"COMPARISON OF TEMPE AND SPECIAL MILK IN THE NUTRITIONAL REHABILITATION OF SEVERELY MALNOURISHED CHILDREN USING BIOCHEMICAL AND CLINICAL PARAMETERS"

By

Mary Kirigo Kiaira, MBChB

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DECLARATION

I HEREBY declare that this is my original work and has not been presented for a degree in any other university

Signed, Mary Kirigo Kiaira

25.11.98

Date

This dissertation has been submitted with our permission as University supervisors.

Signed, Professor Rachel. N. Musoke

Department of Paediatrics and Child health,

University of Nairobi

25.11.98

Date

Dr Nelson M. Muroki,

Department of Food Science and Technology,

University of Nairobi.

25.11.98

Date

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LIST OF ABBREVIATIONS

ANOVA - Analysis of variance

g - grammes

GIT- Gastrointestinal tract

Hb - Haemoglobin

HIV - Human immunodeficiency virus

I.U - International units

Kcal - Kilocalories

KNH - Kenyatta National Hospital

PEM - Protein energy malnutrition

SD - Standard deviation

SPSS - Statistical Programme for Social Sciences

UNICEF-United Nations Children's Education Fund

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SUMMARY

PEM a highly prevalent condition in almost all developing countries, including Kenya is treated with high calorie, high protein feeds. At the KNH special milk is used for the rehabilitation of children with PEM. Special milk is prepared using dry skimmed milk, corn oil, eggs, and sugar.

In Indonesia, a traditional food called tempe has been used in the rehabilitation of children with PEM. Tempe is prepared by fermenting cereals or legumes or a mixture of both with the fungus *Rhizophus oligosporus*. In this study comparison of special milk with tempe in the nutritional rehabilitation of children with either kwashiorkor or marasmic kwashiorkor in the paediatric wards of KNH was done. The period of observation was ten days which mainly covered the acute resuscitation phase. The total protein, albumin, and Hb were determined on the first post admission day, day four, day seven and day ten. Daily observations were done to determine the duration of oedema, apathy, diarrhoea, and changes in weight.

A total of 90 children with a diagnosis of kwashiorkor or marasmic kwashiorkor were recruited and randomly allocated to either tempe group or special milk group. Each group had 45 children.

Overall the 52 children had kwashiorkor and 38 had marasmic kwashiorkor. Each of the treatment groups had equal representation of kwashiorkor and marasmic kwashiorkor. The mean age in the tempe group was 26.1 ± 12.9 months. The mean age in the special milk group was 22.7 ± 10.6 months.

For each group there was a significant increase in the serum protein levels during the study period ($p = 0.000$). The rate of increase in serum proteins in the special milk group was 1.3 g per

day while the rate in the tempe group was 0.9 g per day. On the other hand comparison between the two groups showed that there was no difference between the mean serum protein values during the period of the study (p= 0.073-0.831).

There was a significant increase in the albumin levels as the days of feeding progressed. The change in albumin levels was not affected by the type of feed (p= 0.0134). There was no difference between the mean levels of serum albumin in children fed on tempe and those fed on special milk throughout the period of investigation (p= 0.562-0.855).

The mean Hb levels at the beginning of the study were similar and there was no significant change during the period of study (p= 0.500).

Only 32% of the children gained weight. Twenty percent of these were in the special milk group and 12% were in the tempe group. Analysis of variance for paired data of tempe and special milk showed that the increase in weight in the two groups was not significantly different as the days progressed (p= 0.331). On linear regression analysis the increase in weight in the tempe group was not significant (p=0.988), while the increase in weight in the special milk group was significant (p=0.001). The growth rate for the children in the tempe group was 12.27 g per kilogram body weight per day while it was 16.01g per kilogram body weight per day in the special milk group. The rest of the children in the two groups continued to lose weight until they were discharged from the study on the 10^{th} day.

There was no significant difference in the mean duration of diarrhoea, apathy and oedema between the tempe group and the special milk group (p= 0.323, 0.493, and 0.907 respectively). Survival analysis of the data was done for diarrhoea, apathy, and oedema. The results showed

that the children in the tempe group had lower probabilities of surviving with clinical features of diarrhoea, apathy and oedema for all the time intervals.

It was concluded that tempe could be as good as special milk in the nutritional rehabilitation of children with severe PEM.

CHAPTER ONE

1. INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

Tempe is a traditional Indonesian food prepared by fermenting cereals or legumes or a mixture of both with the fungus *Rhizophus oligosporus*. It has been used in the nutritional rehabilitation of malnourished children. In one study carried out in Indonesia 60% of the malnourished children had a good weight gain in two weeks and their haemoglobin levels increased.

Tempe has been shown to shorten the diarrhoea and rehabilitation periods in malnourished children in a study carried out in Mbooni Family Life Training Centre in Machakos district. The tempe feeds were also found to be less expensive than the commonly used milk feeds. This study and the Indonesian study did not document the biochemical changes and other clinical parameters that are associated with recovery from severe malnutrition.

The purpose of this study is to compare the changes in clinical parameters namely; weight gain, duration of diarrhoea, duration of apathy, the period over which oedema is lost, and changes in biochemical parameters, namely, total protein, albumin, and haemoglobin in children fed on tempe and special milk.

1.2 LITERATURE REVIEW

Protein energy malnutrition is the commonest type of malnutrition in developing countries. It affects primarily children under 5 years of age [15]. The other three important types of malnutrition are Iron deficiency, Vitamin A deficiency, and Iodine deficiency [4].

