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Supplementation of germinated groundnut and little millet laddu to undernourished farm women

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Abstract

Global interest is growing in the development of new food products with excellent nutritional quality and utility. The value addition to groundnuts and millets promotes their production, marketing and offers good opportunities to farmers for better income generation. One such affordable and efficient processing method is germination which can enhance nutritional composition and have useful qualities for a variety of food applications. In the present investigation, germinated groundnut and little millet laddu was developed with the most organoleptically acceptable formulation being 63.50 g of germinated groundnut, 31.50 g of germinated little millets and 5.0 g of milk powder. With a high protein content in both quantity and quality, the developed laddu provided nutritious and energy-dense supplement to undernourished person's regular diet. The results of supplementation study to 30 underweight farm women for two months with the developed laddu showed increase in weight from 36.67±3.63 to 39.23±3.73 Kg and BMI from 17.36±0.23 to 18.62±0.34.

Keywords: Germination, groundnut, little millet, supplementation, groundnuts laddu, underweights

Introduction

An important legume grain of the tropics and subtropics is groundnut which is also called as wondernut or poor man cashew. In developing nations, it was being more widely regarded as a useful dietary and protein extender (Arya *et al*., 2016) [3]. The legume contained significant levels of calcium, phosphorous, magnesium, riboflavin, niacin, folic acid, vitamin E, resveratrol and amino acids as well as 36.0 to 54.0% oil, 16.0 to 36.0% protein and 10.0 to 20.0% carbohydrates (Singh *et al*., 2022) [21].

Groundnut covers 327 lakh hectares worldwide with a production of 539 lakh tonnes with a productivity of 1648 kg ha^{-1}. India ranks first in groundnut area under cultivation and is the second largest producer in the world with 101 lakh tonnes with productivity of 1863 Kg/ha in 2022-23. In Kharif 2022-23, groundnut production was 83.69 lakh tonnes in an area of 45.53 lakh hectares (Nayak *et al*., 2021) [12].

India produces 10.24 MT of groundnuts coming in second place to China. According to the FAO, 5.96 million ha of India's land were used for groundnut farming in 2021. Gujarat (4.65 MT), Rajasthan (1.62 MT), Tamil Nadu (1.03 MT), Andhra Pradesh (0.85 MT), Karnataka (0.50 MT), Madhya Pradesh (0.35 MT) and Maharashtra (0.31 MT) are the major groundnut producing states in India in 2019-20 (Suthar *et al*., 2024) [22].

Annual *Arachis hypogaea* L., belonging to the Fabaceae family of plants stood between 30 to 50 cm tall. Each leaflet measured 1 - 7 cm in length and 1 - 3 cm in width. The leaves were alternate and pinnate with four leaflets. The axillary clusters of peanut flowers were produced above the ground.

An important point to note was nutritional composition of groundnuts varied depending on factors such as the variety of groundnut, soil type, growing conditions and processing methods used (Nankya *et al*., 2021) [10].

Little millets (*Panicum sumatrense*) were one of India's oldest crops with highly suitability to a variety of soil and environmental conditions. Although little millet, like all other nutri cereals was nutritionally superior to cereals, its use was limited. As a result, there is a need to rekindle interest in little millet because of its potential nutritional features and health benefits (Neeharika *et al*., 2020) [13].

Little millets were produced to a limited extent throughout India up to altitudes of 2100 m. These seeds were smaller than normal millet seeds and were similar to proso millets in appearance, but were much smaller. It is an annual herbaceous plant with straight or folded blades that grow to a height of 30 to 100 cm. Because of its early maturity and tolerance to severe agro-climatic conditions, little millets were a reliable catch crop and an excellent cattle feed (Rao *et al*., 2017) [17].

The plant can grow up to 5-2.5 m tall, mostly reddish or purplish in colour; stout stems and partially branched with long hairs. The stipules were absent, leaves were arranged spirally, simple and entire, the petiole growing up to 8 cm length and the blade was broadly ovate to rhomboid-ovate (Saloni *et al*., 2018) [19].

Little millet has health benefits due to the presence of bio-active nutraceuticals like phenolic compounds, tocopherols, carotenoids and low glycaemic index benefiting the diabetics. It was a good source of minerals like calcium, phosphorus, potassium, iron and abundant fibre aiding in fat loss (Indirani and Devasena, 2021) [6].

