THE EFFECT OF SOYA ENRICHED SWEET YAM ON GROWTH OF UNDERWEIGHT CHILDREN

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ABSTRACT

Lack of appropriate foods for infants and young children in the developing countries is one of the important causes of protein-energy malnutrition. Flour has been processed from fresh tubers of *Dioscorea dumetorum* (Sweet Yam) which grows readily in Cameroon. It has been shown to be high yielding, richer in protein and minerals than the other commonly grown and consumed tubers and its starch grains are more digestible. It cannot be stored because of its hardening property. The flour produced was enriched with soya bean flour and fed as porridge and foofoo to underweight children of 9 – 60 months. Its effect on their growth was compared to that of corn soya meal (CSM) and found to be similar. Although the sample size was small and the feeding period short the results were encouraging and call for further studies in the development of low cost local foods for infants and young children.

RESUME

Le manque de nourriture appropriée pour les enfants à l'âge prescolaire dans les pays en voie de développement est l'une des causes importantes de malnutrition proteino-énergétique. La farine a été obtenue à partir des tubercules frais de dioscorea dumetorum (igname sucrée) qui poussent au Cameroun. Cette igname a un plus haut rendement, elle est plus riche en protéine et minéraux que les autres tubercules communément produits et consommés et ses grains d'amidon sont plus digestibles. Cependant, elle ne peut pas être conservée à cause de sa propriété de durcissement. La farine obtenue a été enrichie avec la farine de soja et utilisée sous forme de bouillie ou «Foufou» pour nourrir les enfants de 9 – 60 mois avec un déficit pondéral. Son effet sur leur croissance a été comparée à celle de la farine de maïs enrichie au soja et trouvée être similaire. Bien que l'échantillon soit petit et la période d'alimentation courte, les résultats sont encourageants et demandent des études plus poussées pour la mise au point des aliments locaux peu couteux pour le sevrage et les enfants d'âge préscolaire.

INTRODUCTION

High rate of protein-energy malnutrition in children in developing countries have been attributed to the lack of appropriate weaning foods, hostile environment, poverty and ignorance. During the last two decades some of these countries have made attemps at developing and producing protein enriched foods from cereals (viteri et *al.* 1972, Gopaldas at *al.* 1974 and Chi-Yvan Cho 1983). These mixtures have been too expensive and outside the reach of the poor in urban and rural areas, thus having no impact on the rate of protein energy malnutrition (PEM). Other studies ha-

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ve shown that the diets of preschool children are usually deficient in proteins and total calories (Gopaldas et *al.* 1974, Taylor at *al.* 1971, Ghai et *al*, 1970 and Swaminathan et *al.* 1970).

The Cameroon National Nutrition Survey of 1978 also confirmed that weaning practrices were important determinants of PEM. Infants and young children were either being supplemented with poorly prepared starchy foods or on prolonged breast-feeding without supplementation. Some urban mothers purchasse expensive imported weaning foods and do not follow the instructions. There is thus a great need to develop rich, cheap and readily available weaning foods from local sources in Cameroon.

During studies of the commoly grown yams in Cameroon, *Dioscorea dumetorum* (the sweet yam) was identified as having very good nutritional and agronomic qualities. The yield is about 35—40 tons per hectare (Lyonga 1980) and production can be easily mechanized. The structure of the starch granules are similar to that of cereals and consequently readily digestible (Treche et *al.* 1979). The protein and mineral content are higher than in the commoly consumed tubers (Agbor-Egbe et *al.* 1983). Unfortunately this tuber undergoes hardening (Treche et *al.* 1979) after harvesting and cannot be eaten as fresh tubers.

In order to increase its shelf-life and consumption this yam has been processed into dried slices and flour (Treche et *al.* 1984). Acceptability of both the processing and the product have been tested and results are favourable (Martin et *al.* 1983, Treche et *al.* 1984). In our search for optimum utilization of the flour we decided to enrich it with soya beans and compare its effect on the growth of malnourished children with that of corn soya meal (CSM) supplied by the United States to the World Food Programme.

