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Impact of dietary intervention on undernourished farm women

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Abstract

Background: Women are vulnerable group for under nutrition, due to various physiological states in the life cycle. Especially in developing countries, despite the fact that women are predominantly the food producers for the nation, majority of them are anaemic, malnourished and have health problems due to insufficient nutrient intake. Hence, a study was undertaken to develop an energy dense food product from regionally available food ingredients and to test its efficacy on farm women in improving nutritional status.

Methods: A traditional food product 'laddu' was developed from combination of millet, cereal, legume, oil seeds, fats and sugars by application of simple processing techniques. The developed product was further subjected for nutritional evaluation and dietary intervention on farm women up to 120 days. Impact was studied on anthropometric measurements and nutrient intake of subjects.

Results: Findings indicated that, the product contained 516 kcal of energy per 100 gm. The protein, fat, total dietary fiber, iron and calcium content of the product was 9.80 g, 31.60g, 3.90g, 2.47mg and 159.60mg respectively. Majority of the subjects belonged to lower middle socio-economic group with marginal land holding. Mean body weight of rural farm women increased significantly from 40.67±3.29 to 43.29±4.51 kg and corresponding increase in BMI was also observed from 17.43±0.49 to 18.75±1.26 (kg/ m²). The initial protein, fat and energy intake in experimental group was 31.99±3.01 g, 23.46±4.52 g and 1288 kcal respectively which was increased significantly for all the nutrients after intervention.

Conclusion: In the present scenario, providing nutrition security through development and popularization of nutri-dense food products from regionally available food ingredients among the vulnerable sections of the society is of vital importance.

Keywords: under nutrition, farm women, dietary intervention

Introduction

The millions of women engaged in agriculture across the globe are a heterogeneous group with vastly different realities, opportunities and challenges (Debevec and Gadeberg, 2018) [15]. In rural India, the percentage of women who depend on agriculture for their livelihood is as high as 84 per cent and constitute major percentage of the agricultural labour force in the rural sector, producing much of the country's food. Women make up about 33 per cent of cultivators and about 47 per cent of agricultural labourers (Singh *et al.* 2009) [12]. These statistics do not account for work in livestock, fisheries and various other ancillary forms of food production in the country. Despite the fact that women are predominantly the food producers for the nation, majority of them are anaemic, malnourished and have health problems due to insufficient nutrient intake. According to NFHS-4, 39 per cent of rural women in the age group of 15 – 49 years suffer from chronic energy deficiency and 58 per cent are anemic. Under nutrition denotes insufficient intake of energy and nutrients to meet an individual's needs to maintain good health (Maleta, 2006) [10]. Under nutrition in all its forms is responsible for an estimated 3.5 million preventable maternal and child deaths annually and has enormous human and economic costs in the long run (Bhutta *et al.*, 2013) [4]. Children born to women with low Body Mass Index (BMI) are more likely to be stunted, wasted, and underweight compared to children born to women with normal or high BMI (Sources: FNSA, 2019, WHO). In India women whose BMI is below normal (BMI < 18.5 kg/m²) were 16.2 and 24.3 per cent in rural and urban respectively and in total it is, 20.7 per cent. One-fifth of women in the reproductive age group were estimated to be suffering from chronic energy deficiency while another one-fifth were obese in Karnataka (NSFH 2015-16) [8]. Low intake of nutrients reduce the physical capacity to work and increase the extent of fatigue accident rate and sickness. Improvement in work efficiency and output require adequate diet, sufficient not only in calories but also protein, minerals and vitamins which must be made available.

Dietary intervention is one of the important and effective measure to address under nutrition. Though there are range of foods available in structuring ready to eat foods for under nutrition, millets are promising, nutri-dense, affordable and easily available. Adoption of food in dietary intervention is expected to be more, when the food developed for the intervention is traditional and prepared from regionally available ingredients. Hence, in the present research, a locally grown crop which is popular worldwide, finger millet *in combination with cereal, legume, oil seeds, fats and sugars* is transformed into energy-dense traditional food called *laddu*, to test its efficacy on undernourished farm women.

Materials and Methods

Methodological steps followed to conduct the dietary intervention for undernourished farm women is listed below.