Protein energy malnutrition has long lasting effects on growth, development, learning ability, social adjustment, working efficiency, labour productivity and mortality in childhood. It is a range of pathological conditions arising from deficiency of various nutrients including proteins calories and micronutrients such as zinc and Vitamin A. The clinical spectrum of Protein energy malnutrition includes the extreme states of kwashiorkor and marasmus to degrees of underweight in children. The manifestations vary depending on the age of the child, severity and duration of deficiencies as well as other concomitant nutritional deficiencies and superimposed infections [15]. The severe forms of malnutrition are easily diagnosed because they have a classic presentation. The less severe forms of malnutrition can only be detected if there is regular monitoring of growth. Various clinical parameters have been used for growth monitoring including weight, height, head circumference, and mid upper arm circumference. These parameters are used in the classification of malnutrition. The Wellcome Classification is based on weight for age index and the presence or absence of oedema. (Appendix 1)

1.2.1 Prevalence of PEM

Protein energy malnutrition is highly prevalent in almost all developing countries where it is a major cause of morbidity and mortality. The 1990 UNICEF report [12] documented that among children aged less than 5 years living in the developing countries excluding China, more than

one in six of the malnourished children (or 2.3 million children) were severely malnourished. Asia is the most affected continent with nearly 1 in every 2 children experiencing malnutrition. Two thirds of the world's malnourished children live in Asia. A half of these live in the 8 nations of South East Asia. Latin America was the least affected. The report further stated that if the malnutrition targets for the year 2000 are not reached it is expected that 178 million children will be malnourished. UNICEF's goal for the 1990s is to reduce severe and moderate malnutrition in the children less than five years by half. If the targets are met, 100 million children under five years of age will be saved from malnutrition by the year 2000. However recent reports indicate an increasing number of malnourished children. The 1993 UNICEF report documented that among children aged less than 5 years living in developing countries 193 million were malnourished, with 69 million being severely malnourished.

In Kenya 5 National nutritional survey [2] conducted between 1982 and 1994 have documented a significant level of malnutrition. In these nutritional surveys the indicators used to assess the nutritional status were height for age (H/A) weight for height (W/H) and weight for age (W/A). The National Centre for Health Statistics data was used as the reference population. Children whose height for age index fell below minus 2 standard deviations from the median of the reference population were classified as stunted or short for age and chronically undernourished. Children whose index was below minus three standard deviations (-3SD) were considered severely stunted. Children whose weight for age index falls below minus two standard deviations (-2SD) from the median were classified as underweight. Children whose W/A index was below minus three standard deviations (-3SD) from the median were considered severely underweight. The most recent nutritional survey was carried out in 1994. In this 5th Nutritional survey stunting peaked in the age group 12 - 23 months. Stunting was found to be a problem in the Coast,

Eastern, Nyanza, Rift Valley and Western Provinces. Overall the prevalence of moderate stunting was 34% and severe stunting was 15%.

Wasting was highest in the North Eastern province followed by Coast and Eastern Provinces. Moderate wasting was noted in 8% of children aged under five years while 2% were severely wasted. Wasting peaked in the 12-23 month age group where 8.9% of the boys and 6.7% of the girls were wasted.

The prevalence of underweight was highest in the Coast province and in the North Eastern province. A high prevalence of underweight was also found in the arid and semi arid regions. Like the H/A and W/A indicators, the 12-23 month age group had more underweight children and boys were more underweight than girls. 22.5% of the under five's were underweight and 6% were severely underweight.

Children with extreme forms of PEM were found to have low levels of thyroid hormones, [1] which may be due to iodine malabsorption as part o the generalized malabsorption due to malnutrition or due to a reduced physiological demand by the energy depleted tissues. The energy deficit also interferes with the active energy dependent process of thyroid hormone synthesis and the protein deficit interferes with the availability of enzymes necessary for hormone synthesis.

1.2.2 The Management of Severe PEM

The mainstay of nutritional replacement in PEM has been protein and caloric replacement. Micronutrient replacement in the management of PEM has become prominent only in the recent

past and has focused on Vitamin A, Iron, Vitamin C, Zinc and Selenium. The two phases in the management of PEM are acute phase and rehabilitative phase. The acute phase consists of initial resuscitation and stabilization. It includes initiation of feeds with high calorie and high protein feeds to prevent hypoglycaemia, promote growth as well as temperature regulation to prevent hypothermia, and treatment of existing infections such as pneumonia, urinary tract infections and septicaemia. Treatment for infestations with intestinal parasites is also instituted [16]]. The initial feeds consist of small frequent feeds aimed at giving protein at 0.4 - 0.6 g per kg body weight per day and calories at 100 Kcal per kg body weight per day. On first contact with the malnourished infants vitamin A replacement is instituted to prevent the severe consequences of vitamin A deficiency [16].

In the rehabilitation phase energy dense mixtures as well as iron and vitamins are instituted. Psychological and external stimuli are also provided to the child during the rehabilitation phase. Nutritional counseling and education are offered to the mother and the child is gradually returned to normal diet. Special milk is the high-energy milk utilized in the acute resuscitation phase. It was developed in the nutritional unit in Kampala, Uganda. Some of the problems with special milk include diarrhoea that has been attributed to lactose intolerance. The details of the composition and preparation of special milk are shown in appendix 2.

Muroki [8] reported that unfermented uji fortified with fermented legumes gives a satisfactory palatability, has a high nutrient value and can be used as a weaning diet. According to Mensa et *al* [5] fermented foods have improved tastes, are a good source of easily absorbed nutrients, have low viscosity which increases the amount of dry matter per unit volume and the energy density.

They also have more readily absorbed minerals because of the removal of phytates which retard mineral absorption.

A traditional fermented food used in Indonesia is prepared by fermenting legumes or cereals or a mixture of both with a mould of the genus *rhizopus*. *Rhizopus oligosporus* is the most widely used organism. Sometimes cassava and sweet potatoes are added to the legume-cereal mixture. This food is called tempe. Tempe is an Indonesian term meaning fermented bean.

A review on tempe by Muroki [8] states that tempe has a low beany flavour and hence is more palatable for children. It has a meaty texture and due to the availability of cereals and legumes it can easily be incorporated into local dishes. During fermentation endogenous and exogenous fungal enzymes hydrolyze starch and protein and so tempe has a high digestibility and absorbability. The fungal enzymes have not been found to be harmful to man. Tempe also inhibits mycotoxin formation. It has an antimicrobial effect although the mechanism of action is not known and it also has some anti-oxidant effects. In addition it is a rich source of niacin, riboflavin, folic acid and pyridoxine. The composition and preparation of tempe is shown in appendix 3.