MATERIALS AND METHODS

DIET

The sweet yam flour was produced as described by (Treche et *al.* 1982) in the near-by villages by women. Since the protein content was only 7 %, 1 part of soya bean flour supplied by agricultural research centre Njombe, was added to 9 parts of yam flour bringing it upto 10 % protein (YSM) as in the imported corn soya meal (CSM). Both flours were cooked either in the form of a paste (foofoo)served with local sauces from cassava leaves, groundnuts, okro or kerenkereng (Crochorue alitarius) and as porridge with sugar or futher enriched with eggs, dried skimmed milk or groundnuts.

SAMPLE

9 — 60 months old children were selected at the weighing clinics either because they were underweight for age (less than 80 % of the reference child NAS standard) or whose weight had been stationary. The study was divided into 3 phases of 2 weeks each on home food, test diets and then on home food. After obtaining the consent from mothers a questionnaire was filled on every child noting the previous 3 day dietary history and present symptoms. Stools and blood were examined for parasites and those positive were treated with mintezol and or chloroquine respectively. Weights were measured twice weekly with a salter hanging scale graduated in kilograms and 100 g. Lengths, midarm circumference and triceps skinfold thickness measured as described by Jelliffe (1966) using a specially made wooden board read to the nearest 0.1cm, a Zerfas insertion tape read to the nearest 0.1cm and Harpenden's Calipers read to the nearest 0.02mm respectively. These measurements were made at the beginning and end of every phase. After phase one on home food, the

children were divided into two feeding groups. Children from villages that were closer together belonged to the same group. This made it easier for the workers and children to meet at a selected house for feeding. One group was for (YSM) and the other for (CSM). During the feeding period mothers were asked to note all the symptoms experienced by the children and all food items eaten by the child. Each child was brought to the selected house twice a day for breakfast (porridge) and lunch (foofoo plus sauce) and fed as much as the child would take per meal.

RESULTS AND DISCUSSION

DIET

Table 1 shows the composition of diets that was used for supplementation. For the past decade or two, several efforts have been made to develop, produce and distribute protein rich foods to alleviate protein calorie malnutrition in target populations in many developing countries. Several authors have also shown that the diets of preschool children in developing countries are deficient in calories and protein (Gopaldas et *al.* 1974, Ghai et *al.* 1970 and Swaminathan et *al.*, 1970). The mean deficit for calories and protein have been put by some of these authors at 300 cal. and 12 g. of protein respectively.

Table 1 Composition of Supplementary

TIME	YMS OR CSM MIXTURES	YSM CONTENT/ 100 (GM)		CSM CONTENT/ 100 (GM)		MIN. INTAKE/ KG.
	Porridge with :	Protein (gm)	(Cal)	Protein (gm)	(Cal)	
	Groundnuts	17.9	290.5	16.1	270.8	15 gms/kg.
Break-fast	Milk	19.5	260.1	19.4	250.5	"
	Eggs	19.9	272.8	12.5	244.8	"
	Suggar only	11.4	226.6	10.7	224.7	"
	Foofoo with :					
Lunch	Kerenkereng or	41.7	351.6	40.7	340.7	"
	Cassava leaf (Kpem)	47.1	372.3	47.0	361.4	"
	Total Average/ daily intake	30.5 ± 2.293	308.89 ± 13.214	29.8 ± 2.357	301.6 ± 9.225	Total amt. 135 — 270 gm of mix

Each was sweetened with sugar and enriched with one of the three protein sources.

From the results of the dietary recall of the children's home food, cassava, cocoyams, or rice eaten with cassava leaves/groundnut soup (Kpem) made up their regular menu. This monotony may be broken during harvest seasons by introducing yams, maize, beans, green leafy vegetables and fruits. Fish, meat, bread and beans were eaten only occasionally. Children were usually fed two meals daily and we concluded that such intakes were inadequate when compared to recommandation made by Krause and Mahan (1979).

