Contribution of cowpea (*Vigna unguiculata*) in a mixed diet to the nutrient intake of rural children in Ibadan

BY I. O. AKINYELE AND A. AKINLOSOTU

Department of Human Nutrition, University of Ibadan, Ibadan, Nigeria

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1. Sixty-four subjects from the rural areas of Ibadan participated in a study to determine the contribution of cowpea (*Vigna unguiculata*) foods to the total intake of nutrients in a mixed diet. The subjects were randomly selected from those who, according to their mothers, reacted to cowpea foods (reactors) and those who did not (non-reactors).

2. The results showed that for all subjects, protein, energy and riboflavin needs were not met from the total diet consumed. However, the requirements for vitamin A, thiamin and iron were met.

3. Between 30 months and 3 years of age, cowpeas contributed 36·2 and 30·3% of protein intake for non-reactors and reactors respectively. Corresponding values for energy intake were 17·3 and 17·2% respectively. Lower percentages were contributed by the diets of 4- to 6-year-olds.

4. Irrespective of the classification system used, some of the subjects were found to be suffering from mild to moderate malnutrition, with a few severe cases.

Cowpea (*Vigna unguiculata*) is an important crop which plays a significant role in the diets of Nigerians. It serves as the major source of protein in the absence of sufficient animal protein for the population. The nutritional value of cowpeas thus lies in its protein content which is nearly double that of cereals (Food and Agriculture Organization, 1970). Cowpeas are consumed either alone, or in combination with cereals to enhance the protein value. Such combinations may be too bulky to meet the energy and protein needs of young children.

It has been reported (Dovlo *et al.* 1976) that many mothers are reluctant to feed cowpea diets to their children following weaning because of adverse side effects attributed to the legume. These problems, claimed by mothers, vary from flatulence to the incidence of diarrhoea. While there is no clear-cut documentation of the extent of the problem, the importance of cowpeas in meeting the nutritional needs of young children needs to be recognized. Infants are fed on breast milk from birth which, if taken in sufficient quantities, will supply sufficient nutrients for adequate growth within the first 4–6 months of life (Belavady, 1980). After 6 months, breast milk alone becomes inadequate and supplementary foods are introduced. In Nigeria, cowpeas are the main protein source used in local supplements for weaning by those in the low-income group. The adequacy or otherwise of the cowpea-based diets to meet part or all of the requirements of infants and children has not been determined. This becomes of great importance when one considers the problems which some mothers claim are associated with the consumption of these diets containing cowpea foods.

The present study was carried out to provide information on the contribution of cowpeas to the nutrient intake of the children and determine whether differences exist between those who, according to their mothers, react after the consumption of diets containing cowpea foods and those who do not.

METHODS AND MATERIALS

Study area and subjects

Sixty-four apparently healthy children of poor socio-economic status, living in Osegere and surrounding villages, situated 30–40 km from Ibadan city, participated in the study. The subjects were divided into two groups of thirty-two children each. Group 1 children were the control or non-reactors who, according to their mothers, did not complain of any adverse effects after the consumption of cowpeas, while group 2 children were the reactors who suffered adverse effects after the consumption of cowpeas. The number of subjects used in the study was limited due mainly to the number of reactors within the population initially interviewed as well as logistic problems of handling the detailed survey within the time-period.

The children ranged in age from 30 months to 6 years, were free from any visible disease and residing with their families in the villages. The subjects were randomly selected from a population of 300 families interviewed in that locality. A 3 d food consumption study was carried out using the weighing method (Olusanya, 1977) in which the food consumed by each child was weighed and recorded. The children were served individually at meal times and all the snacks consumed were also weighed and recorded.

Foods consumed by all the children at home included agidi (*Zea mays*) with melon (*Cucureroposis edulis*) soup or okro (*Hibiscus esculentus*) soup, rice (*Oryza sativa*) with meat stew, amala (*Dioscorea* spp.) with melon soup or ewedu (*Cochorus olitorius*) or apon (*Crysophyllum delevolvi*), gari (*Manihot utilisima*) with sugar, cooked maize, bread with tea, eba (*Manihot utilisima*) with melon soup, pounded yam (*Dioscorea spp.*) with vegetable soup, cooked yam with red palm (*Elaeis guineansis*) oil and yam pottage, in addition to consuming various cowpea products such as akara, moinmoin, gbegiri soup, cooked beans with pepper sauce and mashed beans.

Anthropometric measurements

Anthropometric measurements of height, weight, arm circumference and triceps skinfold thickness were carried out according to the methods described by Jelliffe (1966).

Intakes of protein, energy, iron, vitamin A, thiamin and riboflavin from all meals were calculated using food composition tables (Food and Agriculture Organization, 1968). The intakes of these nutrients from diets containing cowpea foods were again separately calculated. The calculated intakes were then compared with recommended dietary allowances (RDA) (National Academy of Sciences/National Research Council, 1980) which are values expected to cover the needs of most of the population. The anthropometric measurements were used to classify the children into normal or malnourished groups using weight-for-height, height-for-age (Waterlow, 1973) and weight-for-age (Gomez *et al.* 1956).

Statistical analysis

Mean and standard deviations were calculated, and tests of significance between means were carried out using Student's *t* test.