Development of energy dense food: A ready to use composite food mix was prepared from regionally available ingredients such as, finger millet (*Eleusine coracana*), rice (*Oryza sativa*), groundnuts (*Arachis hypogaea*), soy (*Glycine max*) flour, desiccated coconut powder, puffed Bengal gram (*Cicer arietinum*) flour and milk powder. All these ingredients were procured from nearest retail outlet at Bangalore, Karnataka, India. From the composite mix, a traditional energy dense food product namely *laddu* was prepared by addition of groundnut, sesame, cashew, ghee, sugar powder and cardamom. Protocol for preparation of *laddu* is presented in flow chart (Fig. 1).

Nutrient analysis: The developed energy dense product (*laddu*) was analyzed for protein, fat, ash and total dietary fiber by using standard protocol (AOAC, 1990) [2]. Carbohydrate was calculated by difference method and calorific value was obtained by multiplying the carbohydrate and protein content by four and fat by nine Kcals. Dietary fiber was estimated by an enzymatic gravimetric method (Prosky, 1990) [11]. Micro nutrients viz., iron, zinc and calcium were analysed using atomic absorption spectrometry (AOAC, 1990) [2].

Ethical approval: Before implementation of the dietary intervention, a clearance certificate was taken from the ethical committee formulated at University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bangalore, Karnataka, India. Subjects with hyperthyroidism, diabetes and other related health problems were excluded from the study.

Selection of subjects: A total of 240 women involved in farm activity from seven villages of Bangalore north were screened for undernourished subjects. The basic criteria for selection of subject was Body Mass Index (BMI) below 18.5 kg/m².

Anthropometric Measurements: Anthropometric measurements viz., height, weight, waist circumference (WC) and hip circumference (HC) were taken for all the subjects. For measurement of body weight electronic balance (Atlas weighing equipment's, India) was used. The weight of individual was taken with minimum clothing, standing erect without shoes, or holding any support. Height was measured by using anthropometry on a levelled surface, without shoes, looking straight with heels together and toes apart. Waist (WC) and hip (HC) circumference were measured by measuring tape. Body Mass Index (BMI) and Waist Hip Ratio

(WHR) indices were calculated. Among these subjects 60 individuals having BMI <18.5 (WHO, 2004) were selected and divided equally into control (n=30) and experimental (n=30) group.

Socio-economic status of selected subjects: A questionnaire was developed to elicit information on socioeconomic status and food habits of the participating subjects through personal interview method. In this data on age, educational status, land holding, occupation, source of income, food habit and meal consumption pattern of the subjects was also collected.

Dietary Survey: Dietary survey of the selected 60 farm women was conducted by using 24-hour recall method for three consecutive days during pre and post interventional period. To assist the subjects, recall better, a set of standardised cups and vessels were used to measure the food intake. Subjects were asked to recall the type of preparation made for breakfast, lunch, evening tea and dinner etc for the previous three days. Data on intake of different food groups was evaluated. Using the quantity of food consumed per day nutrients such as protein, fat, carbohydrate, energy, mineral, calcium, iron, zinc and dietary fiber were calculated and compared against the (RDA 2010). To measure of adequacy or inadequacy of food and nutrient composition the below formula was used.

$$\text{Per cent nutrient adequacy (\% RDA)} = \frac{\text{Intake of each nutrient}}{\text{Recommended Daily allowances (RDA)}} \times 100$$

Dietary intervention: Dietary intervention was carried out for 120 days on selected undernourished farm women. For experimental group (n=30) along with their regular diet, developed energy dense *laddu* (90 g) providing 500 k cal energy and 8.5 g protein was given daily during mid morning. The subjects in experimental group were monitored throughout the intervention period to ensure the consumption of provided experimental food. The control group (n=30) was kept neutral without any dietary intervention.

Statistical analysis: Data obtained was statically analysed with suitable tests. Mean and standard deviation was calculated for each studied variable. Paired 't' test was applied for assessing impact of dietary intervention at 5 per cent significance level.

Results and Discussion

Women selected in present study for dietary intervention are involved in farm activities. For their physical activity, when adequate energy is not consumed for prolonged period along with essential nutrients, leads to undernourishment resulting in low body weight. Hence, in the present study an attempt has been made to increase the daily energy intake of farm women by incorporating an energy dense product with substantial level of other nutrients and to test its efficacy in improving body weight and BMI of women. The findings of the study are presented and discussed below.