Little millets were staple foods of the poor and crops of tribal areas with marginal lands. They were used as food in situations where other food grains cannot be raised or purchased at economic prices (Padulosi *et al*., 2015) [14]. Little millet was a marvellous source of protein with 7.7%, carbohydrates 67.0%, fat 4.79%, iron 9.5 mg 100 g^{-1}, phosphorous 220.0 mg 100 g^{-1} and polyphenols making it a vital option for nutritional security (Sindumathi and Malathi, 2017) [20].

Malnutrition is a condition that occurs when one or more nutrients were less or excess in the body. Malnutrition is the major health problem in our country that is acute and wide spread. Malnutrition at the social level is a consequence of the relation of people with food (Alexander, 1985) [1].

For human nutrition, groundnut was a priceless supply of protein, calories, vital fatty acids, vitamins and minerals. It was suggested that eating groundnuts has various health advantages and will find place in healthy diets by 2050 to 100% as the consumption of nuts, fruits, vegetables and legumes were increasing (Willett *et al*., 2019) [27].

Indians consumed salted or unsalted peanut as snacks. The major preparation methods for these involved coating and frying the peanut kernel (Varela and Fiszman, 2011) [26]. Due to its high oil content, groundnut was typically categorised as an oilseed. Protein, oil and fibre were all abundant in peanuts. In addition to oil, peanuts were frequently used to make soups, sweets, roasted peanuts, confections, snack foods and extenders for meat products (Lukaniuk *et al*., 2011) [9].

Millets have beneficial health effects like antioxidant, anti-diabetic, anti-tumorigenic, atherosclerogenic effects and antimicrobial properties (Yang *et al*., 2012). The regular consumption of whole millets and their products can prevent gastrointestinal cancers, cardiovascular diseases and type II diabetes to a certain extent (Ambati and Sucharitha, 2019) [2].

Little millet was a low glycaemic index food due to its high fiber content making carbohydrate digestion a slow process. It took a long time for glucose to enter the blood and maintained the blood sugar level. It also controlled blood pressure and heart rate. Magnesium in little millet was essential for hundreds of biochemical reactions in the body and was useful to fight depression among elderly (Dey *et al*., 2022) [4].

One of the primary goals of supplementation studies to underweight individuals was to replenish essential nutrients that are lacking in their diets. These studies assessed the impact of nutrient-rich supplementary foods on increasing the intake of critical vitamins, minerals and macronutrients (Uzogara, 2016) [25].

For underweights, gaining weight in a healthy and controlled manner is often a key objective for good health. The supplementation studies investigated the influence of calorie-dense or high-energy foods on weight gain. This is particularly important for individuals with medical conditions or eating disorders that led to significant weight loss (Reber *et al*., 2019) [18].

In addition to overall weight gain, supplementation studies also assessed changes in muscle mass and body composition. Protein supplements promoted muscle growth and improved lean body mass in underweight individuals (Pasiakos *et al*., 2015) [15].

Underweight individuals were at increased risk of nutrient deficiencies due to inadequate food intake and these studies addressed the deficiencies to prevent adverse health effects. These studies provided a structured way of monitoring an underweight individual's progress, through adequate nutrition and support during their journey to a healthier weight gain (Wyka *et al*., 2012) [28].

According to Pulami *et al* (2010) [16], in the formulation of supplementary foods many factors like nutritive value, easy availability, suitable consistency, cultural acceptability, culinary feasibility or digestability, frequency, quantity and volume are to be considered.

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Methodology

This research was carried out at Post Graduate & Research Centre and Central Instrumentation Cell, *PJTAU*, Rajendranagar, Hyderabad. The groundnuts (K-1812) used to develop laddu were procured through Krishi Vigyan Kendra, Wyra, Khammam. All other ingredients were procured from the local markets of Hyderabad. Total 30 undernourished farm women were selected with BMI < 18.5 through anganwadis with the help of Krishi Vigyan Kendra, Wyra, Khammam after screening. Socio-economic information was collected from selected farm women.

Formulation of germinated groundnut little millet laddu

The groundnuts and little millets were soaked for 12 hours and sprouted for 24 hours at ambient temperature, sun dried, roasted and powdered. For every 100.0g of the above prepared composite flour was added with 25.0g of jaggery and pinch of cardamom to enhance the taste. To make the laddu, ghee was greased on to the palm and the mixture was moulded into laddus. The laddu consisted of 63.50g of germinated groundnuts with 31.50g of germinated little millets and 5.0g milk powders (Navya *et al*., 2023) [11].

