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Effect of feeding quality protein maize (QPM) on growth of young children (1-3 years)

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ABSTRACT

Good quality proteins in the diets is one of the most important requirements for proper growth of young children. Maize is the main source of nutrition for millions of people in the developing countries. The conventional variety of maize is deficient in lysine and tryptophan. The cereal is also imbalanced in the leucine -isoleucine ratio. The genetically modified crop called Quality Protein Maize (QPM) is known to be nutritionally much superior. This study was undertaken to find out the effect of feeding QPM on growth of 1-3 year old children. Eighty children from a low socio-economic community in Ghaziabad, Uttar Pradesh, India were grouped into four, each group comprising 20 children. General profile, and anthropometric measurements were recorded, following which each group was fed a different diet *viz.,* QPM diet, conventional(normal) maize diet, milk diet and control (home) diet for a period of 180 days. All four were isoprotein and isocaloric diets. At intervals of fortnight, the anthropometric measurements were taken until the completion of feeding experiment. The QPM fed group performed best in all measurements *viz.,* weight, height, head circumference, chest circumference and arm circumference. Substitution of conventional maize with QPM is therefore recommended for combating protein malnutrition and poor growth, particularly among young children of low socio-economic groups subsisting on maize.

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Key Words : Maize, Protein, QPM, Feeding, Growth, Children

INTRODUCTION

Protein energy malnutrition is an important nutritional problem in India. Animal protein is expensive. The main source of energy is cereal crops and by far is also the major source of proteins. Unfortunately, these have poor nutritional value for humans with respect to amount of amino acids that are required for human growth. Out of 22 amino acids commonly occurring in food proteins, eight are essential for human growth and these have to be provided by dietary proteins.

Cereal proteins contain on an average about 2 per cent lysine, which is less than half of the concentration recommended for human nutrition by the FAO (1985) .One such crop is maize with its high content of carbohydrate, along with traces of lipids, protein, vitamins and minerals. Maize serves as the main source of nutrition for the millions of people in developing countries, accounting approximately 15 to 56 per cent of the total daily calorie intake (Prasanna *et al.,* 2001). From the human nutrition point lysine is the most important limiting amino acid in the maize endosperm protein, followed by tryptophan (Bressani *et al.*, 1975).The deficiency of lysine and tryptophan and excess of leucine, *i.e.* imbalanced leucine isoleucine ratio causes pellagra which occurs in endemic form among population groups subsisting on maize.

The need to genetically ameliorate the poor nutritional value of cereal grain maize has been recognized for a long time. In 1960 a variety of maize called opaque-2 was discovered to have twice the normal levels of lysine equivalent to that of skimmed milk, but in field trials the new grain proved to have disappointed yield and storage qualities. This maize was revised in the mid nineties and Quality Protein Maize (QPM) was developed via conventional breeding methods. This new variety has high protein content, high yields and attractive storage qualities (McPherson, 2000).

The maize kernel includes pericarp (6%), endosperm rich in starch (82%) and germ (12%).Bulk of the protein in a mature maize kernel is in the endosperm and germ, but the germ protein is superior in both lysine and tryptophan. Graham *et al.*(1989) stated that to anyone familiar with the nutritional problems of weaned infants and small children in the developing countries ,and with

the fact that millions of them depend on maize for most of their dietary energy, nitrogen and essential amino acids, the potential advantages of quality protein maize are enormous.Nutritionally superior QPM strain was developed after a long research of 30 years by maize breeders of "Simmyte", now called CIMMYT.The present investigation was undertaken to find out the role of QPM in combating protein malnutrition in children, with the specific objectives:

To find out the energy and protein content in selected recipes of QPM. (2) To find out the effect of feeding the QPM recipes -on growth of young children (1-3 yrs) .

MATERIALS AND METHODS

The host institution for this research was Institute of Home Economics, Agra. The work was done during the years 2008-10.This research comprised six main components: (1) preparation of four recipes each from QPM and conventional maize; (2) protein and energy estimation of the 8 recipes; (3) general profile survey of young children (1-3yrs); (4) experimental feeding of the children; (5) diet survey at two month intervals and (6) anthropometric survey fortnightly.

