Impact of Dietary Intervention on Undernourished Farm Women

Geetha K
University of agricultural sciences, Bangalore

Geetha M Yankanchi
University of agricultural sciences, Bangalore

Lipi Das
Central Institute for women in agriculture

Nethravathi Hiremath
University of Agricultural Sciences, Bangalore

Shilpa Yatnatti (✉️ shilpayatnatti@gmail.com)
University of Agricultural Sciences, Bangalore  https://orcid.org/0000-0002-6274-2232

Jyothi T Sajjan
University of agricultural sciences, Bangalore

Research

Keywords: Under nutrition, farm women, dietary intervention

DOI: https://doi.org/10.21203/rs.3.rs-148638/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.  Read Full License
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 a 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, 31.60 g, 3.90 g, 2.47 mg and 159.60 mg 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.

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). 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 percent of agricultural labourers (Singh et. al. 2009). 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). 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). 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). 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, Kamataka, India. From the composite mix, a traditional energy
Nuts and seeds, along with popped finger millet, were added to the product. It was observed that these ingredients contributed to the nutritional composition of the product. The protein, fat, and energy content of these ingredients ranged between 3.04-5.00 g, 24.64-25.63 g, and 68.40-503 kcal per 100 g (Verma et al., 2015). These findings are supportive of the present research findings for ingredients such as soy flour, sugar powder, and ghee. The nutrient content was 159.60 mg for calcium, 2.47 mg for iron, and 1.29 mg for zinc per 100 gm. It was observed that the developed product contained 5.00 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. The development of energy dense product was achieved by adding groundnut, sesame, cashew, ghee, sugar powder, and cardamom. Protocol for preparation is presented in the flowchart (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). 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). Micro nutrients viz., iron, zinc, and calcium were analyzed using atomic absorption spectrometry (AOAC, 1990).

Ethical approval: Before implementation of the dietary intervention, a clearance certificate was taken from the ethical committee formulated at University of Agricultural Sciences, Gandi 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 leveled 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.

\[
\text{Intake of each nutrient} = \frac{\text{Recommended Daily allowances} \times 100}{(RDA)}
\]

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 kcal 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

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 (1/3rd) 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). 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

Page 3/10
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 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 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.

**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

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 | 0.09ns |
| Height (m) | 1.53±0.06 | 1.53±0.06 | 1.52±0.07 | 1.52±0.07 | 0.13ns |
| BMI (kg/ m²) | 17.43±0.49 | 18.75±1.26 | 5.36** | 16.59±1.14 | 16.63±1.18 | 0.13ns |
| Waist Circumference (cm) | 67.17±5.93 | 69.83±5.44 | 3.55ns | 63.50±4.59 | 63.77±4.33 | 2.050ns |
| Hip Circumference (cm) | 86.0±4.02 | 87.83±4.02 | 1.69ns | 83.4±4.38 | 83.37±4.7 | 1.69ns |
| WHR | 0.78±0.05 | 0.80±0.05 | 1.73ns | 0.76±0.05 | 0.77±0.05 | 1.73ns |

**: 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

Table 4: Pre and post nutrient intake of undernourished subjects
Nutrients | RDA | Experimental | Control
--- | --- | ---:| ---:| ---:| ---:| ---:| ---:| ---:| ---:| ---:| ---:| ---:| ---:| ---:| ---:|
 | | | Nutrient intake | % adequacy | Nutrient intake | % adequacy | Nutrient intake | % adequacy | Nutrient intake | % adequacy | Nutrient intake | % adequacy |
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 |
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 |
CHO(g) | 198.42±19.07 | 257.54±24.1 | 17.00** | 198.96±18.35 | 200.97±16.92 |
Energy(K cal) | 1288±68.15 | 1267±63.18 | 78 | 1271±51 | 57 |
Mineral (g) | 6.66±0.99 | 9.07±1.28 | 78 | 6.65±0.86 | 6.73±0.94 |
Calcium (mg) | 486.53±103.47 | 639.46±97.4 | 80 | 495±72.09 | 83 | 503±80.23 | 84 |
Iron (mg) | 9.06±1.61 | 14.48±2.02 | 69 | 8.92±1.40 | 42 | 9.04±1.33 | 43 |
Zinc (mg) | 5.23±0.44 | 5.52±0.69 | 55 | 5.29±0.54 | 53 | 5.34±0.52 | 53 |
Dietary Fiber (g) | 14.31±2.74 | 36 | 32.41±3.18 | 81 | 13.78±2.86 | 34 | 13.72±2.65 | 34 |

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

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 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) 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.