1.2.3 Clinical Uses of Tempe

Several researchers have conducted clinical studies of tempe. Sumantri [11] in treating malnourished children with chronic diarrhoea found that the chronic diarrhoea stopped in two weeks after initiation of feeds with tempe. Of 14 children, 60% had a good weight gain in two weeks and their haemoglobin levels increased. Mien and Hamana [6] carried out a study on the use of a tempe based formula in dietary treatment of chronic diarrhoea. They compared its

performance with that of a milk-based formula. The chronic diarrhoea was due to either lactose intolerance with malabsorption, or fat malabsorption, intestinal infection due bacterial overgrowth especially in PEM or due to cow's milk intolerance. 79 children under five years of age suffering from chronic diarrhoea were treated using tempe based formula and 32 children were treated with milk based formula. The mean duration of diarrhoea in the tempe based formula group was 2.39 ± 0.09 days and in the milk based formular was 2.94 ± 0.33 days. Sudigbia and Sumantri [10] found out that tempe as a supplementary food has positive effect on the growth velocity of children with diarrhoea. Mwiwa[9] working at Mbooni family life training center compared the performance of milk yellow maize porridge with that of tempe yellow maize porridge in supplementing diets of children with protein energy malnutrition: Of 117 children 61 children were fed with milk yellow maize porridge and 56 were fed with tempe yellow maize porridge. She documented that the diarrhoea period was shorter in the children supplemented with tempe yellow maize porridge. The monetary and social costs of rehabilitation were found to be lower with tempe yellow maize porridge than with milk yellow maize porridge. The growth rate was better in the tempe group than in the milk group. The final conclusion was that the rehabilitation period was shorter with tempe yellow maize porridge than with milk yellow maize porridge.

The aim of this study was to compare the performance of tempe with that of special milk in the nutritional rehabilitation of children admitted in hospital with severe PEM.

1.3 Study Justification

Milk in Kenya is expensive and not always available. Cereals and legumes are readily available in most parts of the country. Although tempe has been tried in Machakos [9] this has not been

done at a hospital setting to establish its performance in very sick malnourished children. Therefore comparing the performance of tempe with the performance of special milk which is normally used in the hospital setting will be important in establishing the use of tempe as a less expensive and more readily available feed in the nutritional rehabilitation of children with PEM.

1.4 Objective

This was to compare the response to tempe based feed with the response to special milk among children with severe PEM using clinical and biochemical parameters.

CHAPTER TWO

2. MATERIALS AND METHODS

2.1 Study area and Study Period

The study was carried out in the paediatric wards at KNH, which serves as the national referral hospital and the teaching hospital for the University of Nairobi. It was carried out between mid August 1997 and mid March 1998.

2.1.2 Ethical considerations

The KNH ethical committee approved the study proposal.

2.2 Study Design

This was a randomized clinical trial of tempe versus special milk.

2.3 Study population

This consisted of children aged 1 - 5 years who were admitted to KNH paediatric wards with a diagnosis of kwashiorkor or marasmic kwashiorkor using the Wellcome classification criteria (see appendix 1). All children who were entered into the admission book with the above diagnosis were considered for the study.

2.4 Inclusion criteria

All those children for whom consent was obtained from a parent or guardian with a diagnosis of kwashiorkor or marasmic kwashiorkor using the Wellcome classification [14] were included in the study.

2.5 Exclusion criteria

Children with cardiac problems or cerebral palsy and those for whom no consent was obtained were excluded from the study. HIV status was considered a main confounder and the HIV testing was done after appropriate counseling. The children found to be HIV positive sent for

appropriate follow-up on discharge.

2.6 Randomization.

Slips of paper written either special milk (S) or tempe (T) were put in unlabelled envelopes and sealed. A parent or guardian was asked to pick an envelope at random to determine which feed the respective child would receive.

2.7 Clinical and biochemical assessment and follow up

On the day of admission, a complete history was taken and a physical examination was performed to confirm the diagnosis of severe PEM and to document the presence of other disease conditions. On day one a chest X-ray was taken to establish the presence of chest infection. A urine sample was taken for urinalysis to determine the presence or absence of urinary tract infection. Blood samples were also taken on day one for Hb levels, total serum proteins and albumin and for HIV testing. Counseling was done before and after the test. The Hb levels, total serum proteins, and albumin determinations were repeated on days 4, 7 and 10. All the analysis was carried out in the hospital diagnostic laboratories.

The investigator weighed the children on the day of admission and thereafter on every other day until the 10^{th} day when they were discharged from the study. The weighing scales were standardized before the study was commenced. The children were examined daily to document duration of oedema, apathy and dirrhoea. All the laboratory findings and clinical findings on examination were entered in a questionnaire (See appendix 4).

Other disease conditions apart from PEM were managed as was appropriate.

2.8 Sample size.

The sample size (n) was calculated for paired samples using the following equation.

$$N = 2\left[\frac{(Z_{\alpha} - Z\beta)\sigma}{\delta_1}\right]^2$$

$Z_{\alpha} = 1.96$ (the point cutting off 5 percent in two tails off the standard normal distribution).

$Z\beta = -1.65$ (the point cutting off 5 percent in the lower tail off the standard normal distribution).

$\sigma =$ Population standard deviation

$\delta_1 =$ Error specification for a particular population difference (which is given by the mean for tempe minus the mean for the special milk). The calculated sample size was 55 although the actual sample size was 90. The larger actual sample size ensured that even with dropouts, the final sample size that completed the study was statistically acceptable.

2.9 Feed Preparation and dispensing

2.9.1Tempe

The tempe flour was prepared at Applied Nutrition Unit of the Department of Food Science and Technology, University of Nairobi. Beans were washed in water and rinsed. They were then soaked for 18 hours in water at room temperature and then dehusked. Then they were cooked for 45 minutes, dried, inoculated with the mould Rhizopurs oligosporus and packed in plastic bags. Thereafter they were left at 35°C for 24-28 hours until they were well covered by the mould. Then they were sliced into small cakes and blanched in hot water for 15 minutes. They were dried and milled to make the tempe flour. The pH was maintained at around 5.3 and the drying temperatures were between 60-80°C .The flour was used within one month of preparation. This

flour was mixed with white maize flour to give a tempe flour: maize flour ratio of 3:7 for optimal nutritional value and minimum cost. The preparation recipe and composition of 100 g of this mixture is shown in appendix 3. To make a litre of the porridge 250 g of the above preparation of tempe flour was mixed with 300 millilitres of water to make a slurry. This was added to pre-heated 700 millilires of water and stirred briskly. The total cooking time was 15 minutes. The porridge was then cooled to ambient temperatures and 4 g of amylase rich flour added and mixed with the porridge. The amylase (donated by The Kenya Breweries) was added to digest the starch and liquefy the porridge. The porridge was then sweetened with sugar and served every three hours.