We therefore aimed at supplementing the children's diet with 360 calories and 24 g. of protein daily by giving 15 g. flour per kilogram body weight. The intakes varied from 100 g to 300 g of the mixture which provided a mean daily consumption of 301.6 ± 9.2 cal. and 29.8 ± 2.36g protein from CSM and 308.89 ± 13.21 cal. and 30.5 ± 2.29g from YSM.

CHILDREN STUDIED : 54 CHILDREN WERE STUDIED.

About 2/3 of the 54 children studied were under 3 years. This may be due to the fact that this constitutes the bulk of the children attending the clinic and also the fact that PEM is more common between 14 and 23 months of age (Cornu 1980 and Maitoka 1983). Table 2 shows the distribution of the children according to age, sex, villages and feeding groups. 45% of the children were 9 – 23 months old, 17% (24–35) months, 26% (36–47) and 13% (48–60) months. There were more females (57%) than males and 15% were still being breast–fed. Recent studies in Cameroon have shown that the prevalence rate of PEM is high in children under 2 years old, (national Nutrition Survey 1978 , Cornu 1980 ; Maitoka 1983).

During the first six months of life breast milk alone can supply all the nutritional needs of the child and passively acquired antibodies protect them from infection. Thereafter they become more vulnerable to growth retardation and infections because of inappropriate weaning and warning antibody protection, (BAI 1980, GL IMPSE 1982).

Table 2 Distribution of children Age (9 – 60) according to village, Age and sex

DIET VILLAGE/SEX		AGE (MONTHS)				
		9 – 23	24 – 35	36 – 47	48 – 60	TOTAL
YSM NSIMENYONG 1	M	5	–	1	3	9
	F	5	2	1	2	10
CSM NSIMENYONG 11 & 111	M	1	–	–	–	–
	F	1	3	4	–	–
YSM AHALA	M	3	3	2	1	9
	F	1	1	–	–	2
CMS SIMBOK	M	2	–	2	1	4
	F	7	–	4	–	11
TOTAL	M	10	3	5	5	23
	F	14 (24)	6(9)	9(14)	2(7)	31(54)
PERCENTAGE		45%	17%	26%	13%	

These 54 children from 4 villages in the Mvolyé areas aged 9 –60 months.

They are among children in a village surviellance growth project who were underweight for age and were classed as mild-moderate malnutrition.

Clinical symptoms occured frequently, (Table 3). This confirmed the close inter-relation between recurrent infections, especially diarrhoea and survival of the malnourished child, (Scrimshaw et *al.* 1970 ; Chen. 1983 and Mora et *al.* 1981). Stool and blood samples were analysed in the beginning of the study and 61 % had either worms or malaria parasites. They were dewormed with mintezole and malaria parasitaemia treated with chloroquine.

Table 3 Percentage of children with different symptoms

Symptoms	Home Food (HF[1])	Feeding period (SP)	Home Food (HF[2])
Parasites [1]	61 %		–
Diarrhoea	31.7 %	30.6 %	25.56%
Fever	49.7 %	45.7 %	45.0 %
Cough	27.7 %	21.4 %	20.4 %
Vomiting	0.56%	0.56%	0 %
Abdominal Pains	5.66%	3.12%	0 %

1 Children were dewormed with mintezole and malaria parasitaemia treated with cloroquine.

NUTRITIONAL STATUS

Table 4a – b shows the mean weights recorded during each period and the changes. Figure 1 shows that the rate of increase in weight were higher during supplementation period and dropped during the second home diet period. Mittal et *al.* (1980), Gopalan et *al.* (1981), Alvarez et *al.* (1982) and Beaudry et *al.* (1973) have reported similar increases in physical growth of preschool children at risk of malnutrition on calories/and or protein supplementation. Although the rates seem to be higher with YSM than CSM, the differences were not significant – Table 4c.

