



Original Article : Open Access

Formulation and evaluation of pulses as phytomedicine in therapeutic food for severely malnourished children

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Article Info

Article history

Received 7 March 2025

Revised 26 April 2025

Accepted 27 April 2025

Published Online 30 June 2025

Keywords

Pulses

Malnourished children

Ready to use therapeutic foods

Consumer quality

Emergency ration

Abstract

Ready to use therapeutic foods (RUTF) are used for treatment of children who are severely malnourished. The commercially available promising RUTF is made from peanut as the main ingredient and is so popular that RUTF itself is associated with peanut. In this context, a research was undertaken to develop an RUTF from pulses replacing peanut. The reason being peanut has potential uses and market demand as a source for cooking oil which is more profitable to the farmers and traders, than using it as a raw ingredient in RUTF specially in India. Industries venturing in RUTF production in India face a discouragement owing to the ingredient cost to be paid for peanuts, which is in high demand. To meet the requirement of food industry and at the same time to exploit the phytomedicinal, nutritional advantage and promote therapeutic foods from pulses this research was undertaken and established special process for RUTF from underutilized pulses of India.

1. Introduction

Ready to use therapeutic food (RUTF) has revolutionized the treatment of severe malnutrition - providing foods that are safe to use at home and ensure rapid weight gain in severely malnourished children. Presently available RUTF originated from a French company "Plumpy nut" and sporadic attempts are being made to develop indigenous RUTF by using the same ingredients as that of "Plumpy nut" (Manay, 2006; Fetriyuna *et al.*, 2023; Mousties *et al.*, 2022; Bai *et al.*, 2022; Hadi *et al.*, 2022). To address the challenges due to the shift in scenarios such as demographic and epidemiological transition, urbanization, climate change and insecurity, food crisis, financial crisis, *etc.*, health promotion has come out as an effective approach. To ensure effective health promotion addressing malnutrition plays an indispensable role (Rajeshwari Ullagaddi and Varsha Murkhandi, 2024).

A functional food is similar in appearance to, or may be a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions. Moringa is renowned for its nutraceutical property and can form a component of functional foods.

Moringa is used for its antioxidant, antimicrobial, anti-inflammatory, antipyretic, antiulcer, antidiabetic and antitumor effects (Kabalan *et al.*, 2024).

Dry foods are nutritious, lightweight, tasty, easy to prepare and easy to store. In developing countries, home food drying remains popular as an alternative to canning. Amla rich in vitamin C retains its vitamins even after drying and converting into powder. This uniqueness of amla can be explored for its usage as a nutraceutical ingredient (Chitra *et al.*, 2024).

India is popular for its pulses and with no campaign; it is a popular and part of everyday Indian diet unlike the rest of the world. Pulses play a crucial role in diets due to their high protein content and abundance of minerals and vitamins. With a substantial share of the world's geographical area and output, India is the top producer and consumer of pulses worldwide. The actual intake in India is far lower, averaging about 30-35 g per day, compared to recommendations by the Indian Council of Medical Research and the World Health Organization for daily per capita consumption at 80 g and a minimum of 47 g, respectively. The demand for pulses in India continuous to be so heavy that the Govt implements pulse mission and achieved self sustenance in pulses. Apart from the major pulses, there are also underutilised pulses, yet extremely nutritious such as cow pea and green gram. The cost is comparatively affordable to be invested by the food processing industry for commercial pulses product production. Amla and moringa abundant production and nutrition in India has to be given a new dimension in product development to make it more profitable. With this background, the present innovation

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was taken up to develop a special process for the development of immune boosting RUTF from a combination of pulses, amla and moringa

There is a dire need to develop RUTF with the same nutritional composition as given by WHO but with alternate ingredient instead of peanut. Alternating peanut or absented peanut but still developing a process for RUTF was the task under taken in this research work.

2. Materials and methods

2.1 Materials

The raw ingredients and packaging material required for product development was procured from the local market of Madurai and Coimbatore, Tamil Nadu. The chemicals used in the study were LR, AR or GR grade. The materials used in the study are displayed in the Table 1 below.

