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IMPACT OF HIGH PROTEIN LADOO SUPPLEMENTATION ON THE NUTRITIONAL STATUS OF MALNOURISHED CHILDREN

TEJASHRI TRIVEDI[1], V. H. PATEL[1] AND REMA S.[1]
[1]Laboratory of Foods and Nutrition, P.G. Department of Home Science,
Sardar Patel University, Vallabh Vidyanagar- 388001, Gujarat, India

ABSTRACT

Malnutrition continues to be a major health burden in developing countries especially in children under five years. India is still habitat to the world's highest demographics of children suffering from malnutrition. Malnourished children are best treated with specially formulated foods known as ready-to-use foods (RUFs) which can balance the diet to provide additional nutrients. In this study, High protein ladoo (HPL) containing soybean, cowpea, rice flour, gingelly seeds, SMP, jaggery and ghee were prepared. Nutritionally, 100g of ladoo contained 510kcal energy, 41.57g% carbohydrate, 17.96 g% protein, 30. 22g% fat and 88.3mg% calcium. The developed ladoo (70g, 2 in no.) providing 357.07kcal and 12.57g protein was supplemented to moderately acute malnourished children enrolled in the experimental group (n=21) for 60 days. The control group (n=11) did not receive any nutritional supplement. A significant improvement was observed in anthropometric measurements such as weight, height, mid upper arm circumference (MUAC) and body mass index (BMI) in the experimental group. WHZ and WAZ also showed significant improvement whereas HAZ did not show any significant change in the experimental group. At the end of supplementation 80.95% of the moderately wasted children (WHZ) and 76.19% of the moderately underweight (WAZ) children improved from the moderately malnourished category to the mildly malnourished category.

Keywords: High protein ladoo, supplementary feeding, nutritional status.

INTRODUCTION

Malnutrition continues to be a major health burden in developing countries especially in children below the age of five years. More than 200 million children in developing countries do not reach their full developmental potential because of poverty, poor nutrition and inadequate care [1] and this results in an increased prevalence of moderate acute malnutrition (MAM) and poor cognitive development [2]. Moderate acute malnutrition (MAM) is defined as weight for height between -3 SD and -2 SD below the median weight for height of the WHO child growth standards [3]. Even with the growing per capita income, sustained economic growth and increased agricultural production, malnutrition continues to beat India in multiple forms. India is still habitat to the world's highest demographics of children suffering from malnutrition [4]. According to NFHS-4 data, 38.4% of under-five children are found to be stunted, 21% wasted and 35.8 % underweight in India whereas in Gujarat 39.3% of children under the age of five are underweight, 26.4% are wasted and 38.5% are stunted [5].

MAM children are best treated with specially formulated foods which can balance the diet to provide additional nutrients [6]. During the 1960s, fortified blended cereal based foods like corn-soy blend as well as other legumes blended with soy were introduced for improvement in the nutrient content and to increase the protein quality [7]. A relatively newer category of specially formulated foods known as ready-to-use therapeutic foods (RUTFs) or ready-to-use supplementary foods (RUSFs) have been introduced by WHO (World Health Organization), recently. These ready-to-use foods (RUFs) are energy-dense, high fat, ready-to-eat pastes often made from a combination of peanuts, milk powder and/or soy, sugar, oil and micronutrients. WHO advocates the use of optimal locally available nutrient-dense foods to prevent children from becoming severely malnourished [6].

In the present study High protein ladoo containing soybean, cowpea, rice flour, gingelly seeds, SMP, jaggery and ghee were prepared. Soybean is referred to as the meat for vegetarians due to its higher quantity and quality of protein. Along with a high quality of amino acid profile it also contains carbohydrate, fat, vitamins and minerals such as folic acid, calcium, potassium and iron **[8]**. Potential health benefits of soy may be limited due to the presence of antinutritional factors, including trypsin inhibitors. But processing techniques like

germination, soaking, dehulling and roasting reduces antinutritional factors from soybeans **[9]**. Several studies suggest the use of soybean as a supplementary food to combat malnutrition in children **[10, 11]**. Cowpea is an underutilized crop with a good protein quality. Rice flour and skimmed milk powder (SMP) contain protein of high quality while gingelly seeds and soya provide omega 3 fatty acids essential for improved growth.