Table 4 (a) Mean weights of children at the end of different periods of the study and feeding groups

Study Periods	Y S M	n	n	C S M	P*
Beginning	11.47 ± 0,98	(29)	(25)	11.96 ± 1.43	NS
After 2 weeks observation on Home Diet	11.48 ± 1.22	"	"	11.92 ± 1.26	"
2 weeks on exp. diet	11.80 ± 1.21	"	"	12.09 ± 1.34	"
2 weeks on home diet	11.69 ± 1.15	"	"	12.15 ± 1.27	"

P* Probability value in the two tailed T – Test.

Table 4 (b) Mean change in weight per study period and feeding groups

study Periods	YSM Group	CSM Group
2 weeks on Home Food (HF)	0.01	– 0.02
2 weeks on Exp. Diet (SP)	0.32	0.17
2 weeks on Home Food (HF)	–0.11	0.06

Table 4 (c) Mean weight gained at different periods of feeding in Kg

Feeding Periods		YSM Age 9–23 (14)	24–35 (6)	36–47 (5)	48–60 (5)	CSM 9–23 (10)	24–35 (3)	36–47 (9)	48–60 (2)
2 weeks on Home Food	HF	0.03	0.08	–0.07	–0.02	–0.08	0.01	–0.02	–0
2 weeks on supplementary diets	SF	0.23	0.27	0.32	0.35	0.09	0.17	0.14	0.3
2 weeks on Home Food	HF	–0.10	–0.13	–0.16	–0.03	–0.15	0.13	0.14	–0

YSM/CSM not significant NS.

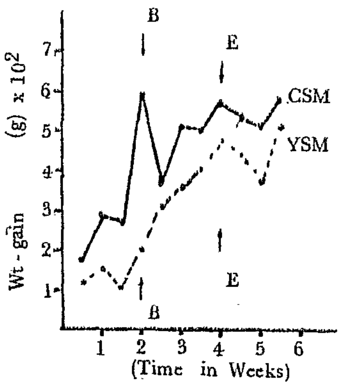

Fig. 1 Cummulative weight gain during study period
B Beginning of feeding
E End of feeding

During the study period the skinfold thickness increased by about 2.5mm in all age groups in both groups of children but the difference between on period and the other was not significant (Table 5a). Very little change was observed in mid-arm circumference and lengths tables 5b – c respectively. This may be because the observation periods were short and disease symptom rates, diarrhoea, fever and cough were high.

Table 5 (a) Mean skinfold thickness of children at the *different periods of the study*

Periods of study	Group YSM (n = 29)	(CSM (n = 25)	P*
2 weeks on Home Food	6.95 ± 065.mm	5.72 ± 0.85 mm	NS
2 weeks on exp. Food	7.39 ± 1.53	6.12 ± 2.1	NS
2 weeks on Home Food	7.38 ± 1.45	6.77 ± 2.19	NS

Table 5 (b) Mean circumference at the end of different periods of the study

Period of study	Groups YSM n (29)	CSM n (25)	P*
2 weeks on Home Food	14.13 ± 0.98 cm	13.79 ± 1.4	NS
2 weeks on exp. Food.	13.59 ± 1.53	13.59 ± 1.53	NS
2 weeks on Home Food	14.09 ± 0.96	13.53 ± 0.68	NS

Table 5 (c) Mean weight of children at the end of different periods of the study

Periods of study	Groups YSM (n – 29)	CSM (n – 25)	P*
2 weeks on Home Food	82.8 ± 5.6 gm	86.23 ± 4.03gm	NS
2 weeks on Exp. Food	84.9 ± 3.92gm	86.65 ± 4.01gm	NS
2 weeks on Home Food	85.01 ± 3.73gm	86.66 ± 3.93gm	NS

P* Probability value in the two tailed T – Test.

Tables 6a – c shows the types and degree of malnutrition using Waterlow's (1973) classification of height for age (chronic PCM) weight for height (acute PCM) and Gomez classification of weight for age (underweight).

