

DIET FORMULATION AND THERAPEUTIC EVALUATION FOR MALNOURISHED CHILDREN

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Abstract:

In Sudan children suffer from high infant mortality rate due to protein energy malnutrition (PEM). The formulation and processing of nutritious weaning and foods and therapeutic diets from local and readily available raw materials, as legumes can participate in solving the problem.

In this study a therapeutic diet was formulated using wheat flour, sugar, milk powder, fenugreek legume seeds powder, and salt at the ratio of 40, 36, 7.2 and 0.8 g /100g respectively.

The portion content of this diet was found to be 10.7%, fat 3.3% ash 1.6% and crude fibre 4.1%, with calculated energy value of 391 Kcal /100g.

The diet showed acceptability, tolerance, good growth rate and weight increase for the treated groups of malnourished children (1-3 years old). In total, the results indicated that the formulated diet is ready for use as a weaning and therapeutic diet particularly for:

PEM:

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Introduction:

There are many factors which result in malnutrition, of which the main are lack of quality and quantity of food, diseases, ignorance or lack of education, poor habits food taboos, environmental and social factors, in addition to economic and agricultural factors.¹

Protein energy malnutrition (PEM) is an early childhood disease which causes a high rate morbidity and mortality of children less than 5-year-old. It represents the main child health problem in the developing countries. Inadequate dietary intake and diseases are the immediate causes or determinant of malnutrition. Weaning is a gradual process by which infant, in addition to breast milk, becomes accustomed to family food or adult diet. Malnutrition is most common in this transitional period. The international organizations, separately or jointly, have established considerable guidelines for assessing the safety and nutritional value foods^{2,3 4} Weaning food is normally introduced at the age of four to six months, the period of fast growth.

Complementary foods are important primarily as an additional source of energy, help to satisfy requirement for all essential nutrients (Protein, iron and vitamins A and C) which are frequently deficient in diets of young infants.³

Materials used for weaning food preparation usually include a cereal in combination with milk powder to improve the protein quality and quantity. These materials should be blended in such proportions as to minimize the deficient amino acids and to have a formulation with nutritive value superior to the ingredients from which it has been made.⁵

This study was therefore planned to investigate the use of wheat, fenugreek, milk powder, oil and sugar for processing of a weaning food composed of more nutrients than kash-milk used for PEM children in Wad Medani' Children Hospital.

Materials and Methods:

This study was conducted at Wad Medani Children' Teaching Hospital, Gezira State, in central Sudan.

Materials:

All materials were purchased from Wad Medani local market. Ingredients were stored in tightly closed containers at 4 C, ready for use.

Wheat (*Triticum Vulgares*): Fine Wheat flour, 72% extraction was used. Fenugreek (*Trigonella foecum – graecum*): Seeds were cleaned and milled; using coffee gender into whole flour, Milk powder (Formost) and cow fresh milk were used. Sugar, oil (ground nuts and sesame) and salt were used.

Methods:**Preliminary questionnaire:**

The mother of each child was privately interviewed at the hospital by the researcher, using local language to collect information on infants, age sex , residence, education of mothers, the duration of breast feeding, weaning pattern, and reasons for weaning.

Malnourished children were classified randomly into 3 groups according to their age, irrespective of their nutritional state classification; group I, age under one year; group II age of 2 years, and group III over 2 years. The total number of the children was 26.

Formulation of fenugreek diet:

The diet involved, is based on fenugreek (FI) in comparison with control diet of the local name (Kwash milk) used in the hospital

Formulation:

The formulae for weaning and therapeutic diets were calculated according to the method described by Jansen and Harber.⁶ The steps followed in these calculations are described below.

1. Record weight of each of the components of each of the components of the mixture, (in grams).
2. Record the amount of nitrogen (N), Protien, lysine (Lys), theronine (Thr), tryptophan (Try) and the sulphur amino acids (SAA) (methionmine plus cystine).

3. add up to the weight and amounts of nitrogen, protein, Lys, Thr, Try, and SAA by the amount (g) of N in the mixture.
4. to obtain mg/g N divide the amounts (mg) of Lys, thr, Try, and SAA by the amount (g) of N in the mixture.
5. to obtain amino acid scores, divide the mg/gN for each amino acid by the corresponding values in mg/gN listed for FAO/WHO/UNU pattern x 100.
6. To calculate percent protein, g protein in mixture is divided by the weight of mixture (g) x 100.
7. To obtain net protein value (NPV) multiply the lowest amino acid score by the percent divided by 100.