Nutrient composition of energy dense *laddu*: The nutrient composition of energy dense *laddu* is presented in Table1. It was found that, the product contained 516 kcal of energy per 100 gm. Other proximate composition was 9.80, 31.60, 0.84 and 3.90 of protein, fat, ash and total dietary fiber respectively per 100 g of the product. Micro nutrient content of the product

was 159.60, 2.47 and 1.29 mg for calcium, iron and zinc per 100 gm respectively. It was observed that the developed *laddu* was rich source of energy, protein and fat along with good amount of micro nutrients. The dietary intervention was aimed to incorporate one third ($1/3^{\text{rd}}$) energy need of the farm women along with regular diet. Accordingly the product formulated was found to be energy dense, mainly due to the ingredients such as, soy flour, sugar powder and ghee. The protein, fat and energy content of *laddu* prepared from rice, foxtail and barnyard samples was ranged between, 3.04- 5.00 g, 24.64-25.63 g and 68.40-503 kcal per 100 g (Verma *et al.*,

2015) [13]. These findings are in supportive to present research findings for energy content, but protein content was also high in present research due to incorporation of ingredients such as soy flour, puffed bengal gram flour, cashew, sesame seeds and ground nut along with popped finger millet. It was observed that, the selected ingredients contributed to the nutritional composition of the developed food product (*laddu*) to make it nutritionally dense (especially in terms of protein, fat and energy) suitable for dietary intervention of underweight women.

Table 1: Nutrient composition of the energy dense *laddu*

Nutrients	Amount per 100 gm
Moisture (g)	4.02
Protein (g)	9.80
Fat (g)	31.60
Ash (g)	0.84
Total dietary fiber (g)	3.90
Carbohydrate (g)	42.40
Energy (kcal)	516.0
Calcium (mg)	159.60
Iron (mg)	2.47
Zinc (mg)	1.29

Socio-economic profile of subjects: Information on socio-economic status of selected subjects both in control and experimental group was collected and presented in Table 2. It was observed that, in experimental group majority of the women belonged to below 30 years group (46.66%) whereas in control group they belonged to above 40-50 years (56.66%) age group. Collectively women were mainly in the age group of 30-50 years. Almost all the subjects in the study were

married irrespective of study group. Nuclear family type was predominant both among control (80.0%) and experimental group (83.33%). In control group most of them were illiterates (50.0%) followed by studied up to middle school (20.0%). Similar trend was observed for experimental group also, where per cent of illiterates and subjects studied up to middle school was same (33.33%).

Table 2: Socio-economic profile of selected subjects

Parameter	Control group (N=30)	Per cent (%)	Experimental group (N=30)	Per cent (%)
Age				
<30	02	6.66	14	46.66
30-39	11	36.66	06	20.00
40-50	17	56.66	10	33.33
Marital status				
Married	30	100.00	29	96.66
Unmarried	00	00	01	3.33
Type of family				
Joint	06	20.00	05	16.66
Nuclear	24	80.00	25	83.33
Educational qualification				
Illiterate	15	50.00	10	33.33
Primary	02	6.66	02	6.66
Middle	06	20.00	10	33.33
High school	03	10.00	04	13.33
PUC	04	13.33	03	10.00
Graduation	00	0.00	01	3.33
Post Graduate	00	00	00	00
Land holding				
Landless	08	26.66	07	23.33
Marginal (<2 hec)	18	60.00	17	56.66
Small (3-5 hec)	04	13.33	05	16.66
Large (> 5 hec)	00	00	01	3.33
Family Monthly Income (Rs.)				
Lower < 2640	00	00	00	00
Upper lower 2641-7886	05	16.66	08	26.66
Lower middle 7887-19758	14	46.66	19	63.33
Upper middle 19756-26354	09	30.00	02	6.66
Upper >26356-52733	02	6.66	01	3.33
Higher >52734	00	00	00	00

Majority of the subjects had marginal land holding in control (60.0%) and in experimental group (56.66%). Most of the subjects belonged to lower middle income group with average monthly income ranged from Rs. 7887-19758 per month, however distribution to this group was slightly higher in experimental group (63.33%) compared to control (46.66%).