Table 6 (a) Distribution of children according to type and degree of malnutrition

Period of study			Normal 95 % n	%	1ST Degree 90 – 95 % n	%	2ND Degree 85 – 89 % n	%	3 RD Degree 85 % n	%
Home Food	(H/F)[1]	A	3	10.34	13	44.83	11	37.93	2	6.90
		B	7	28.00	10	40.00	5	20.0	3	12.0
Supplementary Diet	(SUPP)	A	4	13.79	15	51.72	10	34.48	–	–
		B	8	32.0	9	36.0	5	20.0	3	12.0
Home Food	(H/F)[2]	A	4	13.79	13	44.83	12	41.38	–	–
		B	6	24.00	11	44.00	5	20.0	3	12

Type of malnutrition : Chronic PCM (HT/AGE) Waterlow

Total A = 29) 54 B = 25)

A = YSM : B = CSM : N = Number of children

Chronic PCM according to NAS (90%)

= H/F[1] –A – 44.83 %
B – 22.0 %

= SUPP - A – 34.48 %
B – 22.0 %

= H/F[2] –A – 41.38 %
B – 22.0 %

Table 6 (b) Distribution of children according to type of degree of malnutrition

Period of study			Type of malnutrition Acute PCM (WT/HT)						Waterlow
			Normal 90 %		1ST Degree 80 – 90 %		2ND Degree 70 – 79 %		3RD Degree 70 %
			n	%	n	%	n	%	n	%
Home Food	H/F[1]	A	19	65.52	10	34.48	–	–	–	–
		B	18	72.0	5	20.0	2	8.0	–	–
Supplementation	(SUPP)	A	20	68.97	9	31.03	–	–	–	–
		B	21	84.0	4	16.0	–	–	–	–
Home Food	(H/F)[2]	A	19	65.52	10	34.48	–	–	–	–
		B	19	76.0	5	20.0	1	4.0	–	–

Total A =29)
) 54
B =25)

n = Number of children
A = YSM
B = CSM

Acute PCM according to NAS (80%) H/F[1] a = 0 %
b = 8 %
SUPP. a = 0 %
b = 0 %
H/F[2] a = 0 %
b = 4 %

Table 6 (c) Distribution of children according to type and degree of malnutrition

Period of study			Type of malnutrition. Underweight (WT/AGE) Gomez							
			Normal 90 %		1ST Degree 75 – 89 %		2ND Degree 60 – 74 %		3RD Degree 60 %	
			n	%	n	%	n	%	n	%
Home Food	(H/F)[1]	A	1	3.45	16	55.17	12	41.38	–	–
		B	6	24.0	10	40.00	8	32.0	1	4.0
Supplementation	(SUPP)	A	3	10.34	20	68.97	6	20.69	–	–
		B	6	24.0	11	44.0	7	28.0	1	4.0
Home Food	(H/F)[2]	A	3	10.34	17	58.62	9	31.04	–	–
		B	6	24.50	12	48.0	6	24.0	1	4.0

Total A 29)
54)
B 25)

n – Number of children
A – YSM
B – CSM

Under weight according to NAS (80 % WT/AGE) = H/F[1] a – 41.38 %
b – 32.0 %
SUPP a – 24.1 %
b – 36.0 %
H/F[2] a – 31.0 %
b – 24.0 %

According to this classification, 1st and 2nd degree PCM were most common. Chronic PCM, 44.83 % in YSM and 40 % CSM had 1st degree. 37.93 % in YSM and 20 % CSM had 2nd degree while 6.90 % YSM and 12 % CSM had 3rd degree at the end of the first phase. After the end of supplementation phase, for YSM 3rd degree reduced to zero. No change for CSM. More children moved up to normal on 1st degree on YSM than CSM, (Table 6a figure 2). Using acute PCM, 34.48 % YSM and 20 % CSM were classified as 1st degree. There were no 2nd degree YSM but 8 % CSM. After supplementation the incidence of 2nd degree PCM reduced to zero percent on both diets (Table 6b figure 2). In table 6c figure 2, underweight for age improved from 55.17 % to 68.97 % YSM, 40 % to 44 % CSM for 1st degree, 41.38 % to 20.69 % YSM and 32 % to 28 % CSM for 2nd degree from end of first phase to end of supplementary phase.