Weaning diet Preparation:

A simple processing technique using equipment commonly available in household of the area was followed. 20g powdered milk (formost) was dissolved in 150ml water and brought to boil. Fenugreek flour (9g), salt (1g) and sugar (45g) were added. 50 g of wheat flour were mixed with 150ml water, to smooth paste and then added to boiling milk. The mixture was stirred well and cooked gently for 10-15 minutes, put in trays, which were placed in oven under vacuum at 60C for 16 hours. Dry cook was made into powder, using coffee grinder.

The recipes of the Kwash milk, (Table 1) were mixed together by local blender ready for use. A link to drip container was used.

Table 1: Formulation : Laboratory and House Hold measure

Ingredient	Formulation %	Laboratory measure	House hold measure
Water	0	300	2cup full
Fenugreek Powder	7.2	9g	1 spoon
Wheat flour	40	50g	5 Spoons
Milk Powder	16	20g	2 Spoons
Sugar	36	45G	3Spoons
Salt	0.8	1g	0

Proximate Analysis:

Duplicate samples of diet were analyzed for moisture, protein, fat, ash and crude fiber. Carbohydrate was calculated by difference.

Viscosity, pH and digestibility were also measured using standard procedures.

Results and Discussion:-

In this study 26 mothers having children with protein – energy malnutrition (PEM) responded to information including age (mother and child), residence, sex, and mother’s attitude toward fenugreek diet (FD).

Data on treated children:

For treated infants having PEM, at one year age, 75% were with marasmus, and 25% with Kwashiorkor. For two – years age, 83.3 % with marasmus and 50% with Kwashiorkor 65% of whole malnourished, treated children came from rural areas, and 35% came from urban areas.

Jamila⁷ studying 100 cases of malnutrition, admitted to Wad Medani

children Hospital, found that 50% of infants had marasmus while 22% had Kwashiorkor. Taha⁸ studies 700 cases of malnutrition in Wad Medani Hospital and found that marasmus was predominate type of PEM.

The age of incidence recorded in Jamila⁷ study, showed that 44% of cases of PEM occurred during the first year of life, 45% during the second year and 11% during third. This agrees with study by Oliva (1998), who found that most of PEM occurred during the first and second year of life. It's clear therefore that the peak age of incidence of (PEM) is in general, at 7-12 months, the time at which mothers start to give babies supplementary food.

In agreement with this study, Jamila⁷, found that for malnourished children, 37% of mother work from urban area while 63% from rural areas. However, Tahni⁸ reported 52.7% from rural areas, and 47% from urban areas. These results can be explained by multi-factors which lead to malnutrition predominating in rural areas.

Formulation, processing and composition:

The composition values of wheat, fenugreek and skim milk given in Jansen and Harper (1985) reference were used for calculation of weaning food formulation (Table 2) Accordingly, laboratory and house – hold measures were determined (table 1) for the weaning diet (fenugreek based, FD) preparation. The chemical composition, pH, viscosity and digestibility of the prepared diet are shown in (Table 3).

Table 2: Calculated value of fenugreek diet formulation, prepared for malnourished children

Component (g)	Weight (g)	Nitrogen n(g)	Protein (g)	Lys. (mg)	Thr. (g)	Try. (mg)	SAA (mg)
Wheat flour (72 extraction)	40	0.73	4.68	172	158	56	184
Fenugreek	7.2	0.28	1.73	85	102	14	45
Milk	16	0.92	5.74	416	242	82	202
Sugar	36	-	-	-	-	-	-
Salt	0.8	-	-	-	-	-	-
Total	100	1.93	12015	628	502	152	431
Mg/g N in mixture				325	260	79	223
FAO/WHO UNU pattern (mg/gN)				344	50	63	156
Amino acid score % (A)				94	104	125	143
Protein % (B)			10.7	-	-	-	-
NPV (AXB/100)%			10	-	-	-	-

Table 3: Chemical composition (g/100g), energy value pH, viscosity and digestibility of fenugreek based diet "FD": -

Diet	Moi-ture	Protein	fat	Fiber	Ash	CHO	Energy/ Kcal/ 100g	pH	Visco- sity centipi	Digestibility %
Fenu- greek Diet	6.26	10.7	7.33	4.12	1.6	70.59	391.13	6.93	6.7	4.2

Moisture, protein, fat, fiber and ash were 6.26, 10.7, 7.33, 4.12 and 1.6 g/100 respectively. Carbohydrate was found by difference 70.59g/100g, pH 6.93, viscosity 6.7 centipoises, (diet suitable to flow through feeding tube for malnourished children), digestibility 74.2% and calculated energy 391.13kcal/100g.

The control diet, for an equal number of treated children, termed kwash milk (half and full strength), composition is shown in Table 4.