Table 1: Materials used in the study

Pulses	Pulses such as cowpea and green gram were purchased from the local market.
Raw ingredients	The raw ingredients namely jaggery, milk powder, butter, amla candy, moringa powder were purchased from the local market.
Packaging materials	Poly propylene (PP) pouches with 250 gauge thickness, metallised polypropylene covers was purchased from the dealer.
Chemicals	The chemicals with analytical reagent (AR) or laboratory reagent (LR) or guaranteed reagent (GR) grade were purchased from the local market for analytical purpose.
Glassware	The glassware such as burette, pipette, conical flasks, and volumetric flasks, measuring cylinders, funnels, beakers, petri dishes, test tubes and boiling test tubes were used for analysis in the study.
Equipment	The equipment available in the University was used in the present investigation for the development of RUTF.

2.2 Methods

2.2.1 Trials for formulation of RUTF from pulses

To standardise the process of preparation of RUTF from pulses various trials were devised according to the nutritional standards of

RUTF as provided by WHO and also the final organoleptic quality of the product. Accordingly the proportion of ingredients was carefully selected. The proportion of ingredients required for various trials for the development of the product is presented in Table 2.

Table 2: Proportion of ingredients for the development of RUTF

Ingredients (g)	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Pulse flour/peanut flour (g)	40	40	40	40	40	40	40
Cane sugar (g)	20	20	20	20	20	20	20
Milk powder (g)	20	20	20	20	20	20	20
Butter (g)	10	20	20	20	20	20	20
Water (g)	125	125	125	125	125	125	125
Moringa leaf powder (g)	-	5	5	5	5	5	5
Amla powder (g)	-	10	10	10	10	10	10
Citric acid (g)	-	1.0	1.0	1.0	1.0	1.0	1.0
Ascorbic acid (mg)	-	10	10	10	10	10	10
Calcium sorbate (mg)	-	0.5	0.5	0.5	0.5	0.5	0.5
BHT (permitted synthetic antioxidant)	-	0.2	0.2	0.2	0.2	0.2	0.2

T₀: Commercial RUTF; T₁: Green gram flour RUTF; T₂: Germinated green gram flour RUTF; T₃: Green gram dhal flour RUTF; T₄: Roasted green gram dhal flour RUTF; T₅: Cowpea flour RUTF; T₆: Germinated cowpea flour RUTF.

Six different compositions of ingredients were used for preparation of the RUTF. In all the six trials, variation in the pulse flour used was followed and the preliminary method of processing of the pulse flour were whole pulse flour, germinated pulse flour, roasted pulse flour of green gram, green gram dhal and cow pea as indicated in the

Table 2. The rest of the ingredient was maintained as the same. For instance, T₀ sample contained peanut flour (40 g) while T₁ sample had green gram flour (40 g), T₂ contained germinated green gram flour (40 g) and so on as furnished in Table 2. In the method of preparation all the ingredients were blended uniformly except for sugar and water.

Twenty grams of sugar was added to 125 ml water. The sugar syrup with the addition of citric acid was prepared and boiled till it reaches 115°C. T_0 the syrup, the pulse flour blend with all the other ingredients was added and mixed thoroughly well and mixed well for 3 min. Then, immediately the food additives were added stirred vigorously and transferred to the mould to attain the desired shape. It was cooled at a temperature of 6°C to 8°C for 1 h. The product was wrapped in polypropylene covers stored at room temperature till

use. The same method of preparation was followed for all the six trials from T_0 to T_6 .

2.2.2 Proximate analysis of RUTF

Chemical constituent's such as moisture, carbohydrate, protein, ascorbic acid, calcium and iron were analysed. The method of analysis for chemical constituents adopted in the study is given in Table 3 below.

Table 3: Proximate analysis of pulses RUTF

S.No.	Chemical constituents	Methods	References
1	Starch	Anthrone method	AOAC (1980)
2	Protein	Kjeldahl method	AOAC (1980)
3	Fat	Soxhelt method	AOAC (1980)
4	Iron	Colorimetric method	AOAC (1980)
5	Ascorbic acid	DCPIP visual titration	Ranganna (2001)
6	Free fatty acid	Titration method	Ranganna (2001)
7	Rancidity	Kresis test	AOAC (1980)

2.2.3 Storage studies of the developed products

The RUTF products were packed in polypropylene covers and stored at ambient condition for storage studies for a period of 60 days. The stored samples were utilized for quality analysis.

2.2.4 Sensory quality of the RUTF products

The RUTF products were evaluated organoleptically for various quality attributes such as colour, texture, flavour, taste and overall acceptability by a panel of 15 semi trained judges using 9 point Hedonic scale.