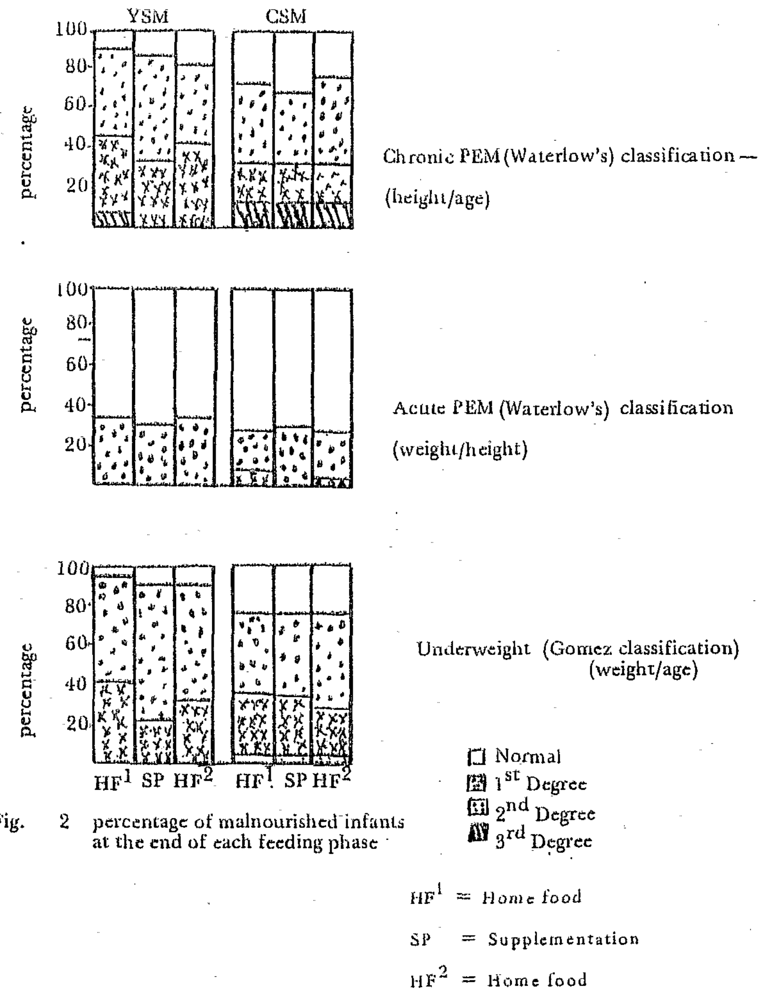

Fig. 2 percentage of malnourished infants at the end of each feeding phase

These findings show that 1st degree malnutrition were most common in these villages. This confirms the UNICEF 1984 report that in most 3rd World countries about 25 % of the children suffer from invisible malnutrition without clinical signs. This situation makes prevention difficult and increases the incidence of underweight children who are at risk of dropping to 2nd and 3rd degree malnutrition with the slightest change of condition. The situation, however, improved during supplementation even though there were negative factors like infectious diseases, poor sanitation, other environmental effects, and abrupt weaning with improper supplementation, interacting and interferring with recuperation from malnutrition. This confirms the need for low cost protein mixtures to increase food availability.