In the present study the impact of high protein ladoo supplementation on the nutritional status of malnourished children (3-5 yrs old) was studied. The specific objective of the study was

- To study the effect of High protein ladoo supplementation on moderately malnourished children (3-5 years old) with respect to growth parameters such as weight for age (WAZ), height for age (HAZ) and WHZ (weight for height).

METHODOLOGY

The methodology is discussed under the following heads:

A. Development of High protein ladoo
B. Nutrient analysis of ladoo
C. Supplementation of ladoo
D. Data analysis

A. Development of High protein ladoo:

Different ingredients such as soybeans, cowpea dal, rice flour, gingelly seeds, skimmed milk powder (SMP), jaggery and ghee (Amul) were procured from the local market of Anand. Soya beans were soaked for 12 hours followed by dehulling, pressure cooking (15 min), sun drying (48 hours) and roasting (15 min). Roasted soya beans were ground to make flour. Cowpea dal was roasted (15 min) and ground to flour. Rice was soaked (12 hrs), sun dried, roasted (15 min) and flour was prepared. Gingelly seeds were cleaned, roasted (15 min) and ground. All the ingredients were mixed in the specific proportion to provide an essential amino acid profile close to the reference protein (egg) by NIN, 2017 **(Fig.1)** and ladoo was prepared.

B. Nutrient analysis of ladoo:

Proximate composition of the developed High protein ladoo was studied. Parameters analyzed were moisture (AOAC, 2000) **[12]**, ash (AOAC, 2000) **[12]**, fat (Sohxlet Sosplus- scs 03) and protein (Pelican Kelplus Supra lxva Instrument). Minerals (calcium, iron, phosphorus, copper and zinc) were analyzed using Inductive Coupled Plasma- Optical Emission Spectroscopy [Perkin Elmer: Avio 200 (ICP-OES)].

C. Supplementation of ladoo:

- Sample size: A sample size of 32 was derived using Open Epi software considering 95% significance level at a power of 80% and assuming that 60 % children will improve in their body weight after supplementation.
- Selection of subjects: Written permission was obtained for conducting the supplementation study from two purposively selected balwadi centers of the lower middle income group situated at V. V. Nagar in Anand district. Selection of balwadi centers was based on compliance obtained from balwadi centers and proximity. All the children attending either of the two selected balwali (n=2) were evaluated for their nutritional status based on anthropometric measurements.

  Based on cut-offs given by WHO, children were classified into normal, mild or moderately malnourished (underweight/ stunted/ wasted). Malnourished children were then selected based on a Z score between -2 and -3 SD. A total of 32 MAM (WHZ <-2 and ≥-3 without oedema, WAZ <-2 and ≥-3) children aged between 3-5 years were purposively enrolled in the study. The children were divided into control (n=11) and experiment (n=21) groups.
- Exclusion criterion: Children suffering from any infectious disease at the time of start of the study were not included in the study.
- Written consent:All parents of the enrolled MAM children were explained in detail about the objective and the methodology of the study. All parents were informed about the ingredients, the processing of the ingredients and the preparation method of the ladoo before the clinical trial. Before the start of the study, ladoo was distributed to the mothers of the subjects in order to help them decide about joining the study. Based

on the willingness to take part in the study written consent was taken from the parents.

- Feeding the ladoo: The supplementation study was conducted for a period of 60 days between December to February, 2019. Ladoo was prepared freshly and 70 grams (2 in number) were packed in polyethene bags and distributed to the MAM children of the experimental group at the balwadi centers. 70 g was decided based on the energy and protein levels supplied by supplementary feeds. Subjects were instructed to finish consuming the ladoo during the same day. Children from control group did not receive any food supplement.
- Parameters studied:
  - ✓ Height (cm), weight (kg) and mid arm circumference (MUAC) (cm) were recorded as per standard methods.
  - ✓ Body mass index (BMI) and Z score for weight for height (WHZ - wasting), weight for age (WAZ - Underweight) and height for age (HAZ - stunting) were calculated using WHO Anthro software (v 3.2.2).
- ✓ Weight gain was calculated using the formula given below **[13]** where, W1 is the initial weight in kg and W2 is the weight in kg on the last day of measurement.
- ✓ Weight gain in g/kg/day

$$= \frac{(W2 - W1)x\ 1000}{(W1\ x\ Number\ of\ days\ from\ W1\ to\ W2)}$$

D. Data analysis: Data was analyzed using SPSS version 19.0 (Statistical Package for Social Sciences). Comparison of means was performed using paired t- test. A p- value of $\leq$ 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