Preparation of recipes (products):

The required quantities of QPM and conventional maize(NM)were obtained from IARI, Pusa, New Delhi. Skimmed milk powder was purchased from Ganapati Trading Co., Ghaziabad, U.P. The QPM and conventional maize were processed to obtain maize flour and maize daliya (broken maize). Two products *viz.,* laddoo and parata were prepared from flour and two products *viz.,* sweet daliya and daliya pulao from the broken maize. Flow chart shows the procedure used for preparing the products.

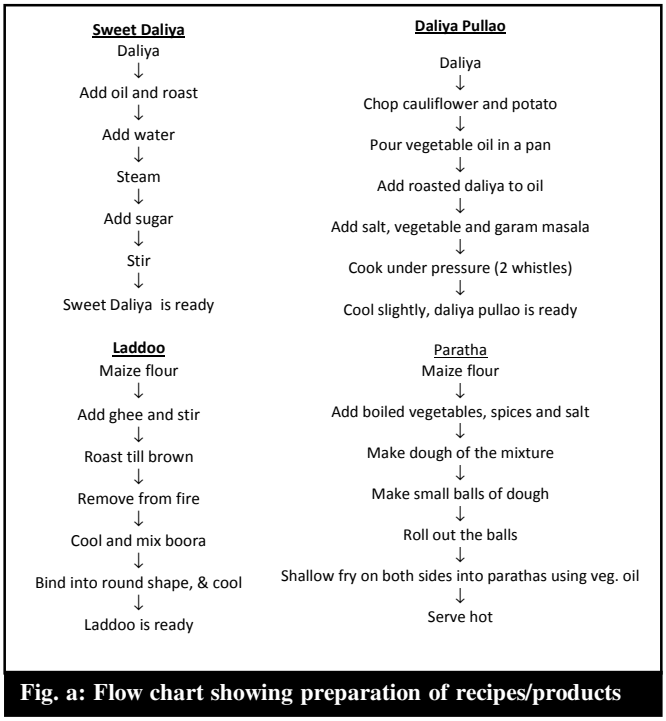

Fig. a: Flow chart showing preparation of recipes/products

Protein and energy estimation of products:

The eight recipes, four of flour and four of broken maize, were analyzed for their protein and energy composition by standard methods ie. Kjeldahl method and Bomb Calorimeter, respectively (AOAC, 1965; ISI, 1978).This was done at the Gumming Research Laboratory, Pusa and at Arbro Testing Laboratory, New Delhi.

General profile survey of subjects:

Data on general information including age, sex, family particulars etc. of the subjects were collected by interviewing the mothers prior to the implementation of feeding experiments.

Experimental feeding:

For this aspect of the study, 80 children of 1-3 years age were selected randomly from two residential colonies of Ghaziabad, U.P. These colonies were authorized by the Municipality and the residents were of the low socio-economic category. A clinical examination of the children was conducted by a medical doctor, following which the children were grouped into three experimental and one control group, each consisting of 20 children. On the recommendation of the doctor the subjects were given a prescribed dose of albendazol for worm treatment, after which the feeding experiment started. The three experimental groups were named as: (1) QPM, (2) Normal maize (NM), and (3) Skimmed milk group, .based on the diets they were provided. The fourth group which was not given any diet by the investigators but continued on home diets formed the control group. Each subject in the experimental groups was served a weighed quantity of cycle menu of sweet daliya, daliya pulao, laddoo and paratha in addition to the home diets for a period of 180 days. Diets of all the experimental groups had iso-protein and iso-caloric levels. The quantity left over in each subject's plate was weighed and deducted from the quantity served and thus the actual consumption was computed,

Diet survey:

In order to find out the protein and energy consumed by the subjects from their home diets ,a dietary survey was carried out by the 24-hour recall method as per

standard procedure (Swminathan,2002).This was done for three consecutive days initially and thereafter at two months intervals .The respondents for this survey were the subject's mothers. The mothers were told to serve the prescribed quantity of home food to ensure isoprotein and isocaloric intake of all four groups.Protein and energy values were computed using the food composition tables of Gopalan *et al.* (2000). Average daily consumption from home diets was then computed and to this was added the average protein and energy values consumed per day from the experimental diets, in order to find out the average total daily consumption of each group of experimental diet subjects .The home diet average formed the consumption of control group.