2.9.2 Special Milk

Special milk was prepared from dry skimmed milk, sugar, corn oil and eggs. A hundred grammes of dry skimmed milk was mixed with sixty grammes of sugar, fifty grammes corn oil and two eggs. Boiled water was added to make a total volume of one litre.

The caloric value of both feeds was 1 Kcal per ml and the protein value was 0.05 gm per ml. Feeding was started at 100 Kcal per Kg body weight per day. As the oedema was lost, the calorie intake was gradually increased at the rate of 20 Kcal per day.

All the feeds administered were entered in a feeding chart that was provided to the mothers (Appendix 5). The volumes and times of administration were also entered.

2.10 Other Feeds

During the hospital feeding times the parent or guardians were allowed to give the children half a

cup of the food served to them. The hospital diet mainly consisted of any one of the following: rice, white maize flour porridge, and mashed potatoes served with any of the following vegetables or meat; green grams, fried beans, fried or boiled meat, green vegetables or white cabbage. It was estimated that half a cup of the hospital diet supplied approximately 80 to 120 Kcal per feeding time. The hospital served two meals in a day.

2.11 Analysis of results.

Analysis of results included the comparison of the performance in the two groups using physical and biochemical parameters. The clinical parameters were period over which oedema was lost, onset and rate of weight gain, duration of diarrhoea, and duration of apathy. The biochemical parameters were total protein, albumin and Hb levels over the period of observation.

All the data was analyzed as paired observations using SPSS version 6 on windows. Subjects in the tempe and the special milk group were paired using important clinical characteristics as described by Colton [21].

CHAPTER THREE

RESULTS

3.1 Distribution of the children by diagnosis, age, sex and feed

The children in the study were grouped according to their diagnosis, age, sex and feed allocation. Table 1 shows that of the 90 children recruited for the study 52 children had kwashiorkor while 38 children had marasmic kwashiorkor. There were two groups of children with 45 children each. These were the group on tempe and the group on special milk. The chi-square test was done for the two feeds versus the diagnosis and for diagnosis versus the two feeds. The p-values ranged from 0.136 to 0.765 suggesting no significant differences between the two groups under consideration. The mean age of the children in the tempe group was 26.1$\pm$ 12.9 months and the mean age in the special milk group was 22.7 $\pm$ 10.6 months.

Table 1: Classification of children recruited for the study by diagnosis and type of feed administered during rehabilitation

	TEMPE	SPECIAL MILK	TOTAL	p-value
Kwashiorkor	28	24	52	0.677
Marasmic Kwashiorkor	17	21	38	0.626
Total	45	45	90	
p-value	0.136	0.765		

Table 2 shows the age distribution of the study population in the tempe group and the special milk group. To determine whether there was a difference between the two groups of children on either tempe or special milk in the various age groups, the chi-square test was done. The p-values ranged from 0.1853-1.0000 suggesting that there was no significant difference between the two groups.

Table 2: Distribution of the study group children by age group and feed

AGE GROUP	**TEMPE**	**SPECIAL MILK**	**p-value**
<24 (Months)	23	34	0.1853
25 - 36 (Months)	14	7	0.1904
37 - 48 (Months)	4	3	1.0000
49 - 60 (Months)	3	1	0.6171

Table 3 shows the age distribution of the female children in the tempe group and the special milk group. To determine whether there was a difference in the female children on either tempe or special milk in the various age groups, the chi-square test was done. The p-values ranged from 0.0479 -1.0000 suggesting that there was no significant difference in the female children on the two feeds.

Table 3: Distribution of the study group female children by age and feed

AGE GROUP	TEMPE	SPECIAL MILK	p-value
<24 (Months)	10	19	0.1374
25 - 36 (Months)	7	4	0.5465
37 - 48 (Months)	2	1	1.0000
49 - 60 (Months)	2	0	0.04795

Table 4 shows the age distribution of the male children in the tempe group and the special milk group. The chi-square test was done to determine whether there was a difference in the male children on either tempe or special milk in the various age groups. The p-values ranged from 0.3428 - 0.8501 suggesting that there was no significant difference in the male children on the two feeds.

Table 4: Distribution of the study group male children by age and feed

AGE GROUP	TEMPE	SPECIAL MILK	p-value
<24 (Months)	13	15	0.8501
25 - 36 (Months)	7	3	0.3428
37 - 48 (Months)	2	2	0.6171
49 - 60 (Months)	1	1	0.4795

3.2 Presence of other disease conditions in children on either tempe or special milk feeds

The children who were recruited into the study had other disease conditions. These were malaria, pneumonia, urinary tract infection, tuberculosis, HIV, Cancrum oris, rickets, and scabies. Table 5 shows the distribution of the children with these disease conditions on the two feeds.

Table 5: Disease conditions other than PEM found in the study population

	Tempe Group	**Special Milk Group**
Disease condition	**Number Affected**	**Number Affected**
Pneumonia	20	23
Malaria	7	15
Urinary tract infection	8	10
Tuberculosis	3	4
HIV	2	6
Cancrum oris	2	0
Rickets	0	1
Scabies	2	3

Some children had more than one other disease condition apart from PEM. The most commonly encountered disease conditions were pneumonia, malaria and urinary tract infections in order of decreasing frequencies. The distribution of the various disease conditions was similar in the two groups.

3.3 Changes in body weights.

After the initiation of the feeds the oedema which was observed in all the admitted children began to subside. Subsequently the children began to lose weight. Most of the children continued

to lose weight until they were discharged from the study on day ten. Only 32% of the children gained weight. Twenty percent of these were in the special milk group and 12% were in the tempe group. Analysis of variance showed that the increase in weight in the two groups was not significantly different as the days progressed. The p-value was 0.331. However, on regression analysis the increase in weight in the tempe group was not significant (the p-value was 0.988) while the increase in weight in the special milk group was significant (the p-value was 0.001). The growth rate for the children in the tempe group was 12.27 g per kilogram body weight per day while it was 16.01g per kilogram body weight per day in the special milk group. The results are summarized in Table 6 shown below.