A. Nutrient analysis:

High protein ladoo was developed from soybean, cowpea, rice, SMP, Jaggery and ghee as a RUF for the treatment of malnourished children. Proximate composition of the high protein ladoo is depicted in **Table 1**.The developed ladoo provided 510 kcal of energy, 18 g protein, 30 g fat and 88 mg of calcium per 100 g. while 70 g is the quantity of ladoo used for feeding which provided 357 kcal energy, 12.57 g of protein, 21.15 g fat and 61.81mg of calcium per day. The cost of the ladoo was 20/- for 70 g of ladoo.

B. Screening of subjects:

For the supplementation study, all the children from the two selected balwadi centers were evaluated for their nutritional status. About 100 children were included in the screening phase. Based on their Z score for WAZ, HAZ and WHZ children were categorized. Confirmation of the date of birth resulted in 21% of the children being excluded during the screening. The prevalence of WAZ, HAZ and WHZ in the children included for screening is presented in **Fig 2.** The prevalence of WHZ was found to be high (38%) compared to WAZ (36.7 %) and HAZ (27.8 %) among the children included in the screening.

C. Effect of supplementation

A total of 33 children were enrolled in the study. At the end of the study one child suffering from infection dropped out. Therefore, 32 children (40.6% boys, 59.4% girls) remained for follow up, of whom 21 received ladoo supplementation and 11 did not receive any supplement. Anthropometric changes after 60 days of supplementation in both the groups are presented in **Table. 2**. Percentage change in all the anthropometric parameters are presented in **Fig 3(a) & (b)**. It showed that the average weight of control and experimental group was 11.72 ± 0.255 kg and 11.82 ± 0.256 kg, respectively, before the supplementation of high protein ladoo which was nearly similar in both the groups. After 60 days of supplementation to the experimental group, it increased significantly ($p<0.01$) in the control and the experimental group by 3.24 % and 10.40%, respectively. A similar trend was observed for height also. After supplementation, height increased significantly by 1.45 % and 1.95 % in control and experimental groups, respectively. The average value of MUAC for the control group was 13.85 ± 0.208 cm and 13.97 ± 0.185 cm before and after supplementation, respectively which showed no significant ($p=0.552$) difference whereas MUAC increased significantly ($p=0.003$) by 2.91% in the experimental group after supplementation. There was no significant

difference in the BMI of the children in the control group after supplementation. In the experimental group BMI was found to be 11.42 ± 0.926 to 13.51 ± 0.149 kg/m^2 before and after, respectively. A significant ($p<0.05$) increase was observed in the BMI of experimental group after ladoo supplementation by 18.3 %.

Studies conducted by several researchers showed an increase in the anthropometric measurements after soy ladoo supplementation to preschool children for six months **[14]**. Sharma et al (2018) also reported a % change in height by 0.90%, weight by 9.06% and BMI by 8.13% in the group supplemented with soy poha ladoo for 90 days **[15].** In the present study the weight gain of the children in the supplementation group was significantly higher due to the nutrient content of the ladoo. The developed ladoo was energy dense and high in protein quantity and quality. All the preprocessing treatments such as soaking and dehulling given to the ingredients used in the preparation of ladoo has also promoted significant reduction in the antinutritional factors. Soaking reduces phytate content along with other antinutritional factors such as saponins, trypsin inhibitors and polyphenols from the soybean. Heat processing treatment such as roasting increases digestibility of proteins, carbohydrates and other nutrients and enhances the flavor. Additionally cereal and pulse combination in the preparation of the ladoo has provided a complete protein essential for proper growth and development. All the ingredients used in the preparation and the amounts were fixed in a proportion such that all the essential nutrients especially amino acids were provided in the required amount **[16]**.