We also decided to present the date in two age groups 9 – 35 months and 36 – 60 months using the method described by Mcgill *et al.* (1978) and Hebert et *al.* (1983). This technique allows for simultaneous comparison of subgroups of children from a particular survey or study with international standards and with other subgroups within the study. Notice the stricking difference between the two age groups on both diets (figure 3). The variability and proportion of negative factors seem to have had a greater effect on all age groups on CSM. diets. The group mean did not change for CSM (9–35 months old) went down in 36 – 59 months but moved up for all age YSM. The negative factors and variability may be infectious diseases. The inter-relationship between malnutrition and infection has been reported by several authors (Mata 1972, Welsh 1979, Rowland 1977 and Chen 1982).

A horizontal line on the graph at 95 %, 90 % and 80 % of reference median indicate cut off points. The region between the lines correspond to mild and moderate PCM.

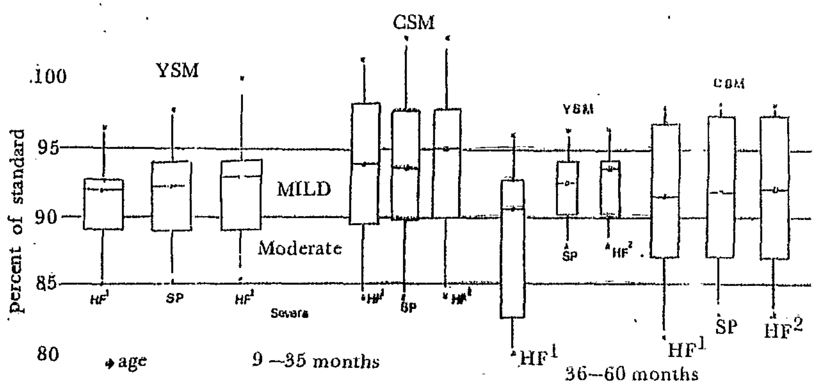

Fig 3
Ht-for-age

HF¹	Home Food
SP	Supplementary
HF²	Home Food

- * extreme (highest or lowest) value
- means at end of first period on Home food
- o means at end of supplementation
- o means at end of second period on Home food
- — end of upper tail 95th percentile
- — end of lower tail 5th percentile
- — uper limit of box 75th percentile
- — lower limit of box 25th percentile
- — width of box square root of number 8 cases

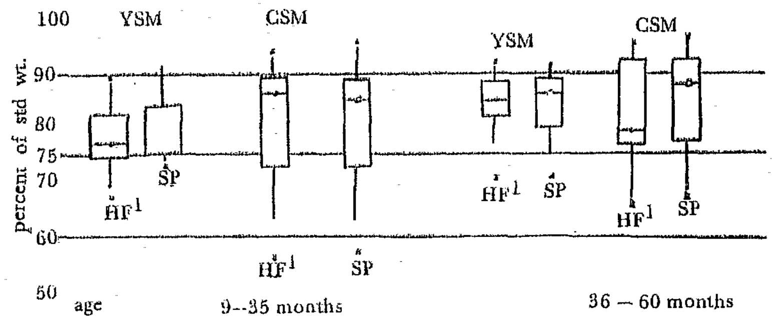

Fig. 4

Wt—for—age

H/F¹	Home food
SP	Supplementary

- * extreme (highest or lowest) value
- . means at end of firt period on home food
- o means at end of supplementation
- o means at end of second period on Home food
- — end of upper tail 95th percentile
- — end of lower tail 5th percentile
- — upper limit of box 75th percentile
- — lower limit of box 25th percentile
- — width of box square root of number 8 cases

line drawn at 90% std. «wt cutoff for mild PCM
line drawn " 75% " " " " moderate PCM
line " " 60% " " " " severe PCM

CONCLUSION

YSM was better accepted as porridge by the younger children and as foofoo by the older children. No significant difference was observed between YSM and CSM on the rate of growth nor acceptability and tolerance. CSM has been widely distributed as a protein enriched cereal. From this very small preliminary study the flour *D. dumetorum* seems to have very high potentials for developing appropriate weaning foods considering the importance laid on this subject by WHO (1984). This study will be continued in a large and better controlled samples in order to develop for Cameroon enriched forms of a locally grown tuber.

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