RESEARCH PAPER

Comparison of Ready-to-Use Therapeutic Food with Cereal Legume-based *Khichri* Among Malnourished Children

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Objective: To compare the acceptability and energy intake of Ready-to-Use Therapeutic Food (RUTF) with cereal legume based *khichri* among malnourished children.

Design: An acceptability trial with cross-over design.

Setting: Urban low to middle socioeconomic neighborhoods in Delhi.

Subjects: 31 children aged ≥6 to ≤36 months with malnutrition, defined as Weight for height (WHZ) <–2 to ≥–3 SD, with no clinical signs of infection or edema.

Intervention: Children were offered weighed amounts of RUTF and *khichri* in unlimited amounts for 2 days, one meal of each on both days. Water was fed on demand. Caregivers' interviews and observations were conducted on the second day.

Outcome Measures: Acceptability of RUTF compared to *khichri* based on direct observation and energy intake for test and control meals.

Results: The proportion of children who accepted RUTF eagerly was 58% as against 77% for *khichri*. 42% children on RUTF and 23% on *khichri* accepted the meal but not eagerly. The median (IQR) energy intake over the two day period in children aged 6 to 36 months from RUTF was 305 (153, 534) kcal, and from *khichri* was 242 (150, 320) kcal (*P*=0.02).

Conclusion: RUTF and *khichri* were both well accepted by study children. The energy intake from RUTF was higher due to its extra energy density.

Keywords: *Acceptability, Khichri, Malnourished, Ready-to-use therapeutic food (RUTF).*

WHO recommends that severely malnourished children be fed for a few days on a low protein, low energy diet (F75) containing 75 kcal and 0.9 g protein/100 mL, fortified with vitamins and minerals, until life threatening complications are in control(1). The rehabilitation phase then begins with an energy and protein dense (100 kcal and 2.9 gm protein/100 mL) milk based diet (F100) fortified with a vitamin mineral (CMV) mix to promote rapid weight gain. The F100 diet is not recommended for use at home as it requires water for reconstitution, which facilitates growth of pathogenic bacteria. The risk of bacterial contamination with F100 is therefore high, and it needs to be prepared before each meal and cannot be prepared and stored for multiple feeds. Further, F100 resembles infant formula and its promotion may negatively impact breastfeeding. WHO has recommended development of an alternate therapeutic diet which can be used at the community level(1).

In India, *khichri* (rice and green gram gruel) is often used for the dietary management of moderately malnourished children as a practical and culturally acceptable food for young children. However, *khichri* is required to be fed several times and this is difficult for caregivers because the recipe requires

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cooking and reheating before it is offered each time. Besides, green gram is costly for poor communities, where most malnourished children reside. Also, *khichri* is a good medium for bacterial growth.

An alternative solid ready-to-use therapeutic food (RUTF) has been developed(2-4). RUTF has a 5 times greater energy density than F100 but a similar nutrient to energy ratio. Part of the dried skim milk in F100 is replaced with a mixture of peanut butter and lacto serum, and oil by vegetable fat mixture, including essential fatty acids with adequate viscosity and melting point to produce the RUTF(2,3). RUTF has a high concentration of micronutrients and vitamins whose unpleasant taste is well masked(2-4). The child can consume RUTF without adding water, unlike the F100. Thus, the risk of bacterial growth and proliferation is reduced. These characteristics make RUTF a safer intervention in communities. Besides, RUTF does not require cooking.

In Africa, RUTF has shown excellent acceptability in cross over or comparative trials(2,3). The acceptability of this new high energy dense food is important to assess in India before its practical use can be addressed in the country. We conducted a preliminary study to test the acceptability and energy intake of RUTF as compared to commonly used cereal legume gruel (*khichri*). We anticipate that the study findings would provide a basis for planning large scale evaluations of RUTF.

METHODS

The setting was the urban low to middle socioeconomic neighborhoods of Tigri in South Delhi. The population characteristics have been described elsewhere(5,6). Childhood malnutrition is common in this setting(7,8). The study was approved by the ethics committee of the Society for Applied Studies.

Sample size: Two studies comparing the intake from RUTF and F100 showed that the difference in intake to be expected between the two feeds was about 1 SD(2,4). To obtain a difference significant at the 0.05 percent level with 95% power, a minimum of 26 children were needed. To allow for dropouts and missing data, we planned enrolment of 30 children. Forty children were identified to account for dropouts during the 'pretesting' phase, due to illness and refusals.