Table 6: *Effect of tempe and special milk on the body weights of severely malnourished children during nutritional rehabilitation*

	TEMPE	SPECIAL MILK
Those who gained weight	11	18
% that gained weight	12	20
Mean growth rate in g/kg/day	12.27 ±11.86	16.01 ± 8.88

3.4 Changes in clinical parameters in children with severe PEM fed on either tempe or special milk

Table 7 shows the comparisons of the mean days of oedema, diarrhoea and apathy. From the p-value obtained from ANOVA between the two groups of children (Table 7) it is apparent that there was no significant difference in duration of dirrhoea, apathy and oedema.

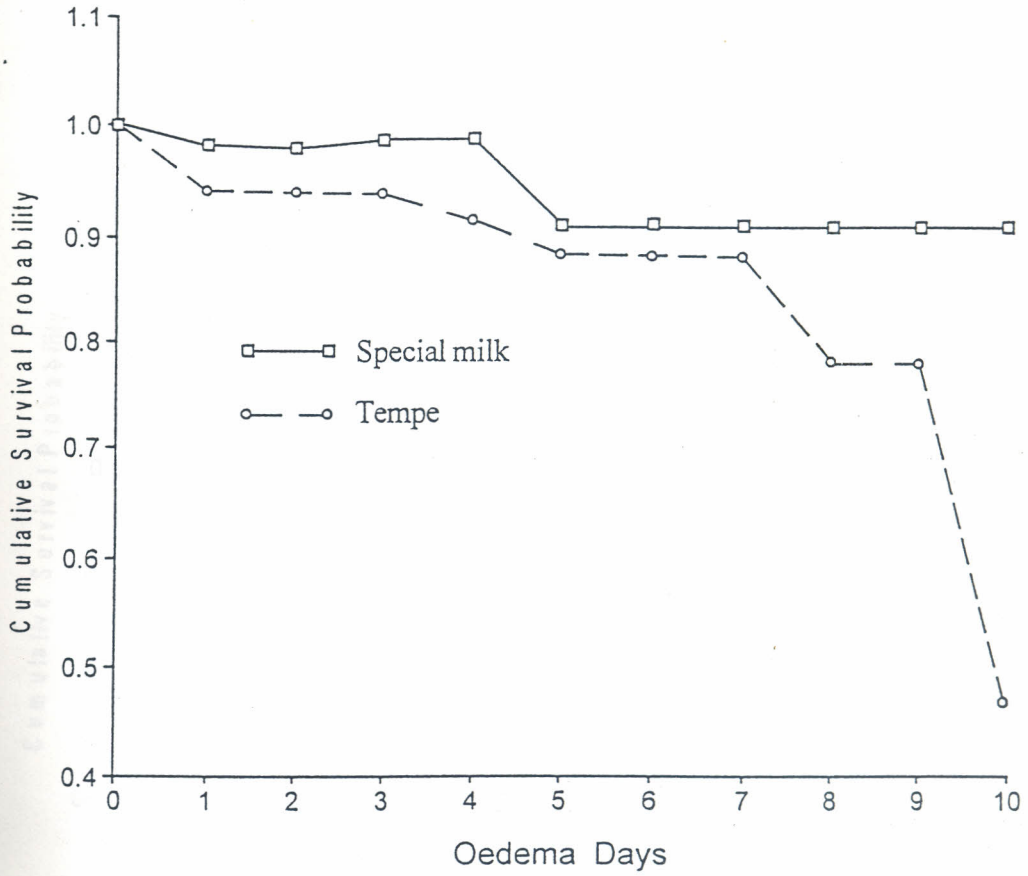
Table 7: *Comparisons of mean days diarrhoea, apathy, and oedema in severely malnourished children rehabilitated with either tempe or special milk.*

	Tempe group	**Special Milk group**	
Clinical parameter	Mean days ± SD	Mean days ± SD	p-value for ANOVA
Diarrhoea	2.27 ± 1.32	2.61 ± 1.54	0.323
Apathy	5.13 ± 2.03	5.53 ± 2.84	0.493
Oedema	6.32 ± 2.95	6.35 ± 3.23	0.907

There was no significant difference in the mean oedema days between the group on special milk and the group on tempe. The p-value for the analysis of variance between the two groups was 0.907.