Z-score, also known as Standard Deviation (SD) score is the measure of dispersion/relative deviance of the data from the mean/median value i.e. measure of the distance between the child's value and value of the reference population. Nutritional status is well predicted by calculating Z-score for weight-for-height, height-for-age and weight-for-age. As summarized in Table 2, the mean WAZ and WHZ score improved significantly ($p<0.01$) in the experimental group after supplementation of ladoo for 60 days whereas no significant difference was observed in HAZ after supplementation. As far as control group is concerned no significant difference was seen in WAZ, HAZ and WHZ before and after supplementation. The mean weight gain for the control group was 0.53 ± 0.114 g/kg/day and in the experimental group it was observed to be 1.74 ± 0.154 g/kg/d after supplementation which showed a highly significant ($p=0.004$) difference. A randomized controlled trial also reported weight gain velocity to be 2.71 g/kg/day in moderately acute malnourished children treated with ready-to-use supplementary food in Camerron **[17]**. In the present study, at the end of the supplementation period 80.95% of the moderately wasted children (WHZ) recovered and shifted to the yellow zone of mild malnutrition whereas 76.19% of the moderately underweight (WAZ) children also improved from MAM. However, in the study done by Gabriel (2015) **[17]** recovery rate in the group of MAM children supplemented with RUSF based on soy and corn flours, peanut paste, sugar, soy oil and premix containing minerals and vitamins was reported to be 73%.

CONCLUSION

Based on the above findings, it can be concluded that the developed high protein ladoo as a ready-to-use supplementary food had a significant effect on the weight, height, MUAC, BMI, WAZ and WHZ of MAM children in the experimental group. Supplementary foods made from locally available ingredients combined with house hold processing techniques have shown to be highly effective in this study. Thus the use of locally available and underutilized ingredients needs to be promoted for the production of supplementary foods in the prevention and treatment of malnourished children.

Children are the future of the nation and the nutritional status of under five children is an important indicator of the overall development of the community and of the nation. Healthy children will develop into healthy adults hence the developed supplementary food should be advocated in government feeding programs.

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Table 1: Proximate composition of High protein ladoo

Nutrients	100g	70 g (2 in number)
Energy (Kcal)*	510.10	357.07
Carbohydrate (g)*	41.57	29.09
Protein (g)	17.96	12.57
Fat (g)	30.22	21.15
Moisture (g)	1.7	1.19
Ash (g)	3.80	2.66
Calcium (mg)	88.31	61.81
Iron (mg)	0.73	0.51
Phosphorus (mg)	81.83	57.27
Copper (mg)	0.10	0.07
Zinc (mg)	0.56	0.39

*calculated values (NIN, 2017) **[18]**

Table-2 : Anthropometric changes after supplementation of High protein ladoo.

Anthropometric parameters	Control (n=11)		Experiment (n=21)	
	Before	After	Before	After
Weight (kg)	11.72 ± 0.255	12.10** ± 0.257	11.82 ± 0.256	13.05** ± 0.265
Height (cm)	93.90 ± 1.368	95.27** ±1.395	96.49 ± 1.14	98.38** ± 1.134
MUAC(cm)	13.85 ± 0.208	13.97^{NS} ± 0.185	14.05 ± 0.149	14.46** ± 0.147
BMI(kg/m^2)	13.30 ± 0.151	13.35 ^{NS} ± 0.155	11.42 ± 0.926	13.51* ± 0.149
Weight for age –Z score (WAZ)	-2.40 ± 0.175	-2.35 ^{NS} ±0.178	-2.27 ± 0.155	-1.78** ± 0.144
Height for age-Z score (HAZ)	-1.92 ± 0.334	-1.961 ^{NS} ± 0.321	-1.43 ± 0.232	-1.31 ^{NS} ± 0.212
Weight for height-Z score(WHZ)	-1.92 ± 0.126	-1.78 ^{NS} ± 0.130	-2.35 ± 0.124	-1.54** ± 0.115

Values are the mean ± SEM.
*and ** indicate significant difference at $p \leq 0.05$ and $p \leq 0.01$, respectively.
NS: Non significant