Enrolment: A door to door survey was conducted, to identify children aged 6 to 36 months. Subsequent to obtaining consent, the child's weight (Seca scale with sensitivity 25g) and length (infantometer with sensitivity of 0.1 cm) were taken by three anthropometrists. These three anthropometrists underwent several sessions of intra and inter observer standardization exercises. Exercises were conducted till there was no difference in weight measurements and only a ±0.2cm in length measurements among the three. Consent for participation was taken from families of children whose weight for height was <–2 to ≥–3SD according to the WHO growth standards(9), and clinically free of signs of infection and edema(10).

The acceptability trial involved feeding of two meals a day, one of each type (RUTF and *khichri*) for two days. Prior to initiating the trial, the 36 potentially eligible children underwent a 'pretesting' phase. During this pretesting phase, *khichri* and RUTF were given for two days to the caregiver to be fed at 2 meals each (one meal of each on both days) to familiarize the mother and child with the diet.

Of the 36 children who participated in the pre-testing, 31 children were enrolled in the main trial **(*Fig.*1)**. The trial children were brought to the study clinic set up in Tigri on two consecutive days. The 31 children when assessed using the Integrated Management of Neonatal and Childhood Illness protocol(11) did not reveal presence of local or systemic bacterial infection. After obtaining consent again, they were enrolled into the study.

Randomization: The study had a cross over design. The randomization list for the sequence in which meals would be fed to a particular child on the two days was generated offsite by a statistician not otherwise involved with the study. Using a simple randomization scheme, half the participants were assigned to receive *khichri* and the other half RUTF as their first meal on the first day. The other food i.e. *khichri* or RUTF was given as the second meal on the first day. The food received by a child at the second

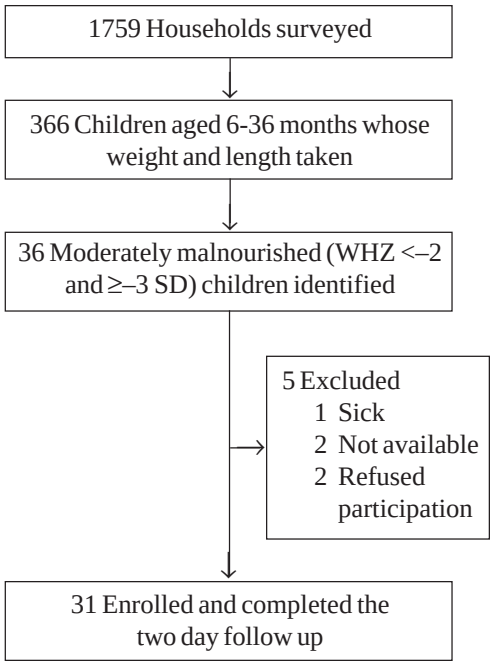

FIG. 1 *Trial profile.*

meal on the first day was administered as the first meal on the second day (*i.e.* if *khichri* was the second meal on day 1, *khichri* was given as first meal on the second day of the observation). Each enrolled child received four meals; one meal of *khichri* and one of RUTF on each of the two days.

Intervention: The energy and nutrient content of the two foods *i.e.* RUTF and *khichri* is given in ***Table* I.** *Khichri* was prepared using rice (100 g), green gram (60 g), groundnut oil (20 mL), spinach (100 g) and water (640 mL). 760 g of *khichri* so prepared yielded 760 kcal i.e. 1 kcal/g of cooked *khichri* (***Table* I**). The energy content for *khichri* was calculated using national food composition tables(12).

Children were offered the food that they were scheduled at two meals at 10 am and 2 pm on each of the two days. The meal time lasted an hour. Caregivers were instructed to feed their children and to encourage them to eat as much as they could of the pre-weighed food in the one hour period. If children ate the preweighed amount, the initial amount was reoffered. Measured volumes of plain water was also given in between the meals. Caregivers were asked not to feed the child any other foods during the interval between the two feeds. Once the meal time was over, the foods were weighed again and the amount of food consumed in grams was estimated. The leftover water was also measured to estimate the volume of water consumed.