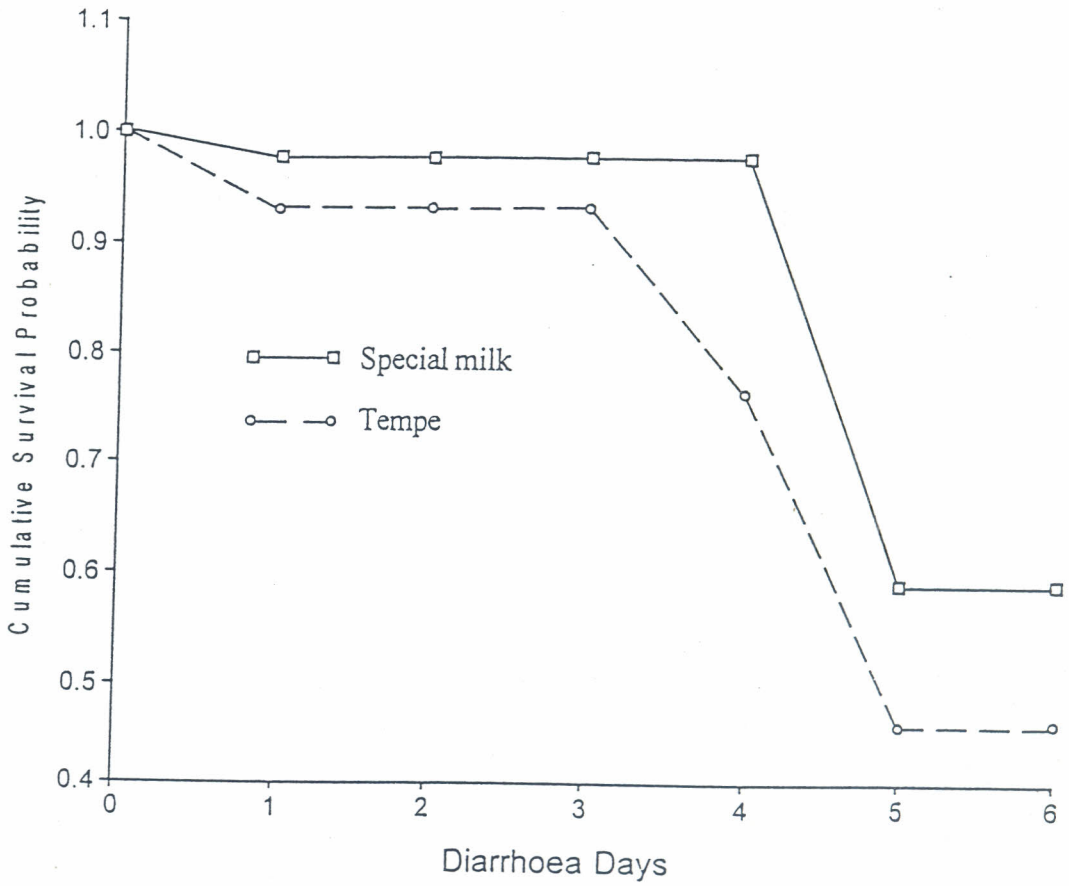
Figure I. shows the cumulative survival probability versus oedema days. It shows that the children in the tempe group had lower probabilities of having the oedema for all the time intervals than the children on special milk.

Figure I. Survival curve for cumulative probabilities of surviving with oedema for various time intervals in the tempe and special milk groups



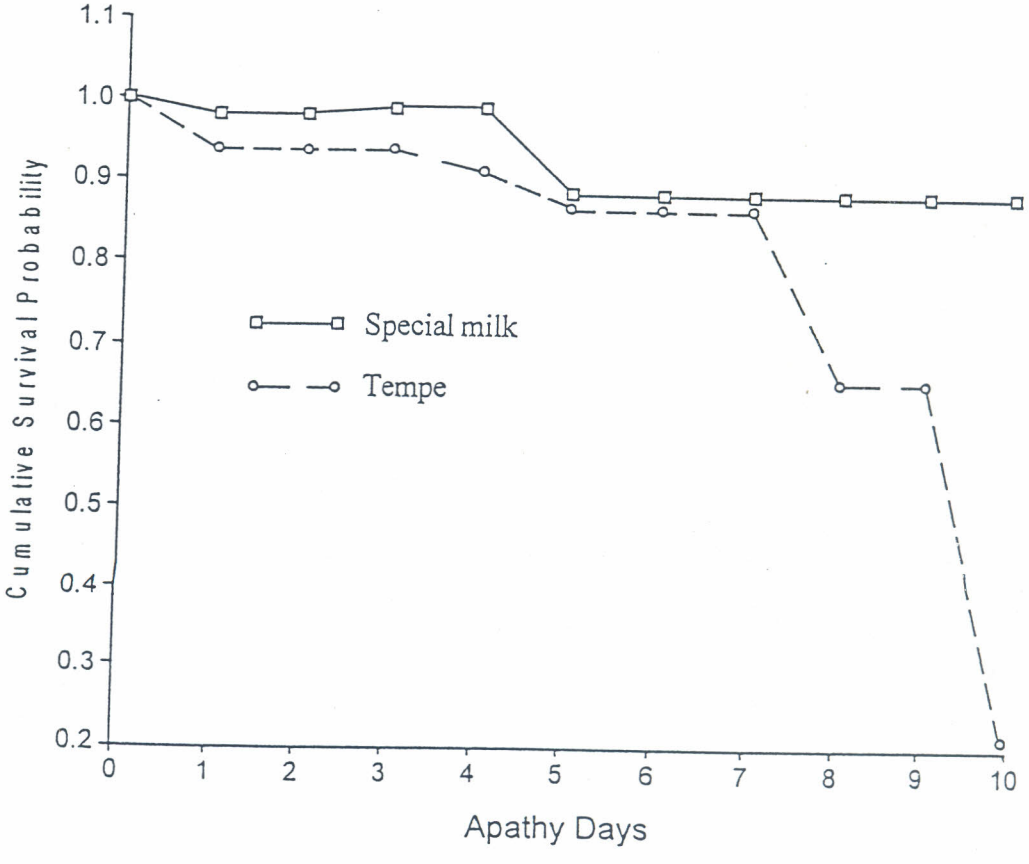
Just as in the case of oedema there was no significant difference in the mean diarrhea days. The p-value for the analysis of variance was 0.323. Figure II shows the cumulative survival probabilities versus diarrhoea days. According to this figure children in the tempe group had lower probabilities of having diarrhea for all the time intervals than the children on special milk.

Figure II: *Survival curve for cumulative probabilities of surviving with dirrhoea for various time intervals in the tempe and special milk groups*



Investigations on the days of apathy showed no significant difference in the mean apathy days between the group of children on tempe and the group on special milk. The p-value was 0.493. Figure III shows cumulative survival probabilities versus apathy days. It is apparent that the children in the tempe group had lower probabilities of having apathy for all the time intervals than the children on special milk.

Figure III: Survival curve for cumulative probabilities of surviving with apathy for various time-intervals in the tempe and special milk group.



3.5 Changes in serum proteins

Table 8 shows the mean levels of serum proteins in children fed on Tempe or Special milk and the p-values for the differences between the two means on each of the days of investigation.

Table 8: A comparison of the mean serum protein levels on respective days between the group of children on tempe and the group on special milk and the corresponding p-values

Tempe			Special milk		
Day	mean	n	mean	n	P-value
1	46.34 ± 9.11	40	47.62 ± 9.77	40	0.493
4	49.20 ± 11.37	39	49.72 ± 11.30	39	0.831
7	52.12 ±10.50	33	55.86 ± 12.30	33	0.135
10	55.06 ± 9.70	30	59.55 ± 14.06	30	0.073

From the p-values it is apparent that there was no difference between the mean serum protein levels. Analysis of variance (ANOVA) was done to determine the p-value for change in protein levels over the 10 days of feeding. The p- value obtained for change in protein levels by days was 0.000 suggesting a significant change in the protein levels as the days of feeding progressed. The p-value for the change in protein levels between the feeds was 0.010 suggesting that the change in serum protein was affected by the type of feed.