Table 4: control diet (Kwash milk), used in Wad Medani Teaching Hospital, Sudan, for Malnourished children.

Ingredients	Half – strength milk		Full- strength milk	
	Lab measure	House hold measure	Lab measure	House hold measure
Cows milk	700ml	4cups	1000ml	6cup
Water	100ml	2cups	-	-
Sugar	40g	2.5spoons	60g	4 spoons
Oil	45g	3 spoons	80g	5 spoons

Nutritive value of "FD" and kwash milk:

The protein content of fenugreek based diet and kwash milk (half strength, full strength) is 10.7 and (2.2-3.3)g/100g respectively, with calculated values of 391.13kcal/100g and (57.3-97.3)kcal/100g respectively.

The protein content of half-strength "kwash-milk" was found

2.2g/100ml, while full-strength 3.3g/100ml. the energy content of half-strength 57.32kcal/100ml and the digestibility 68.9 while the energy content of half-strength 97.32 kcal/100ml and the digestibility 70%. It can be noted that the digestibility of fenugreek based diet was 74.25% table3. They indicate good protein quality. Haram¹¹ reported that Sudanese fenugreek seed protein digestibility range 79.9-85.9%

Effect of fenugreek based diet "FD" and kwash milk on diarrhea:

Comparing fenugreek based diet with kwash milk, in relation to diarrhea, it was noted that fenugreek diet reduced stool output for 61.5% of infant who received it. Kwash milk reduced stool output for 30.8% only of infants who received it Table5.

Table 5: Frequency (per day) and duration of dairrhoea of index and control treated groups of infants.

Group	Frequency	Duration
Group I: Index	4	2
Control	4	6
Group II: Index	4	3
Control	4	5
Group III: Index	5	3
Control	5	5

The mean duration of diarrhea in fenugreek based diet 2.6%, while that of kwash milk was 5.3days. This finding agreed with Dewit et al.12 who reported a medium duration of diarrhea 1.8days for children fed

(incabarina) diet while the duration of diarrhea in children fed a lactose hydrolyzed milk, was found 5.3days.

The finding also agreed with Alarcon,¹³ who reported a shorter duration of diarrhea in children fed a diet based in local Peruvian staples than in children fed milk diet (1.5,4.9) days respectively.

That positive effect of "FD" may be due to the high fiber and good protein digestibility. Although kwah milk is considered one of the best treatments for diarrhea in order to prevent dehydration. The treated children have rejected it especially in severe PEM cases. In this study, the digestibility of kwask milk was reported low: (full-strength 68.8%; half strength. 70%).The reason for these lower digestibility values may be due to the oil added to kwash milk.

Data on the frequency (per day) and duration of diarrhea that the mean duration of all control groups was the mean duration of all FD treated group was 26days.

Effect of fenugreek based diet "FD" and kwash milk on child growth:

Children of group I (less than one year of age), fed FD showed a better growth than those fed kwash milk (control), with a significant difference (p. <0.01), (Fig.1).

Children of group II (2years of age), fed FD, showed a better growth than those fed kwash milk (control), with a significant difference (p. <0.01), (fig.2).

Figure (1) : initial and final boy weight (kg) for group (> one years infant treatment and control group.