Anthropometric measurements:

Height, weight, head circumference, chest circumference and arm circumference of the subjects were measured by the standard methods of Jeliffe (1962). This was done prior to the feeding and thereafter at intervals of fortnight till the completion of feeding experiment.

OBSERVATIONS AND ASSESSMENT

The results obtained from the present investigation as well as well as relevant discussion have been presented under following heads :

Protein and energy content of food products (Recipes):

The four recipes *viz.,* sweet daliya, daliya pulao, laddoo and paratha prepared from conventional maize and QPM had the energy (kcal) and protein contents as shown in Table 1. It can be noticed that QPM based recipes, in general, had much higher protein value than those based on conventional maize; the ranges being 2.73 g to 6.59 g and 1.95 g to 4.56 g, respectively per 100g. However the QPM products/recipes were comparable to the conventional maize recipes with respect to their energy value .The kcal derived from 100g of the products ranged

Table 1: Protein and energy contents of conventional maize and QPM recipes

Variety	Name of recipe	Energy Kcal/100g	Protein (gm/100g)
Conventional maize	Sweet 'Dalia'	402 (987)	4.56 (11.17)
	'Dalia' Pulav	452 (700)	2.82 (4.37)
	Laddoo	510 (622)	1.95 (2.37)
	Paratha	426 (791)	2.43 (4.51)
QPM	Sweet 'Dalia'	376 (959)	6.59 (16.81)
	'Dalia' Pulav	468 (698)	3.53 (5.27)
	Laddoo	585 (732)	2.73 (3.41)
	Paratha	422 (896)	5.54 (11.76)

Figure in parenthesis represent content on dry basis
Mean of duplicate analysis

Table 2 : Socio-economic characteristics of subjects' families

Parameters	Range	Group-wise distribution of subjects							
		QPM		N.M.		Milk		Control	
		N	%	N	%	N	%	N	%
Income per month (Rs.)	500-1000	6	30	5	25	0	0	4	20
	1001-1500	0	0	8	40	2	10	0	0
	1501-2000	6	30	2	10	9	45	4	20
	2001-2500	6	30	3	15	2	1	8	40
	2501-3000	2	10	2	10	7	35	4	20
Mean		1700		1475		2100		1950	
S.D.		687		642		527		678	
No. of family members	2-5	5	25	6	30	3	15	4	20
	6-8	13	65	14	70	15	75	16	80
	9-11	2	10	0	0	2	10	0	0
Mean		7		6		7		6	
S.D.		1.716		1.374		1.491		1.2	
Family expenditure on food P.M. (Rs.)	500-1000	6	30	5	25	0	0	4	20
	1001-1500	1	5	10	50	7	35	0	0
	1501-2000	7	35	4	20	7	35	13	65
	2001-2500	6	30	1	5	6	30	3	15
Mean		1575		1275		1725		1625	
S.D.		586		402		402		471	

between 376 to 585 in the former and 402 to 510 in the latter. The higher nutritive value, protein in particular, of the QPM can be seen to have reflected as higher / better anthropometric measurements of the subjects (Table 4).

General profile of subjects:

According to the data (Table 2) obtained by interviewing the mothers, the study subjects were in the age group of 12 to 30 months. Females formed 48.8 per cent and males 51.2 per cent. Monthly income of the families to which the subjects belonged, ranged between Rs. 500/- and 3000/- whereas the mean of family income of the four groups *viz.,* QPM, conventional maize, milk and control ranged between Rs. 1475 to 2100. The mean family size (when rounded off) came to be 6 to 7. Majority of the families had only one earning member and the expenditure on food, per month, showed a mean of about Rs. 1275 to 1725 in the four groups. One can very well understand that this low amount of money which is available for food in a large family can not take care of the recommended dietary intakes of small children; hence, the children's nutritional status is of great concern today. QPM can be of great benefit to solve the problem, without affecting the total food expenditure of the family. Table 2 summarizes the findings about the socio-economic factors studied.