TABLE I NUTRITIVE VALUE OF RUTF AND *KHICHRI* PER 100 GRAMS

Nutrients	RUTF	*Khichri*
Energy (kcal)	545	100
Proteins (g)	13.6	3.1
Lipids (g)	35.7	2.9
Minerals		
Calcium (mg)	320	16.8
Phosphorus (mg)	394	55.8
Potassium (mg)	1111	117.9
Magnesium (mg)	92	29.9
Sodium (mg)	189	9.8
Iron (mg)	11.5	0.5
Zinc (mg)	14	0.4
Copper (mg)	1.78	0.06
Iodine (µg)	110	
Selenium (µg)	3	
Vitamins		
Vitamin A (mg)	0.91	0.20
Vitamin D (µg)	16	
Vitamin E (mg)	20	
Vitamin C (mg)	53	3.7
Vitamin B1 (mg)	0.6	0.05
Vitamin B2 (mg)	1.8	0.06
Vitamin B6 (mg)	0.6	
Vitamin B12 (µg)	0.53	
Vitamin K (µg)	21	
Folic acid (µg)	210	28.3
Ca D Pantothenate (mg)	3.1	
Biotin (µg)	65	
Niacin (mg)	5.3	0.5

Prior to commencing meals on the second day, each child was again examined for local and systemic infections and none of the children had either of these.

Observation of feeds and interviews with caregivers: Observations were conducted on each child on the second day for both the meals. An observation

checklist was used to observe the child for a minute after every 15 minutes i.e. a total of 4 observations per child were obtained for *khichri* and RUTF. Caregivers of all enrolled children were also interviewed by nutritionists using a semi-structured questionnaire to enquire about their perceptions about the RUTF.

Analysis: Acceptability was categorized as 'accepted eagerly' if they ate food readily, did not make a fuss, spit out, vomit or cry during the observed meal. Children were categorized as 'accepted but not eagerly' if they ate the offered food but either made fuss, spit out, vomited or cried during the observed meal. The third category was children who did not consume the offered food at all.

A summary variable was created from the 4 observations for each food observed *i.e.* RUTF and *khichri*. The higher category of acceptability was assigned if the defined behavior was observed in at least two observations. The categories of acceptability across RUTF and khichri were compared by Pearson chi-square test.

Energy intakes were estimated from the amount (in grams) of each food consumed by a child at each meal. The difference in median energy intakes for both foods on the two days was estimated between the two groups and compared by a Wilcoxon signed rank test.

RESULTS

Among the 31 trial subjects, 16 (51.6%) were male. Eight, 19 and 4 children were aged 6 to 12, 13 to 24 and 25 to 36 months, respectively. ***Table* II** depicts the acceptability of RUTF and *khichri*. ***Table* III** provides the amount of RUTF and *khichri* consumed and the energy intakes in the two groups.

TABLE II ACCEPTABILITY OF RUTF AND *KHICHRI*

Acceptability	RUTF $n = 31$	*Khichri* $n = 31$	*P* value*
Accepted eagerly	18	24	0.35
Accepted, but not eagerly	13	7	0.35

**Chi square test*

During the interviews with caregivers, 22 (71%) of the 31 caregivers reported that their children had liked the RUTF. The common reasons stated for liking RUTF were that children ate most of the portion served to them (22/22), child asked for more (3/22), did not make a fuss about eating (2/22), smacked his lips (1/22), never used to eat any food but ate RUTF (1/22) and that the child started passing a single stool per day (1/22). Nine (29%) caregivers reported that RUTF was not liked by their children; the most common reasons were children did not eat enough of the food (8/9), grimaced while being fed (1/9), spat out the food (1/9) and refused to eat it (3/9).

Twenty eight of the 31 caregivers thought the consistency of RUTF was appropriate for children, the appearance (packet and color) was good (10/28), the food looked like chocolate (3/28), their child ate it (1/28) and it gave more energy than home foods (2/28). Three caregivers felt the consistency was thick and therefore inappropriate for children. However, two of them had reported that their children had liked the food when asked so. Caregivers were also asked whether they would feed RUTF to their children if it were available to them in the future. Of the 31 interviewed, 29 said that they would use it; the reasons cited were that it gave energy to their children (22/29), their children liked it (11/29) and it increased the child's appetite (3/29).

TABLE III INTAKE OF RUTF AND *KHICHRI* FROM TWO MEALS OFFERED IN UNRESTRICTED AMOUNT ON TWO CONSECUTIVE DAYS

	n	RUTF	*Khichri*	*P* value*
Amount consumed (g)	31	56 (28, 98)	242 (150, 320)	<0.0001
Energy intake (Kcal)	31	305.2 (153, 534)	242 (150, 320)	0.02
Children aged 6-11 months	8	234.3 (185.3,327)	149 (107, 204)	0.01
Children aged 12-36 months	23	316.1 (141.7,545)	290 (178, 374)	0.11

*All values are median (IQR); *Wilcoxon signed rank test*

WHAT IS ALREADY KNOWN?

- RUTF (Ready to Use Therapeutic Food) is a nutrient dense spread with a nutritional value close to WHO F100 and has been developed for the treatment of severely malnourished children.