Food Habits: Data on meal pattern and food habit of the subjects is as presented in Fig 2. Findings indicated that, though majority of them consumed three meals per day both in control (76.66%) and experimental (96.66%) group, 23.33 per cent subjects in control group consumed two meals per day. It was observed that non vegetarian food habit was predominant both in control (60.0%) and experimental group (80.0%). In rural areas the habit of consuming two meals per day was more prevalent but changing food consumption pattern due to various reasons has influenced rural farm women in consuming three main meals per day. But the prevalence of underweight among these selected farm women reveals insufficient intake of food both in terms of quality and quantity leading under nutrition. Though subjects were non vegetarians the frequency of consumption of non vegetarians foods is twice or thrice in a month, as revealed during personal interview.

Effect of dietary intervention on anthropometric measurement: The pre and post interventional anthropometric findings are presented in Table 3. Findings indicated, the average body weight of rural farm women increased from 40.67±3.29 to 43.29±4.51 kg. Corresponding increase in BMI was also observed from 17.43±0.49 to 18.75±1.26 (kg/ m²) during intervention. These increases in parameters were observed to be statistically significant.

Whereas no change was observed in control group. In experimental group, waist circumference was slightly increased from 67.17±5.93 to 69.83±5.44 cm after intervention. Also, small shift in WHR was observed post intervention (0.78±0.05 to 0.80±0.05). However, these impacts were statistically non significant. But in control group these positive changes were unseen.

Nutritional anthropometry is measurement of human body at various ages and levels of nutritional status. Comparison of pre and post evaluation of the anthropometric assessment indicates the significant influence of the dietary intervention on subjects under study. In the present study it was observed that, the dietary intervention with additional calories and protein along with regular diet has contributed towards increasing body weight of the selected farm women. This is clearly indicated by BMI assessment, as the experimental subjects shifted from underweight category to normal after the interventional period. There are limited studies available to compare effect of dietary intervention on underweight women. Prentice *et al.*, in 1987 [1] reported that, energy dense prenatal dietary supplement (430 kcal/day) decreased the proportion of low-birth weight babies (less than 2501 g) from 23.7–7.5 per cent, emphasizes the importance of selective targeting of interventions to truly at-risk groups. Benefit of nutritional supplementation in free living, frail, undernourished elderly people was studied by Payette *et al.*, in 2002 [7] and reported that, nutrition intervention is feasible in free-living, frail undernourished elderly people and results in significant improvement of nutritional status with respect to energy and nutrient intake and weight gain. These findings supports the present research work, that dietary intervention with adequate energy dense food supplements contribute to improvement in undernourished subjects.

Table 3: Pre and post mean anthropometric measurements and indices of under nourished subjects

Anthropometric indices	Experimental			Control		
	Pre	Post	t-value	Pre	Post	t-value
Weight (Kg)	40.67±3.29	43.29±4.51	2.63**	38.30±4.29	38.40±4.27	0.09 ^{ns}
Height (m)	1.53±0.06	1.53±0.06		1.52±0.07	1.52±0.07	
BMI (kg/ m ²)	17.43±0.49	18.75±1.26	5.36**	16.59±1.14	16.63±1.18	0.13 ^{ns}
Waist Circumference (cm)	67.17±5.93	69.83±5.44	3.55 ^{ns}	63.50±4.59	63.77±4.33	2.050 ^{ns}
Hip Circumference (cm)	86.0±4.02	87.83±4.02	1.69 ^{ns}	83.4±4.38	83.37±4.7	1.69 ^{ns}
WHR	0.78±0.05	0.80±0.05	1.73 ^{ns}	0.76±0.05	0.77±0.05	1.73 ^{ns}