2.2.5 Consumer acceptability of the developed RUTF

Based on the results of the sensory evaluation trials the most accepted combination was subjected to consumer acceptability studies. Accordingly, 100 children from public and private schools in Coimbatore District who volunteered to be a part of the study along with the parent's approval were selected. Fifty children of the age 5 to 7 years of age were selected for the study. The sample size was 50 each from the public and private schools. The children comprised of boys and girls equally in each lot. The nutritional status of the children were assessed and found a mixed population comprising of well nourished (50%), mal nourished (47%) and severely malnourished (3%), but were not classified for the consumer acceptability test. The aim of the test was to find out the acceptability of the product irrespective of their existing nutritional status. The RUTF sample was provided to the children on the last day of the week and the parents were instructed to give the product during the week end at 11.30 am in the morning. Its because the parents indicated that most of the children wake up late in the morning during week ends and the time as 11.30 am would be ideal for them as it is post breakfast one hour for the children, The amount of sample given to each child was 12.5 g per bar. The children were asked to evaluate the acceptability of the bar for colour, taste, flavour and over all

acceptability. To make it easy for them to get the scores emojis of face were picturised in the score card and the children were asked to choose one from it. The consumption of the product and acceptability scores was instructed to be under adult supervision. The control sample was the commercially available RUTF made from peanuts.

The score card provided for the children are given below. The scores and evaluation were made to remain uncomplicated as the best response from children would be like and dislike and accounted for the percentage of likes and dislikes. The product attributes were colour, texture, flavour taste and overall quality. The highest score was 5.0 for like very much and 0 for dislike very much.

2.2.6 Cost analysis

The cost involved in packaging of developed products were analysed by taking into account, the fixed and variable cost involved in the course of processing

2.2.7 Statistical analysis

The data were statistically analyzed using a paired t-test under a completely randomized design (CRD) with three replications. The analysis was carried out using WASP software. Furthermore, a least significant difference (LSD) test was applied at a 5% significance level ($p = 0.05$) to identify any statistically significant differences between the samples.

3. Results

The nutritional, microbial and sensory quality of the developed products was analysed and the results obtained are furnished in the following Tables.

3.1 Nutritional quality

The nutritional quality of the developed product was analysed for all the trials and the results are tabulated in Table 4.

Statistical analysis

S.No.	CV %	CD@1%	CD @5%	Sig/Non-Sig
1	0.666	0.158	0.105	s
2	2.719	19.759	13.172	s
3	1.767	0.755	0.503	s
4	1.412	-	-	ns
5	1.029	0.440	0.293	s
6	1.589	0.756	0.504	s
7	1.701	0.283	0.188	s
8	1.339	0.837	0.558	s
9	1.412	0.068	0.045	s
10	-	-	-	-

The results obtained on the nutritional quality analysis of the developed RUTF during the initial storage period as evident from Table 4 indicated that the highest moisture content was recorded in T_5 as 6.8 g and lowest in T_0 as 3.8 g per 100 g of the sample. On contrary, the maximum calories was provided by T_0 as 582 and minimum by T_0 as 423 cal per 100 g of the sample. T_0 samples provided a carbohydrate content of 6.20 g only where as T_1 samples gave 28.46 g per 100 g. A similar trend existed for fat content also as 30.38 (T_0) and 19.5 (T_1) g per 100 g, respectively. The protein content of the treated samples were notable higher than the control and the values were found to be 17.38 for T_3 and 15.20 for T_0 . The control samples had 1.00 mg and 50.00 mg of iron and ascorbic acid, respectively, whereas the treated samples that contained pulse flour, moringa powder and amla powder provided iron content that ranged from 1.90 to 1.93 and ascorbic acid from 30 to 32.30 mg per 100 g of the sample, respectively. There was no indication of rancidity and

increased content of free fatty acid in the initial period of storage irrespective of control and treatments.

As the storage days passed by there was a notable difference in the nutritional quality of all the samples. At the end of 60 days of storage, the moisture content ranged from 3.84 (T_0) to 6.29 g (T_5), calories 578 (T_0) to 339 calories (T_5), 6.15 g to 9.27 g of carbohydrate, 15.12 to 17.02 g of protein and 30.25 to 18.62 g of fat per 100 g of the sample. There was a notable decrease in the proximate nutrients in all the samples during storage of 60 days as provided in Table 5.

3.2 Sensory analysis of the developed RUTF products

The sensory analysis of the developed RUTF products was done by 15 semi trained panelists using nine point Hedonic scale and the results are presented in Table 6. The period of storage study was 60 days and the product was evaluated for sensory quality at the beginning and at the end of storage.