WHAT THIS STUDY ADDS?

- RUTF is well accepted and provides higher energy intakes than equivalent number of meals of *khichri*.

Less common reasons were that it will protect the child from disease (1/29), the child's weight will increase (1/29), it is like chocolate (1/29), it will improve child's health (1/29) and that the government always gives products that are beneficial for children (1/29). Only 2 (6.4%) caregivers said they would not give it because their children did not like it (1/2) or eat it (1/2).

DISCUSSION

In this preliminary trial, while both *khichri* and RUTF were accepted well by young children, acceptability of *khichri* was somewhat better. *Khichri* is a culturally acceptable and palatable meal and widely consumed by families and children in this setting. Under conditions of unlimited access at each of the test meals, the intake of RUTF was lower but the energy intake from it was significantly higher. The energy density for RUTF was five fold higher and this would explain the lower consumption as well as the substantially higher energy intake.

The findings of this study are consistent with previous reports; improved energy intakes were reported in severely malnourished children in two other studies that compared RUTF with the F100 diet(2,4). In a therapeutic feeding centre in, Chad, in severely malnourished children, Briend, *et al*.(2) observed a two fold higher mean energy intake from RUTF as compared to F100 diet. In another study from Senegal, also in severely malnourished children, the mean daily energy intake was 70% higher in the RUTF group(4).

An important question to address is whether a product like RUTF has a potential use under special circumstances and whether a more decisive safety or efficacy evaluation is merited. RUTF has been proposed as potentially useful in situations of war and disaster, in home treatment of severe malnutrition when hospitalization is not feasible or in centres without a kitchen, or as an add-on in health facilities where diets can only be offered 2 or 3 times a day. This would require assessment of its use in less supervised circumstances. Further RUTF has been less well studied in infants and in malnourished children with infections. Clearly RUTF does not have a role in settings where standard treatment of malnutrition is feasible. As it avoids problems of quality control and microbial contamination, RUTF may be considered for evaluation in difficult circumstances where standard protocols are not feasible to implement.

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REFERENCES

1. World Health Organization. Management of severe malnutrition: a manual for physicians and other senior health workers. Geneva, Switzerland: World Health Organization; 1999.
2. Briend A, Lacsala R, Prudhon C, Mounier B, Grellety Y, Golden MH. Ready-to-use therapeutic food for treatment of marasmus. Lancet 1999; 353: 1767-1768.

3. Briend A. Highly nutrient-dense spreads: a new approach to delivering multiple micronutrients to high-risk groups. Br J Nutr 2001; 85 Suppl 2: S175-S179.

4. Diop EHI, Dossou NI, Ndour MM, Briend A, Wade S. Comparison of the efficacy of a solid ready-to-use food and a liquid, milk-based diet for the rehabilitation of severely malnourished children: a randomized trial. Am J Clin Nutr 2003; 78: 302-307.

5. Bhandari N, Bahl R, Taneja S, Strand T, Molbak K, Ulvik RJ, *et al*. Substantial reduction in severe diarrheal morbidity by daily zinc supplementation in young north Indian children. Pediatrics 2002; 109: 86-92.

6. Bhandari N, Bahl R, Taneja S, Strand T, Molbak K, Ulvik RJ, *et al*. Effect of routine zinc supplementation on pneumonia in children aged 6 months to 3 years: randomized controlled trial in an urban slum. Br Med J 2002; 324: 1358-1362.

7. Bhandari N, Bhan MK, Sazawal S. Impact of massive dose of vitamin A given to preschool children with acute diarrhea on subsequent respiratory and diarrheal morbidity. Br Med J 1994; 309: 1404-1407.

8. Bhandari N, Bahl R, Hambidge KM, Bhan MK. Increased diarrheal and respiratory morbidity in association with zinc deficiency - a preliminary report. Acta Pediatr 1996; 85: 148-150.

9. World Health Organization. The WHO Child Growth Standards. Available from http://www.who.int/childgrowth/standards/en/. Accessed May 26, 2008.

10. World Health Organization. Integrated Management of Childhood Illness (WHO/CHD/97.3E). Geneva, Switzerland: World Health Organization; 1997.

11. Government of India. Integrated Management of Neonatal and Childhood Illnesses: Health Worker Chart Booklet. New Delhi, India: Ministry of Health and Family Welfare; 2003: 5-6.

12. Gopalan C, Sastri BVR, Balasubramanian SC, Rao N, Deosthale YG, Pant KC. Nutritive value of Indian Foods. Hydrabad, India: National Institute of Nutrition, Indian Council of Medical Research; 1999.