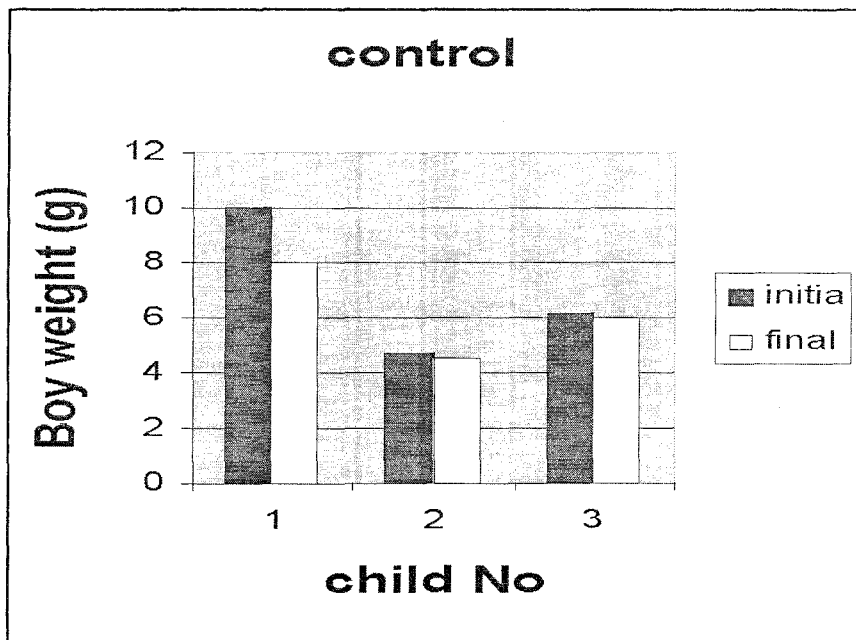
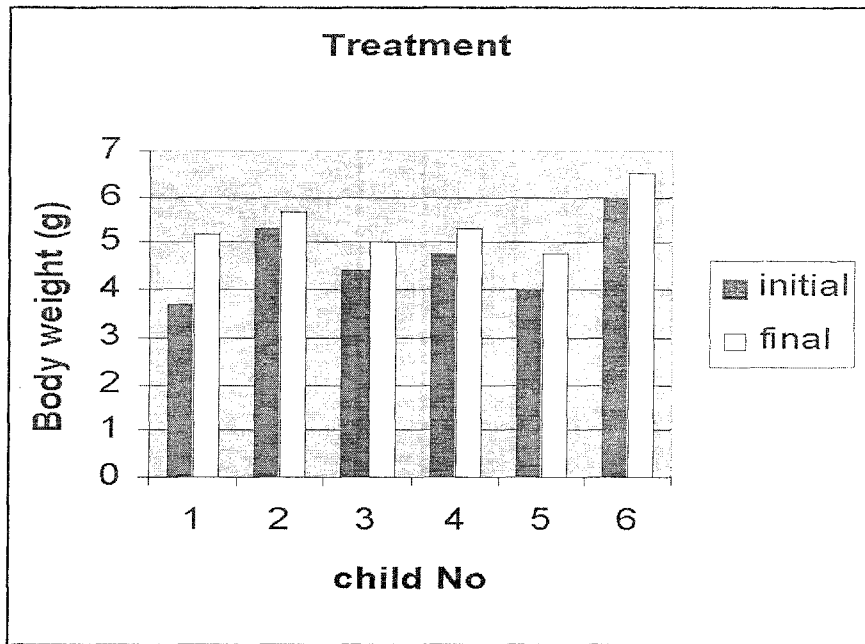


Figure (2): initial and final body weight (g) for group II (over two year infant), treatment and control group