**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 nutrient 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 subjects 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

**Funding:** This research work is funded by Indian Council of Agricultural Research (ICAR) - Central Institute for Women in Agriculture (CIWA). The funding body overviewed the research work and manuscript for publication.

**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.

**Acknowledgment:** We acknowledge Indian Council of Agricultural Research (ICAR) - Central Institute for Women in Agriculture for funding the project and University of Agricultural Sciences, Bangalore for facilitating the conduct of research project.
References

Prentice AM, Cole TJ, Foord FA, Lamb WH, Whitehead RG, et al. Increased birth weight after prenatal dietary supplementation of rural African women. American Journal of Clinical Nutrition. 1987;46:912–925

Helrich K. AOAC, Official Methods of Analysis Arlington, VA, USA: Association of Official Analytical Chemists. 1990.

Bhandari S, Sayami JT, Thapa P, Sayami M, Kandel BP, Banjara MR, et al. Dietary intake patterns and nutritional status of women of reproductive age in Nepal: findings from a health survey. Archives of public health. 2016;74(1):1-11.

Bhutta ZA, Salam, RA, Das JK, et al. Meeting the challenges of micronutrient malnutrition in the developing world. British medical bulletin. 2013;106 (1):7-17.

Ministry of Health and Family Welfare, National Family Health Survey – 4, 2015-16

Unicef India: women's nutrition. https://www.unicef.org/india/what-we-do/womens-nutrition. Accessed 5 Jan 2021.

Helene Payette. Veronique boutier, Carole coulomb, Katherine gray-donald., Benefits of nutritional supplements in free-living, frail, undernourished elderly people: A prospective randomised community trial. Journal of the American dietetic Association. 2002;105:1088-1095.

National family health survey, 2015–2016. India, Mumbai: IIPS. http://rchiips.org/NFHS/NFHS-4Reports/India.pdf. Accessed 5 Jan 2021.

Indian Council of Agricultural Research (ICMR), Nutrient requirement and recommended dietary allowances for Indians. A report of the expert group of the Indian council of medical research National institute of nutrition, Hyderabad, India; 2010.

Ken Maleta, Under nutrition Community Health Department, College of Medicine, Blantyre, Malawi. Malawi Medical Journal. 2006;18 (4): 189-205.

Prosky L, Collaborative study of a method for soluble and insoluble dietary fiber. In New Developments in Dietary Fiber. Springer. 1990:193-203.

Singh, Roopam, Sengupta, Ranja, et al. EU FTA and the Likely Impact on Indian Women Executive Summary. Centre for Trade and Development and Heinrich Boell Foundation. 2009.

Verma S, Srivastava S, Tiwari N, et al. Comparative study on nutritional and sensory quality of barnyard and foxtail millet food products with traditional rice products. Journal of food science and technology, 2015;52(8):5147-5155.

World Health Organization, Changing history, Geneva, 2004. https://www.who.int/whr/2004/en Accessed 5 Jan 2021

Debevec L, Gadeberg M, What's the truth about the role of women in agriculture today. 2018. https://wle.cgiar.org/thrive/big-questions/what-truth-about-role-women-agriculture-today. accessed on 6.01.2022

Figures
Finger millet was cleaned and washed, dried on cotton cloth for about 8 hrs

Dried finger millet was popped on heavy bottom pan

Rice was cleaned, washed and drained properly. Then dried in hot air oven for 3hrs at 80°C

Dried rice grain was roasted on heavy bottom pan

Popped finger millet, roasted rice and puffed bengal gram dal were powdered in milling machine separately

Ground nut was roasted; husk was removed and then coarsely powdered

Popped finger millet flour, rice flour, defatted soya flour, desiccated coconut powder, milk

Powder and puffed bengal gram dal powder were roasted in ghee till it becomes golden brown in colour

To this mixture sugar powder, roasted sesame, groundnut, fried cashew and cardamom powder were added

All the ingredients were mixed properly till it becomes proper consistency to make a laddu

Small portion of the mixture was taken (90 g) and formed into balls to make traditional Indian sweet product ‘laddu’

Figure 1
Preparation of energy dense traditional food laddu
Figure 2

Meal pattern and food habits of subjects