Table 6: Changes in the sensory characteristics on storage of the developed products

RUTF	Storage days	Sensory attributes				
		Color and appearance	Flavour	Texture	Taste	Overall acceptability
T_0	0	6.5 ± 0.11	6.5 ± 0.12	6.5 ± 0.12	6.5 ± 0.15	6.5 ± 0.17
	60	5.5 ± 0.04	5.5 ± 0.14	5.5 ± 0.12	5.5 ± 0.06	5.5 ± 0.05
T_1	0	8.0 ± 0.005	8.0 ± 0.17	8.0 ± 0.20	8.0 ± 0.13	8.0 ± 0.14
	60	7.0 ± 0.09	7.0 ± 0.23	7.0 ± 0.05	7.0 ± 0.08	7.0 ± 0.21
T_2	0	8.8 ± 0.08	8.8 ± 0.19	8.8 ± 0.20	8.8 ± 0.27	8.8 ± 0.26
	60	8.2 ± 0.08	8.2 ± 0.15	8.2 ± 0.26	8.2 ± 0.18	8.2 ± 0.19
T_3	0	8.0 ± 0.01	8.0 ± 0.20	8.0 ± 0.23	8.0 ± 0.22	8.0 ± 0.23
	60	7.0 ± 0.01	7.0 ± 0.17	7.0 ± 0.10	7.0 ± 0.16	7.0 ± 0.17
T_4	0	8.2 ± 0.12	8.2 ± 0.005	8.2 ± 0.18	8.2 ± 0.17	8.2 ± 0.19
	60	7.1 ± 0.06	7.1 ± 0.05	7.1 ± 0.05	7.1 ± 0.05	7.1 ± 0.06
T_5	0	7.5 ± 0.05	7.5 ± 0.08	7.5 ± 0.04	7.5 ± 0.06	7.5 ± 0.05
	60	7.0 ± 0.08	7.0 ± 0.1	7.0 ± 0.07	7.0 ± 0.06	7.0 ± 0.05
T_6	0	7.0 ± 0.07	7.0 ± 0.14	7.0 ± 0.004	7.0 ± 0.15	7.0 ± 0.08
	60	6.5 ± 0.18	6.5 ± 0.17	6.5 ± 0.16	6.5 ± 0.14	6.5 ± 0.015

The results of the sensory quality shows that the control sample T_0 has obtained the lowest sensory score such as 6.5 for colour texture, flavour, taste and overall acceptability out of a total score of 9.0 during the initial storage period and further got reduced to 5.5 for all the attributes after 60 days of storage in the control samples. The treated samples that contained pulse flour in the place of peanut flour exhibited higher scores for colour, texture, flavour, taste and over all acceptability both during initial and final storage period. Among the treatments T_2 scored the highest number as 8.8 for all the

attributes during the initial period of storage that slightly reduced to 8.2 after 60 days of storage.

3.3 Consumer acceptability test

The results of sensory evaluation indicated that the RUTF prepared with germinated green gram flour as the base obtained the highest score in laboratory sensory evaluation trials. Therefore, these samples were subjected to consumer acceptability tests among children and were rated for likes and dislikes with scores 5 and 0. The scores obtained are tabulated and furnished in Table 7.

Table 7: Consumer acceptability scores and percentage

Attributes	Like very much	Percentage of samples	Dislike very much	Percentage of samples
Germinated green gram RUTF				
Colour and appearance	5	87	0	13
Texture	5	95	0	5
Flavour	5	95	0	5
Taste	5	95	0	5
Over all quality	5	95	0	5
Completely and continuously finish eating the product		98	Incomplete, discontinuous and unfinished product eating	2
Peanut RUTF				
Colour and appearance	5	73	0	27
Texture	5	12	0	88
Flavour	5	48	0	52
Taste	5	12	0	88
Over all quality	5	36	0	64
Completely and continuously finish eating the product		36	Incomplete, discontinuous and unfinished product eating	64

The consumer acceptability scores as evident from Table 7 is comparison of pulse RUTF with that of the peanut RUTF. The Table shows that 87% of the children liked the color of the pulse RUTF where as texture, flavour, taste was liked very much by 95%. About 98% of the children were able to completely continuously realized eating the product. The dislike towards pulses RUTF was only 5% among the children. On the contrary only the color, texture, flavour,

taste, overall quality of the control RUTF was only 73%, 12%, 48%, 12% and 36% of very much liking amongst the children. About 64% of the children were not able to completely, continuously and realizing finish the product.