Protein and energy intakes before and during feeding experiment:

Table 3 depicts the quantity of protein and energy consumed by the experimental and control groups just before starting the experiment and during the feeding experiment at 2 months intervals. Since, it was planned to

Table 3: Protein and energy intakes of different groups before and during feeding experiment

Stages	Group-wise protein intakes (g)							
	QPM		NM		Milk		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Protein:								
Initial	23.51	1.02	23.83	1.89	20.47	1.03	23.82	0.53
2 months	24.87	1.33	25.34	1.16	25.68	0.87	24.22	0.82
4 months	24.67	1.11	25.54	1.12	25.75	0.94	24.44	1.05
6 months	25.05	1.07	25.68	1.11	25.90	0.82	24.66	1.17
Energy:								
	Group-wise energy (Kcl) intakes							
Initial	953	29.46	980	27.41	985	68.89	966	22.63
2 months	1263	2166	1248	5.58	1247	9.12	1243	4.11
4 months	1260.7	19.13	1248	6.11	1248	7.69	1244	4.56
6 months	1256	14.61	1250	5.68	1249	7.29	1245	5.77

Table 4: Mean initial, final and difference of anthropometric measurements and control groups

Parameters	Group-wise measurement				
	Stages	QPM	NM	Milk	Control
Weight (Kg)	Initial	8	8.53	8.47	7.73
	Final	11.32	10.19	10.97	9.3
	Difference	3.32	1.66	2.50	1.57
Height	Initial	77.77	80	76.19	79.07
	Final	84.44	83.58	82.64	82.97
	Difference	6.67	3.58	6.45	3.9
Head circumference (cm)	Initial	44.73	44.83	42.11	44.44
	Final	48.64	47.17	44.81	46.59
	Difference	3.91	2.34	2.70	2.15
Chest circumference (cm)	Initial	46.37	43.75	45.45	48.71
	Final	49.51	45.38	47.60	49.58
	Difference	3.14	1.63	2.15	0.87
Arm circumference (cm)	Initial	14.11	13.16	14.29	13.64
	Final	15.77	14.22	15.68	14.70
	Difference	1.66	1.06	1.39	1.06

keep all the groups on isocaloric and isoprotein intakes, it can be seen that the quantities listed under consumed quantities were almost similar. It was the effect of quality of the diet and this study aimed to find out, and not the quality. Prior to the starting of the experiment, the children in the four groups were consuming about 21 to 24 g protein and 950 to 980 kcal. which gradually increased to about 25 g and 1250 kcal, respectively during the period of experimental feeding. These values do not represent all what was served, but are the actual intakes from consumed diets. *i.e.* after deducting the left over in the plates; hence there was some variation in the intakes .The consumed quantities met the ICMR(2001) recommended dietary allowances(RDA) of 22g protein and 1240 kcal energy, although the quality varied in the four feeding groups.

Anthropometric status:

It is very well established that anthropometric measurements are reflections of nutritional intakes, particularly protein and energy. In the young children body weight, height, chest circumference, arm circumference and head circumference are important measurements. Further, it is also well recognized that both quality and quantity of protein exert influence.

Table 4 has the average data of the study–subjects, pertaining to these measurements prior to the feeding experiment and at the completion of the experiment after 6-month feeding. The fortnightly gains in each feeding group are depicted in Fig. 2 to 6. It can be noticed that the QPM group performed best in all anthropometric parameters, exceeding even the milk -fed group. On the whole the control group measurements were far lower. Thus, it can be stated that QPM can promote good growth in young children, due to its very superior quality of protein.