Supplementation of laddu to underweights

30 farm women were selected based on BMI of < 18.5 which was considered as undernourished. The germinated groundnut and little millet laddu (50.0g) were supplemented daily to 30 members for 60 days along with their regular diet. The weights were measured on 15th, 30th, 45th and 60th day of supplementation and BMI calculated. Each 50.0g laddu costed Rs. 28.0 per day.

Height (cm)

Height was measured accurately to the nearest 0.1 cm using vertical rod. The farm women were made to remove the slippers and stand on the height rod platform by the rod and the foot was touching the rod with heals, shoulders and back of head in upright posture (Jelliffe, 1966) [7].

Weight (Kg)
Body weight of subjects was taken to the nearest 0.1 Kg on a portable electronic weighing balance. The scale calibration was checked regularly before taking each measurement. The farm women were made to stand at the centre of the balance platform without chappals with minimum clothing (Jelliffe, 1966) [7].

Body Mass Index (BMI)
Height and weight of the farm women measured was used to calculate the body mass index. The subjects were classified based on standard BMI.

$$\text{Body Mass Index (BMI)} = \frac{\text{Weight (Kg)}}{\text{Height (m}^2\text{)}}$$

Results and Discussion
The diets of farm women had energy of 1300 - 1400 Kcal, monotonous diet consisting of rice and low in vegetables and fruits. The intake of green leafy vegetables and eggs was 0 - 1 time per week and chicken was largely consumed 1 - 2 times in a week. The intake of mutton too was limited to 1 - 2 times in a month with few families consuming beef. The intake of milk was in tea and other milk products are not consumed regularly.
Each 50.0g laddu provided protein of 17.58g, fat of 0.99g, carbohydrates of 15.90g and energy of 232.8 Kcal. Also, it provided 11.49 g of dietary fiber along with minerals like sodium, potassium, calcium, iron, zinc, copper and manganese of 8.12, 277.30, 60.35, 1.23, 1.42, 0.12 and 0.63 mg daily. About a tenth of energy RDA was provided with this laddu.
The selected farm women socio factors were discussed below in the following Table 1. The age of selected women was above 45 years and family size of women had 1 - 2 members (35.0%), 3 - 4 members in 50.0% of families and 15.0% had more than 5 members. Among the selected women, 85.0% of them were only able to sign their name and rest partially literate. Among those women, 25.0% of them were working in their own farms.
Non-agriculture labour was the source of livelihood among 15.0% of women. Nearly 60.0% of the women depended upon pension as the source of income as they are unable to work in fields due to joint pains, back problem and general weakness due to anemia. Based on the poverty scale, all 30 women were under BPL. Among them, 85.0% of women live in their own houses and 15.0% lived in rented houses. The majority of women (65.0%) were living in pucca houses with 2 to 2½ rooms. Of the 30 women, 55.0% reported MPCI less than INR 3000.00 and 45.0% reported MPCI between INR 3000.00 to 5000.00. None of the women were growing vegetables in their backyard kitchen gardens.

Table 1: Socio-economic information of selected farm women

Factors	Category	Percentage
Age	Above 45 - 55 years	100.00
Gender	Women	100.00
Family size	1 - 2 members	35.00
	3 - 4 members	50.00
	5 and above members	15.00
Education	Sign their name	85.0
	Partial literacy	15.0
Occupation	Agricultural labour	25.00
	Non - agriculture labour	15.00
	Pension	60.00
Poverty level	BPL	100.00
House	Own	85.00
	Rented	15.00
	Kutcha house	35.00
	Pucca house	65.00
Monthly per capita income (INR)	< 3000.00	55.00
	3000 - 5000	45.00

Anthropometric measurements like height, weight and BMI were analysed before intervention, at 15, 30, 45, 60 days and presented in Table 2. The anthropometric measurements served as a good indicator of past and present nutritional status of an individual. The physical measurements are very useful in determining nutritional status because they depend in part on nutrient intake. The physical growth is considered as one of the major outcomes of interaction between nutrients and the environment (Ulijaszek and Kerr, 1999) [24]. So, in the current study height and weight were measured and BMI calculated before and after the intervention to determine its influence.