3.4 Microbial quality

The total plate count, bacteria and fungi in the product over a storage period of 60 days was analysed and the results are given in Table 8.

Table 8: Changes in the microbial quality during storage

RUTF	Storage days	TPC $\times 10^3$	Bacteria $\times 10^3$	Fungi $\times 10^5$
T_0	0	0	0	0
	60	0	0	0
T_1	0	0	0	0
	60	1	1	0
T_2	0	0	0	0
	60	1	1	0
T_3	0	0	0	0
	60	1	1	0

T ₄	0	0	0	0
	60	2	2	0
T ₅	0	0	0	0
	60	2	2	0
T ₆	0	0	0	0
	60	2	2	0

The total plate count, bacteria and fungi was not present irrespective of control and treated samples during initial period of storage. However, as the storage days increased TPC and bacteria ranged from 1×10^3 to 2×10^3 cfu/ml in both control and treated samples as furnished in Table 8.

3.5 Cost analysis

The cost of production of the product was calculated taking into account the fixed cost, variable cost, total production, man days, interest and depreciation and the values are provided in Table 9.

Table 9: Cost analysis of the developed products

Price /25 g	T ₀	T ₂
Cost price	Rs 14.00	Rs. 9.00
Selling price	Rs 16.00/25 g locally made/imported -Rs 24-25/25 g	Rs. 12.00

The cost of the most acceptable RUTF which was T₂ RUTF made from germinated green gram flour was worked out to be Rs.9.00 as cost price and Rs. 12.00 as selling price as agenzied Rs. 14.00 to Rs.25.00 for peanut RUTF, respectively.

4. Discussion

The nutritional composition of the developed RUTF indicated that the the calories, carbohydrate, protein, fat and the micronutrients were on par with the control samples. This proves that RUTF can be processed replacing peanut flour with pulse flour, yet achieving the same nutritional content. The moisture content of the control samples was lesser when compared to the treated samples. This could be due to the inherent nature of the starch in the pulses that absorbed and retained more waster when compared to peanut during processing. Upon storage also there was only a negligible increase in the moisture content. The calories provided by the control RUTF was more than the treated samples. As peanut is rich source of fat compared to pulses, the similar trend existed in the product also.

The carbohydrate and protein content were higher in the treated pulse flour RUTF than the control. Due to this factor, the calories provided by the treated were also on par with the control. The iron and ascorbic acid content of the control samples were notably higher. This was due to the fact that synthetic iron and ascorbic acid was deliberately added to the product to make it rich in micronutrients. On the contrary the pulses RUTF were devoid of these synthetic micronutrients and the source of iron and ascorbic acid was only moringa powder and amla powder, that led to the low level of these micronutrients, yet being sufficient enough for a supplementary food. During storage there was a slight change in the macro nutrients and notable loss in ascorbic acid irrespective of the control and treated samples. Similarly, Kresis test performance which indicates

rancidity of the sample was negative both during the initial and final period of storage.

Between the treated samples of green gram and cowpea, the nutritional content was extremely pronounced in green gram than cowpea RUTF. But still addition of cow pea flour yielded an equivalent nutritious RUTF. This assured that though cow pea does not find a place in regularly in day to day cooking in Indian dietary certainly it has a place in the production of RUTF. The data is in line with the studies of Sato *et al.* (2021) where it was proved that amino acid-enriched plant-based RUTF treatment was not inferior to peanut-milk RUTF treatment in restoring plasma amino acid levels among patients with oedematous or non-oedematous malnutrition. Similarly, studies of Thapa *et al.* (2017) and Jadhav *et al.* (2019) demonstrated that efficacy of indigenous RUTF in treatment of severely malnourished children is on par with the commercial imported RUTF made from peanut. The indigenous RUTF has high acceptability among the children compared to the commercial RUTF which is equally shown in the present investigation.

From the results of the sensory quality, it could be inferred that the RUTF prepared from germinated green gram flour had the highest consumer acceptability even more than the control sample which is the commercial RUTF. This high score was essentially due to the highly acceptable non greasy mouth feel that prevailed in the product throughout storage. The colour of the germinated green gram RUTF was a slightly greenish and gathered more attention. These results are in line with the studies of Nada *et al.* (2022) that concluded that Peanut need not be the sole ingredient for RUTF as RUTF from Soy flour also had highly acceptable consumer quality and the colour and texture of soy flour RUTF had higher sensory quality than peanut RUTF.