On regression analysis the p-value for the special milk group was 0.0000 suggesting that there was a significant increase in serum protein levels as the days of feeding progressed. The rate of increase in serum proteins in this group was 1.3 g per day. In the Tempe group the p-value was 0.0007 suggesting that there was a significant increase in serum proteins as the days of feeding progressed. The rate of increase in serum proteins was 0.9 g per day.

3.6 Changes in serum albumin

The mean values for the serum albumin were determined for both the Tempe group and the Special milk group on each of the days of investigation. The p-values for the differences between the means on each day were determined. The p-values in Table 9 suggest that there was no difference between the mean levels of serum albumin in children on tempe and those on special milk throughout the period of investigation.

Table 9: A comparison of the mean serum albumin levels between the group of children on tempe and the group on special milk and the corresponding p-values

Tempe			**Special milk**		
Day	Mean	n	mean	n	p-value
1	18.32 ± 5.31	41	19.03±5.51	41	0.562
4	20.01 ± 5.52	40	20.26 ± 6.47	40	0.855
7	*22.35 ± 7.01*	*33*	*23.32 ± 8.63*	*33*	*0.623*
10	24.40 ± 6.70	30	25.27 ± 10.17	30	0.694

To determine the p-value for change in serum albumin levels over the 10 days of feeding Analysis of variance (ANOVA) was done. The p- value obtained was 0.000 suggesting a significant change in the albumin levels as the days of feeding progressed.

On regression analysis the p-value for the special milk group was 0.0005 suggesting that there was a significant increase in serum albumin levels as the days of feeding progressed. The rate of increase in serum albumin in this group was 0.7 g per day. In the Tempe group the p-value was 0.0000 suggesting that there was a significant increase in serum albumin as the days of feeding progressed. The rate of increase in serum albumin was 0.6 g per day in this group. The p-value for the change in albumin levels between the tempe group and the special milk group was 0.134 suggesting that the change in serum albumin was not affected by the type of feed.

3.7 Changes in the haemoglobin levels

Table 10 shows the mean values of haemoglobin levels in both the Tempe and the special milk groups. The p-values for the differences between the means were computed and are also shown in Table 10. From these results there was no significant difference between the means for each of the days.

Table 10: *A comparison of the mean haemoglobin levels between the group of children on tempe and the group on special milk and the corresponding p-values*

Tempe			Special milk		
Day	**Mean**	**n**	**mean**	**n**	**p-value**
1	8.59 ± 1.76	40	8.06 ± 2.28	40	0.209
4	8.46 ± 1.75	40	8.18 ±2.03	40	0.598
7	8.87 ± 1.42	34	8.07 ± 2.03	34	0.252
10	9.06 ± 1.68	32	8.54 ± 2.02	32	0.294

Analysis of variance (ANOVA) was done to determine the p-value for changes in haemoglobin in levels over the 10 days of feeding. The p- value obtained was 0.500 suggesting that there was no significant change in the haemoglobin levels as the days of feeding progressed. The p-value for the change in haemoglobin levels between the feeds was 0.069 suggesting that the change in serum haemoglobin was not affected by the type of feed.

On regression analysis the p-value for the special milk group was 0.9554 suggesting that there was no significant increase in haemoglobin levels. In the Tempe group the p-value was 0.6708 suggesting that there was no significant increase in haemoglobin as the days of feeding progressed.

3.8 Mortalities

A total of 11 children died during the period of study. Five were from the **special milk** group and 6 were from the **tempe group.** The overall mortality rate was 12.2 %. Details are shown in Table 11.

Table 11: Mortalities during the study period

Day of death after admission	Diagnosis	Age in months	Feed	Sex	Other existing conditions
1	Kwashiorkor	18	Special Milk	Female	Extensive skin ulceration's and hypothermia
1	Kwashiorkor	40	Tempe	Female	Pneumonia and extensive skin ulceration's
1	Kwashiorkor	60	Tempe	Male	Pneumonia and cancrum oris
1	Marasmic kwashiorkor	14	Tempe	Female	Extensive skin lesions and cancrum oris
4	Marasmic Kwashiorkor	18	Special milk	Female	Pneumonia
5	Marasmic Kwashiorkor	23	Special Milk	Male	Tuberculosis
5	Marasmic Kwashiorkor	16	Tempe	Female	Pneumonia and extensive skin lesions
5	Kwashiorkor	24	Special Milk	Male	Urinary tract infections
5	Marasmic Kwashiorkor	24	Special Milk	Female	Malaria
8	Marasmic Kwashiorkor	33	Tempe	Female	Severe pneumonia
10	Kwashiorkor	14	Tempe	Female	Severe pneumonia

One child aged 18 months in the special milk group died on day 4. By day 4 the child was still very sick with oedema and apathy persisting. The initial albumin and total protein levels were low. Two of the children who died on day 5, one on special milk and one on tempe, had not shown any improvement in terms of loss of oedema and apathy or any biochemical improvement in terms of albumin and total protein levels. The third child who died on day 5 had shown initial good clinical response in terms of loss of oedema and apathy. The fourth child who died on day five had shown biochemical improvement but still had oedema and apathy. The

child who died on day 8 had shown clinical improvement and increases in total protein and albumin. The child was found dead in bed after feeding. The child who died on day 10 was a very sick child who had features of severe pneumonia and did not show any biochemical or clinical improvement with the feeds and other appropriate management. Apart from these mortalities one mother absconded from the study with her child before investigations were completed. Other ward personnel erroneously discharged two children prematurely. Two blood specimens were not analyzed as they were left on the laboratory bench for much longer than is appropriate for the required parameters. The laboratory did not receive two blood specimens although they were sent from the wards.

CHAPTER 4

4.1 DISCUSSION

Several factors determine the response of children with PEM to rehabilitation diet. Among these are the quality and quantity of feeds, compliance to a feeding schedule, the severity of the PEM, and the presence of other disease conditions in the individuals with PEM.