Height (cm): The height of 30 farm women was taken on 0^{th} day before starting of supplementation. The mean ± SD value of height was 145.17±6.98 cm which remained same during the study period.

Weight (Kg): The weight of all subjects was taken initially before supplementation was started followed by their weight before intervention and on 15^{th}, 30^{th}, 45^{th} and 60^{th} day of intervention. The mean ± SD value of weight was 36.67±3.63, 37.18±3.58, 37.79±3.62, 38.26±3.59 and 39.23±3.73 Kg respectively.

Table 2: Effect of intervention on anthropometric measurements and BMI

Parameter	Before intervention	After 15 days	After 30 days	After 45 days	After 60 days
Height (cm)	145.17±6.98				
Weight (Kg)	36.67±3.63	37.18±3.58	37.79±3.62	38.26±3.59	39.23±3.73
BMI	17.36±0.23	17.61±0.25	17.89±0.28	18.12±0.34	18.62±0.34

Note: Values are expressed as mean ± SD
BMI: Body mass index

The findings of the current investigation are consistent with the information provided by Lauque *et al.* (2000) [8] who carried out a study on protein energy oral supplementation among malnourished children for 60 days randomly using a record of dietary intake, anthropometry, hand grip strength and minimal nutritional assessment. On 0^{th}, 30^{th} and 60^{th} day, dietary consumption and body weight were also noted. The average daily supplement intake was 400 Kcal. The

study concluded that the mean weight gain was 1.5 ± 0.4 Kg of the subjects.

Body mass index (BMI)

BMI was a numerical value using the individual height and weight. It was commonly used to screen and classify individuals as underweight, normal, overweight and obese. BMI of each subject was calculated for 5 times *i.e.*, before intervention, 15th, 30th, 45th and 60th day. The mean ± SD value of BMI was 17.36±0.23, 17.61±0.25, 17.89±0.28, 18.12±0.34 and 18.62±0.34 respectively on those days.

The results showed increased weight from 36.67±3.63 Kg (pre-test) to 39.23±3.73 Kg (post-test) and BMI from 17.36±0.23 (pre-test) to 18.62±0.34 (post-test). The increased weight of 6.98% and body mass index of 7.26% was observed during the study period of 60 days with supplementation of germinated groundnut and little millet laddu. The higher negative t stat indicates that supplemented laddus impacted weight gain among the farm women.

Studies carried out by a several researchers revealed an increase in anthropometric measurements after preschool that children received soy laddu supplementation for six months. (Ghatge, 2012) [5]. It was reported percentage change in weight by 9.06% and BMI by 8.13% in the group supplemented with soy poha laddu for 90 days (Sharma *et al*., 2018).

Table 3: Effect of intervention after 60 days on anthropometric measurements

Parameter	Pre	Post	df	t stat	p-value
Weight (Kg)	36.67±3.63	39.23±3.73	24	-20.443**	0.000
BMI	17.36±0.23	18.62±0.34	24	-17.142**	0.000

Note: Values are expressed as mean ± SD
df: degree of freedom
**significance at 1%
BMI: Body mass index

The farm women in this study were provided with vegetable seeds of brinjal, bhindi, bottle gourd, bitter gourd, cucumber, palak, coriander and carrot for encouraging to grow vegetables in their backyards towards daily intake of vegetables and fruits as it was minimal.

Conclusion

The supplementation of developed laddu to underweights in the present study had 30 farm women supplemented daily for 60 days along with their regular diet. The results showed that there was an increase of weight from 36.67±3.63 Kg to 39.23±3.73 Kg and BMI from 17.36±0.23 to 18.62±0.34 by 60th day due to supplementation of laddu. The inclusion of germinated groundnut and little millets in diet can help in providing nutritional security to a certain extent. The groundnuts to millet combination used in the laddu improved protein profile for healthy growth and development. The ingredients used in the prepared laddu provided essential nutrients in required amount to farm women.

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Conflict of Interest

There is no conflict of interest as declared by all the authors.

Author contributions

KN carried out the research work, compiled the data and wrote the original manuscript, JSW conceived presented the idea, monitored the research work and edited the draft, BAK reviewed the progress of the research work, PRP helped in carrying out of statistical analysis.

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