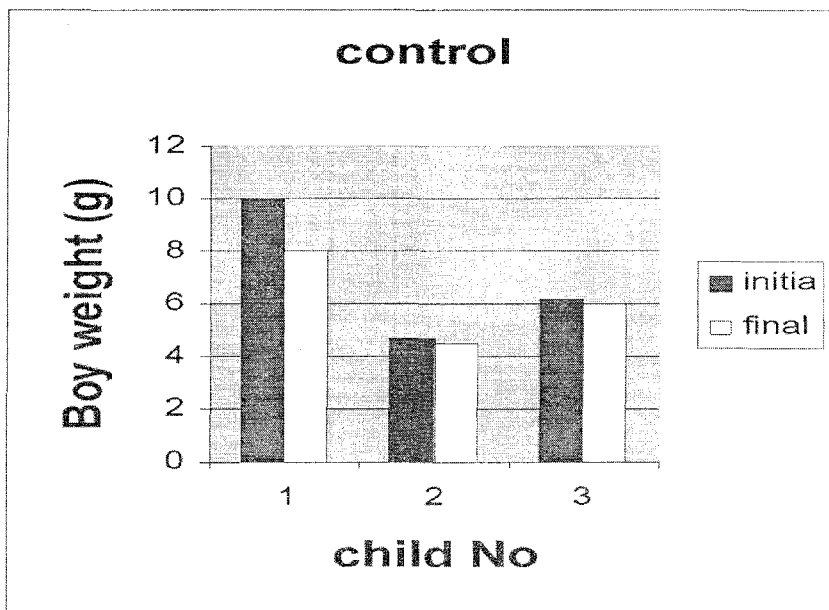
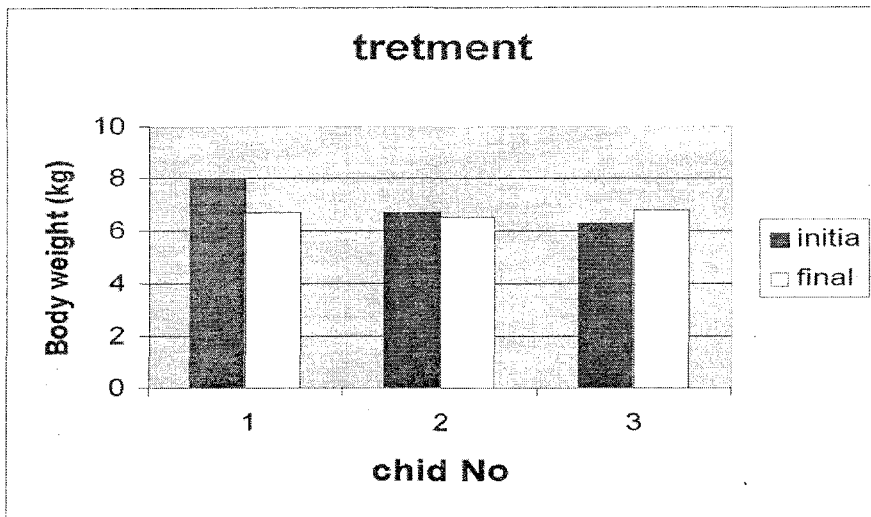
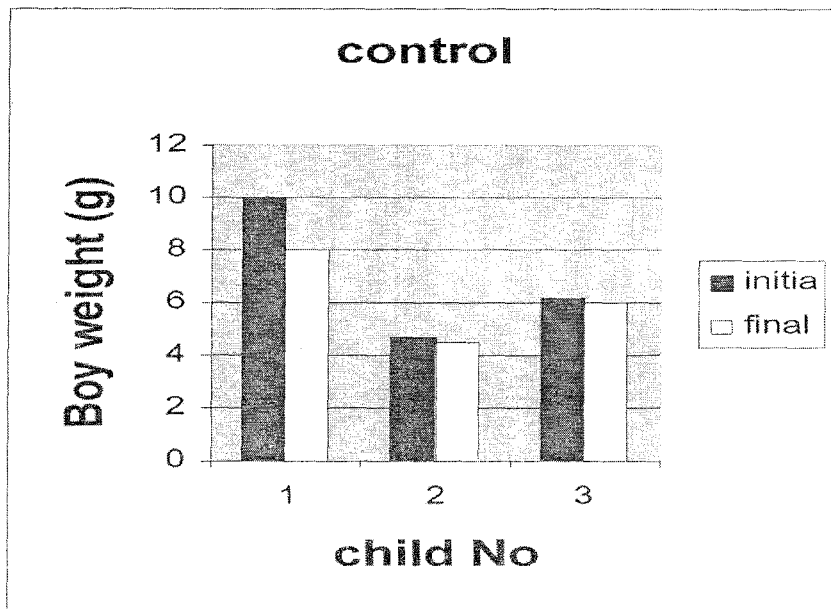
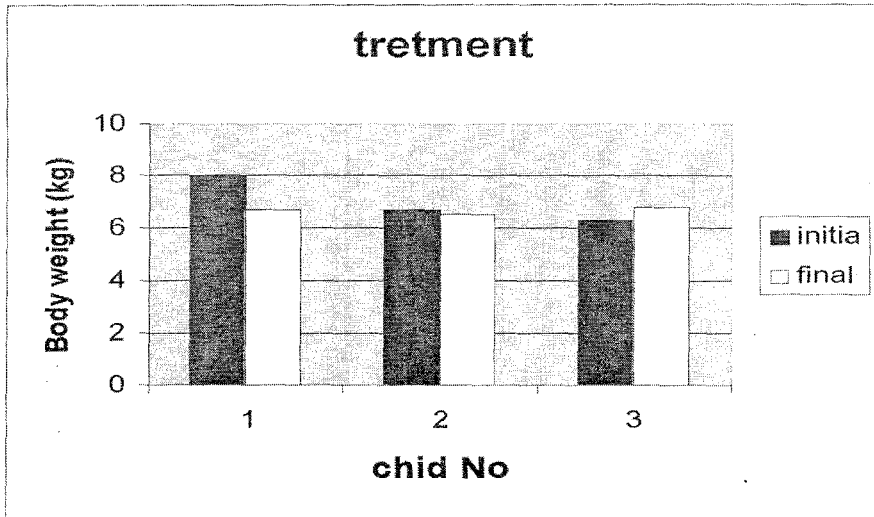


Figure (2): initial and final body weight (g) for group II (over two year infant), treatment and control group



Children of group 111 (over 2 years of age), fed FD, showed a better growth, compared to those fed wash milk (control), with a significant difference ($p < 0.05$).

From the above results it is concluded that, FD diet is a good therapeutic diet for treatment of children with severe protein energy malnutrition.

Conclusion:

Fenugreek based diet can be effectively used as therapeutic and weaning food, providing a supplement to enhance protein quality for feeding of infants, particularly malnourished infants. The diet preparation technique can be easily adopted at both household and hospital levels.

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