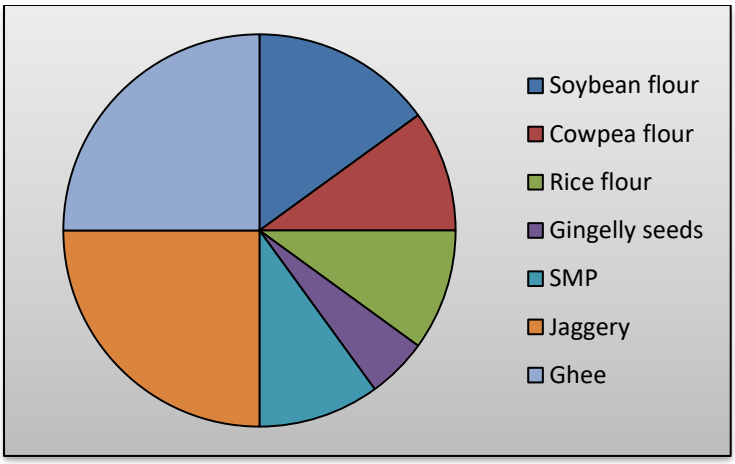

Fig 1 Composition of High protein ladoo

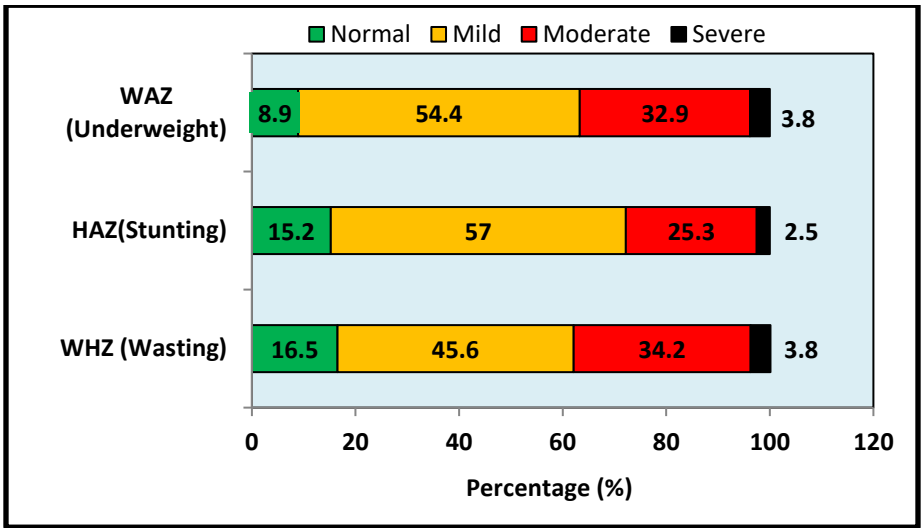

Fig 2: Prevalence of WAZ, WHZ and HAZ among the children (n=79) included in the screening

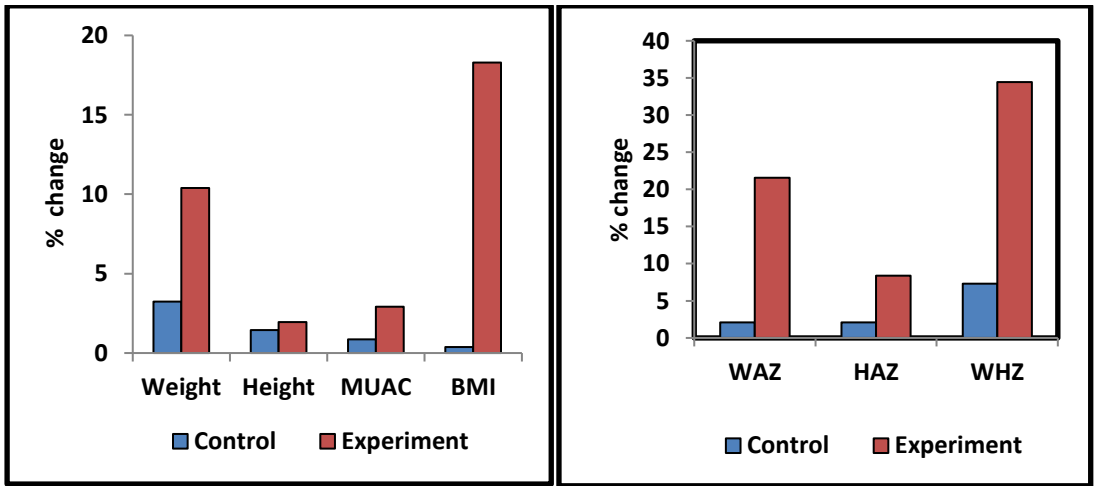

Fig 3(a) & (b): Percent (%) change in anthropometric parameters