In this study there was no difference in the 45 children on special milk and the 45 children on tempe, with a diagonosis of either kwashiorkor or marasmic kwashiorkor. The pattern of other co-existing disease conditions was similar in the 2 groups. Both feeds were palatable to the children, and in both groups compliance to the feeding schedule was good.

The total serum protein levels as well as essential amino acids are decreased in children with severe PEM. In this study low levels of serum proteins were documented at the beginning of the study period. The serum protein levels increased as the days of feeding progressed in both the special milk group and the tempe group. The rate of increase was higher in the group of children who were fed on special milk. This apparent better performance on the total serum proteins in the special milk group could be attributed to the higher levels of the essential amino acids methionine, lysine tryptophan and cystine (19, 20). The egg supplement in the special milk was an additional source of essential amino acids (Appendix 2). Bioavailability of nutrients is higher for milk than for the plant-based tempe. Fermentation increases the bioavailability of nutrients, but it could be that it is not increased to be of the same level as that of the special milk. Although only a few children gained weight after the initial weight loss, more children in the special milk group gained weight and the growth rate was higher than for the tempe group. In the Mwiwa

study (9) all the children gained weight and the children in the tempe group in that study had a higher growth rate than in the milk group. The children in the Mwiwa study were followed up for a longer time (28 days) and the study population excluded children with other disease conditions like pneumonia, measles or tuberculosis. It is possible that if the children in this current study were followed up for a longer time, more children would have gained weight. However, because of logistical difficulties it was not possible to extend the period of study beyond 10 days. As a result the documentation of weight gain was limited by the short duration of follow-up.

Albumin is a major constituent of plasma proteins. It has a half life of about twenty-one days (17). In PEM the concentration of albumin is low. This was also the finding in this study. The observation that there was a significant increase in albumin levels in both the special milk group and the tempe group as the days of feeding progressed, supports the view that tempe could be as good as special milk in the provision of other essential amino acids required for albumin biosynthesis during recovery from severe PEM. Further support of this comes from the results of regression analysis that showed that the rate of increase of albumin was independent of the type of feed.

In both the special milk group and the tempe group, there was no significant increase in Hb levels as the days of feeding progressed. It is known that the Rhizopus oligosporus mold used in the preparation of tempe releases bound iron and other minerals and also changes the redox potential in the GIT in favour of iron absorption. It is possible that the follow-up of 10 days was not long enough to detect any changes in Hb levels. There is the possibility of other unrelated factors affecting the change in Hb levels.

There was no significant difference in mean oedema days in the two groups despite the significant increases in total proteins and albumin in the two groups. However, on the survival analysis, children in the tempe group had lower probabilities of surviving with the oedema for all the time intervals analyzed. There was also no significant difference between the mean apathy days in the special milk group and the tempe group, although for all the time intervals the children in the tempe group had lower probabilities of surviving with apathy. These two observations could be attributed to some of the other properties of tempe including its anti-oxidant effects [8].

The mean diarrhoea days were not significantly different in the two groups as the days of feeding progressed. However, the probability of surviving with diarrhoea for all the time intervals was lower with the tempe than with the special milk feeds. This could be due to the fact that children with PEM have an associated lactose intolerance. In addition, tempe is known to have anti-diarrhoea and anti-microbial effects (11). The absence of fats in tempe, which are known to enhance diarrhea in severe PEM (9) could be an added advantage in the tempe group.

4.2 CONCLUSIONS

1. In regard to the changes in total proteins, albumin, and Hb, tempe is as good as special milk in the nutritional rehabilitation of children with severe PEM
2. For all time intervals children fed with tempe have lower probabilities of surviving with the clinical features of oedema, apathy or diarrhoea than the children fed on special milk.

4.3 RECOMMENDATIONS

1. A similar study should be conducted for a longer period of time to compare the responses in weight gain and increases in Hb when children with severe PEM are fed with tempe or special milk.

2. Tempe feeds show a potential for use in nutritional rehabilitation of children with severe PEM and should be considered for introduction in KNH.

Wellcome classification status K☐orkor Maras☐washiorkor

4. SYSTEMIC EXAMINATION

4.1 RESPIRATORY SYSTEM

Respiratory rate/min _____

Indrawing Present Absent ☐ ☐

Rales Present Absent ☐ ☐

4.2 ABDOMINAL EXAMINATION

Liver size _____

Spleen size _____

4.3 CARDIOVASCULAR EXAMINATION

Congestive cardiac failure present Abse☐ ☐

5. LABORATORY INVESTIGATIONS

5.1 URINE EXAMINATION

Pus cells Present Absent ☐ ☐

Nitrates Present Absent ☐ ☐

Red blood cells Present Absent ☐ ☐

Type of Organisms in culture sensitivity

_____

5.2 CXR Pneumonia Present Absent ☐ ☐

5.3 HIV Positive Negative ☐ ☐

5. 4 PROTEIN ANALYSIS

Grammes/dl	DAY 1	DAY 4	DAY 7	DAY 10
Total protein				
Albumin				
Haemoglobin				

5.5 CHANGES IN CLINICAL PARAMETERS AS A FUNCTION OF TIME DURING THE FEEDING ON TEMPE

DAYS	1	2	3	4	5	6	7	8	9	10
Oedema :present										
:absent										
Weight gain started										
Weight gain not started										
Dirrhoea present										
Dirrhoea absent										
Apathy present										
Apathy absent										
Weight in Kg										

5.5.1 CHANGES IN CLINICAL PARAMETERS AS A FUNCTION OF TIME DURING THE FEEDING ON SPECIAL MILK

DAYS	1	2	3	4	5	6	7	8	9	10
Oedema :present										
:absent										
Weight gain started										
Weight gain not started										
Dirrhoea present										
Dirrhoea absent										
Apathy present										
Apathy absent										

Appendix 5

FEEDING CHART

TIME	AMOUNT OF SPECIAL MILK/TEMPE GIVEN	OTHER FEEDS GIVEN
9 A.M		
12 NOON		
3 P.M		
6 P.M		
9 P.M		
12 MID-NIGHT		
6 A.M		