interesting finding in the present study was that all the selected children who were in low income group were deficit in their height compared to NCHS standards. It was supported by Hakeem [15] who indicated that deficit in height decreased with increasing the income level.

Mean weight of the supplemented children increased by the end of study period compared to the baseline value. Supporting the findings of the present study supplementation of the energy dense foods had good impact on growth status of the children[16]. Similar findings have been reported in children supplemented with the Amylase Rich Flour (ARF) food [17].

In the present study, it was observed that after 3 months of supplementation hemoglobin content was increased significantly. Owino et al [18] have reported that supplementation of energy dense foods have improved the hemoglobin concentration. In another study supplementation of fortified beverage for 6 months has significantly improved the hematologic and anthropometric measurements and significantly lowered the overall prevalence of anemia deficiency among the children [19]. Similar findings have been reported in various research studies [20].

It is thus evident that in comparison to the control group children the cognitive performance was good in the supplemented group children. This may be due to the fortification of micronutrient dense foods in the weaning biscuits supporting these findings, supplementation of fortified fruit powder beverage for 16 weeks showed significant improvements in cognitive performance[21]. In another study supplementation of beta-carotene fortified biscuits significantly improved the cognitive functions of the children[22].

The limitation in the present study is that 100% potato flour, maize flour and green gram flour biscuits should be formulated and its impact should be studied. Alkaloids and cyanogenic compounds should be estimated in the developed biscuits.

Conclusion

To sum up, all these observations evidence the improvement in anthropometric measurements, increased hemoglobin level and better cognitive performance among the malnourished children and clearly indicate that potato flour weaning biscuits undoubtedly helps to improve the nutritional picture and health of the children as that of maize and green gram biscuits. If such potato flour can form a daily ingredient of the diets of the children right from weaning it can go a long way to help in changing the current malnutrition scenario among the children and bring out better all round development of the children.

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