From the results of the consumer acceptability, it could be inferred that 87% of the children liked the colour of the product, while 13% has disliked it. The reason was the greenish colour in the germinated green gram flour RUTF which led to higher likes and lower dislikes. Ninety five per cent of the children liked the texture, flavour, taste and overall quality of the germinated green gram RUTF. The texture they expressed verbally as soft, pliable and easy to swallow. The flavour was attractive and not too intense as described by the children. The taste was sweet without the feel of greasiness as they eat and all of them finished eating the product. Only five percent of the children disliked the product and expressed that the product is like chocolate but different from it which made them dislike.

On the other hand, peanut RUTF colour was liked very much by 73% of the children, Texture being only 12%, flavour as 48%, taste as 12% and overall quality as 36%. The percentage towards disliking of the product is higher amongst the children than towards liking. Complete, continuous and finish eating the product is a food psychology in children indicating that the product is highly acceptable

for them. This was achieved as 98% in green gram RUTF as against only 36% of the children finished consuming it. The reason for incomplete, discontinuous and unfinished eating of peanut RUTF was mostly due to the greasy mouth feel during eating and children disliked it very much.

Sensory analysis was the science developed and consolidated to evaluate the interaction between the human sense organs and food. Originally, sensory research was aimed more at evaluating intrinsic attributes such as appearance, aroma, flavor, and texture. In parallel, sensory analysis encompassed consumer research techniques to expand the investigation of extrinsic attributes perceptions, *e.g.*, label, price, brand, health claims, design, and also nutritional, ecological, and technological appeals. Intense competition promotes an increase in food products for sale, expanding the range of options at the time of purchase. In addition, the greater availability and exchange of information makes consumers more discerning and selective. Thus, understanding more deeply the factors related to consumer decision-making has become a fundamental part of an efficient sensory and consumer science strategy. The present investigation is in line with the opinion of (Scudino *et.al*, 2023).

Conduct of the consumer acceptability test with children in the present investigation was made uncomplicated and the results drawn show the percentage of acceptability of the product among children. This also serves as a preliminary indicator regarding consumer acceptability before launching of the product commercially.

The microbial analysis indicated that the products were within the safe limit of microbial count and there was no detectable microorganism during the initial period of storage irrespective of the product. However, upon storage there were detectable bacteria found in the cow pea RUTF indicating poor shelf life of the product. Though cowpea was nutritionally equivalent to green gram, it exhibited a poor shelf life as it is evident from microbial infestation even on sixty days of storage. Therefore, it could be opined that cowpea might not be an ideal ingredient for replacing peanut in RUTF.

From the results of cost analysis, it could be assured that green gram can definitely replace peanut in RUTF in terms of cost control produced in the product preparation. The reduction in the cost of green gram RUTF is mainly due to the raw material cost, which is usually used as an effective tool in cost control measures. This technology of green gram RUTF will provide a cost effective product and will encourage food industry to venture in indigenous RUTF.

5. Conclusion

So far peanut was the sole ingredient for RUTF and in the Indian context; it is expensive to make it indigenous, though several attempts have been made. The necessity for finding an alternate to peanut is, it reportedly gives a greasy mouthfeel that prevents happy eating by children amidst their lack of appetite. Also, peanut is a potential allergen rendering it suitable globally for all children. From this research work, it was proved that germinated green gram flour is a potential alternate to peanut in RUTF in terms of nutritional and sensory quality. The use of underutilized pulses such as green gram and cowpea in development of high value and therapeutic foods will therefore increase the market potential of these pulses. Also, production of green gram and cowpea is abundant in India to meet the industrial requirement. It will be a new venture for pulses processing industry as this product will give a new dimension apart

from the traditional processing of pulses as dhal, flour and conventional value addition. Hence it is concluded that pulses not only serve as food but also an effective phytomedicine in management of malnutrition among children.

Acknowledgements

The authors are highly grateful Tamil Nadu Agricultural University, Coimbatore for resources.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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Citation

G. Gurumeenakshi, R. Packiyalakshmi and K. Shanthi (2025). Formulation and evaluation of pulses as phytomedicine in therapeutic food for severely malnourished children. *Ann. Phytomed.*, **14**(1):851-859. <http://dx.doi.org/10.54085/ap.2025.14.1.85>.