** : Significant at 0.01 level; * : significant at 0.05 level and ns: non-significant

Note: WC: Waist circumference; HC: Hip circumference; WHR: Waist Hip Ratio

Effect of dietary intervention on nutrient intake: Pre and post dietary interventional comparison of nutrient intake is presented in Table 4. Results of nutrient intake indicated that, the protein, fat and energy intake in experimental group was 31.99±3.01 g, 19.46±4.52 g and 1288 kcal respectively and increased to 39.73±3.90 g, 38.02±4.49 g and 1740±122 kcal after intervention. However, in control group the intake of these proximate was remained unchanged. It was also found that, post interventional increase in intake of micronutrients (Calcium, iron and zinc) among experimental group. Dietary fiber intake was increased from 36 to 81 per cent adequacy in experimental group. It was noticed that, dietary intervention in experimental group significantly increased the intake of all the essential nutrients with improved adequacy of the nutrients. Whereas in control group no difference was

observed. Bhandari *et al.*, in 2016 [3] studied, dietary intake patterns and nutritional status of women of reproductive age in Nepal and reported that, the dietary intake patterns to combat against nutritional deficiencies are not appropriate and nutritional status of women of reproductive age is still poor, indicates the need for dietary intervention among women. Payette *et al.*, (2002) [7] reported that nutritional supplementation in elderly people has significantly improved the energy and protein intake. These findings are in supportive to present study. The food product developed for dietary intervention was not only rich in energy, it also contained all the essential nutrients in optimum level, which is reflected in the increased nutrient intake among farm women. Increase in nutrient intake helps in improving the nutritional status of the women under study.

Table 4: Pre and post nutrient intake of undernourished subjects

Nutrients intake	RDA	Experimental					Control				
		Nutrient intake	% Adequacy	Nutrient intake	% Adequacy	't' test	Nutrient intake	% Adequacy	Nutrient intake	% Adequacy	't' test
Nutrients		Pre		Post			Pre		Post		
Protein (g)	55	31.99±3.01	58	39.73±3.90	72	24.68**	31.06±3.17	56	30.93±3.10	56	0.64 ^{ns}
Fat (g)	25	19.46±4.52	76	38.02±4.49	152	46.67**	21.46±4.23	86	21.22±4.23	85	1.24 ^{ns}
CHO(g)		198.42±19.07		257.54±24.1		17.00**	198.96±18.35		200.97±16.92		1.72 ^{ns}
Energy(K cal)	2230	1288±68.15	58	1740±122	78	26.02**	1267±63.18	57	1271±51	57	0.87 ^{ns}
Mineral (g)		6.66±0.99		9.07±1.28		28.17**	6.65±0.86		6.73±0.94		0.85 ^{ns}
Calcium(mg)	600	486.53±103.47	81	639.46±97.4	80	60.07**	495±72.09	83	503±80.23	84	1.17 ^{ns}
Iron (mg)	21	9.06±1.61	43	14.48±2.02	69	40.72**	8.92±1.40	42	9.04±1.33	43	1.06 ^{ns}
Zinc (mg)	10	5.23±0.44	52	5.52±0.69	55	3.97*	5.29±0.54	53	5.34±0.52	53	0.90 ^{ns}
Dietary Fiber (g)	25-40	14.31±2.74	36	32.41±3.18	81	42.88**	13.78±2.86	34	13.72±2.65	34	0.26 ^{ns}

*Significant at @ 5 per cent **Significant @1% ns: Non significant

Conclusion

Under nutrition denotes insufficient intake of energy and nutrients to meet an individual's needs to maintain good health. In this regard, development and supplementation of nutritionally dense food product to combat malnutrition is an effective strategy. A traditional energy dense product 'laddu' has positive influence on nutritional status of the farm women. Such, food based approaches are recognized as an essential part of an urgently needed more comprehensive strategy for improving nutrition by increasing the availability and consumption to combat nutrient deficiencies. It is also needed to ensure food and nutrient security through development and popularization of nutri- dense food products among the vulnerable sections of the society utilising locally available region specific foods.

Declarations

Ethics approval and consent to participate: The study was undertaken with the institutional ethical approval certificate provided with No. AICRP FN 2018001 dated: 10.02.2018. Written consent was taken from the subject's prior participation in to the study.

Consent for publication: Manuscript doesn't contain any individual persons data in any form

Availability of data and material: The datasets used or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests

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Authors contributions: K. Geetha, Geetha M. Yankanchi and Lipi Das structured research work. Monitored and evaluated the research findings. Also provided the valuable suggestions for preparation of manuscript. Netravathi Hiremath conducted the research work, collected and analysed the data. Shilpa Yatnatti and Jyothi T Sajjan prepared manuscript and corresponded with other authors for suggestions.

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