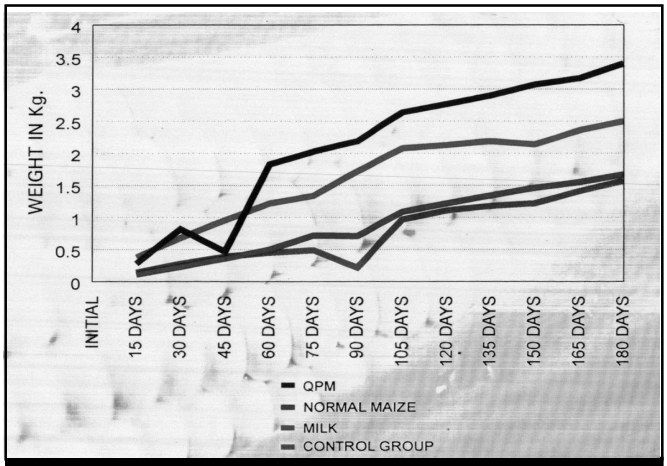

Fig. 2: Comparative gains in weight

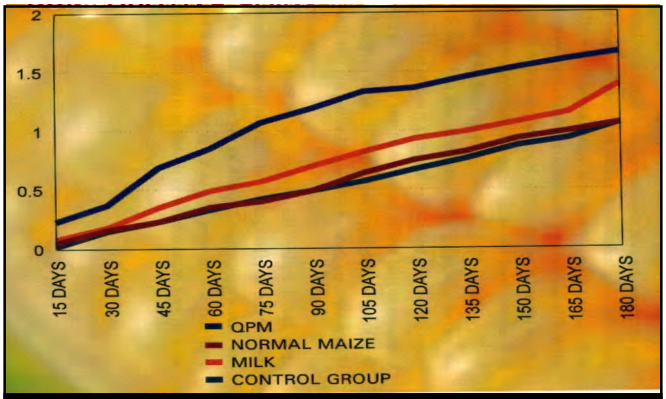

Fig. 3: Comparative gains in arm circumference

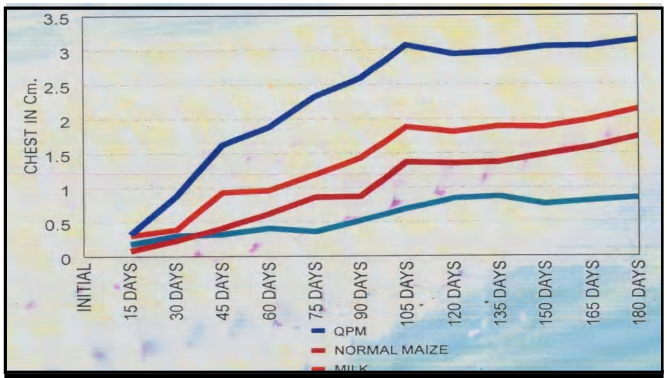

Fig. 4: Comparative gains in chest circumference

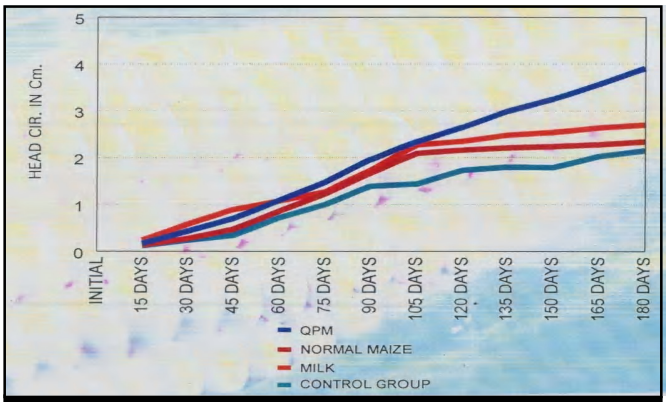

Fig. 5: Comparative gains in head circumference

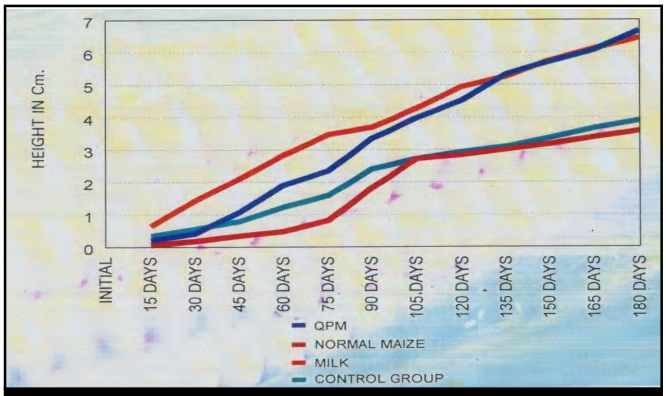

Fig. 6: Comparative gains in height

Conclusion:

Inclusion of QPM as a substitute of conventional maize in the diets of young children ,particularly in the low socioeconomic groups, can be highly beneficial in combating PEM, thus meeting the growth standards.

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