Ethical considerations

Since the experiment was based on foods normally consumed by the children in the home environment, the study was approved by the ethical committee of the University of Ibadan.

RESULTS

The daily nutrient intakes of the subjects are presented in Tables 1–4. Anthropometric measurements and classifications of nutritional status are presented in Tables 5–7.

The results indicate that there were no significant differences ($P > 0.05$) in the intakes of protein, energy, vitamin A, thiamin and riboflavin among reactors and non-reactors between 30 months and 3 years of age. Though nutrient intakes were not significantly different, the reactors always had lower intakes. However, the intakes for Fe were significantly ($P <$

Table 1. *Daily nutrient intakes of children, age 30 months to 3 years, from Ibadan with no reaction to cowpeas* (Vigna unguiculata) (*control*)

(Mean values and standard deviations for twenty-three children)

	Protein (g)	Energy kJ	Energy kcal	Iron (mg)	Vitamin A* (μg)	Thiamin (mg)	Riboflavin (mg)
Recommended dietary allowance (RDA)†	23	5712	1360	10	250	0·5	0·8
Daily intake:							
Mean	17·98	3984·1	948·6	11·35	3903·9	0·7	0·35
SD	4·1	382·2	291	3·1	3899·4	0·3	0·12
Percentage of RDA met by daily intake	78·2	69·5	69·5	113·5	1561·6	140	43·8
Daily intake from cowpea foods:							
Mean	6·5	687·1	163·6	2·24	1473·7	0·24	0·06
SD	3·3	337·3	80·3	1·1	1024·8	0·15	0·03
Percentage of daily intake contributed by cowpeas	36·2	17·3	17·3	19·7	37·7	34·3	17·1
Percentage of RDA met by cowpeas	28·3	12·0	12·0	22·4	589·5	48	7·5

* Uncorrected values for retinol.
† National Academy of Sciences/National Research Council (1980).

Table 2. *Daily nutrient intakes of children, age 30 months to 3 years, from Ibadan with reaction to cowpeas* (Vigna unguiculata) (*reactors*)

(Mean values and standard deviations for twenty-four children)

	Protein (g)	Energy kJ	Energy kcal	Iron (mg)	Vitamin A* (μg)	Thiamin (mg)	Riboflavin (mg)
Recommended dietary allowance (RDA)†	23	5712	1360	10	250	0·5	0·8
Daily intake:							
Mean	19·3	3571·7	850·4	9·20	2829·9	0·56	0·32
SD	7·9	1087·8	259	3·1	1899	0·21	0·13
Percentage of RDA met by daily intake	83·9	62·5	62·5	92	1131·6	112	40
Daily intake from cowpea foods:							
Mean	5·85	614·9	146·4	2·0	1233·3	0·23	0·04
SD	4·4	495·6	118	1·5	1598	0·16	0·09
Percentage of daily intake contributed by cowpeas	30·3	17·2	17·2	22·2	43·6	41·1	21·9
Percentage of RDA met by cowpeas	25·4	12·8	10·8	20·4	493·3	46	8·8

* Uncorrected values for retinol.
† National Academy of Sciences/National Research Council (1980).

Table 3. *Daily nutrient intakes of 4–6-year-old children from Ibadan with no reaction to cowpeas* (Vigna unguiculata) (*control*)

(Mean values and standard deviations for nine children)

	Protein (g)	Energy kJ	Energy kcal	Iron (mg)	Vitamin A* (μg)	Thiamin (mg)	Riboflavin (mg)
Recommended dietary allowance (RDA)†	29	7686	1830	10	300	0·7	1·1
Daily intake:							
Mean	18·5	4676·7	1113·5	14·6	5676·6	0·71	0·53
SD	4·9	1776·6	423	5·3	4339·7	0·2	0·24
Percentage of RDA met by daily intake	63·8	62·2	62·2	146	1892·2	101·4	48·2
Daily intake from cowpea foods:							
Mean	4·8	443·5	105·6	1·7	738·9	0·15	0·05
SD	3·5	265·4	63·2	1·2	358·7	0·11	0·03
Percentage of daily intake contributed by cowpeas	25·9	9·3	9·3	11·6	13·0	21·1	9·4
Percentage of RDA met by cowpeas	16·6	5·8	5·8	17	246·3	21·4	4·5

* Uncorrected values for retinol.
† National Academy of Sciences/National Research Council (1980).

Table 4. *Daily nutrient intakes of 4–6-year-old children from Ibadan with reaction to cowpeas* (Vigna unguiculata) (*reactors*)

(Mean values and standard deviations for eight children)

	Protein (g)	Energy kJ	Energy kcal	Iron (mg)	Vitamin A* (μg)	Thiamin (mg)	Riboflavin (mg)
Recommended dietary allowance (RDA)†	29	7686	1830	10	300	0·7	1·1
Daily intake:							
Mean	17·9	4206	1001·4	13·1	2600·2	0·53	0·53
SD	5·2	1272·2	302·9	6·1	2082	0·15	0·14
Percentage of RDA met by daily intake	61·7	54·7	54·7	131	866·7	75·7	30·9
Daily intake from cowpea foods:							
Mean	4·71	441·0	105	1·69	698·3	0·15	0·04
SD	1·6	149·9	35·7	0·6	477		0·02
Percentage of daily intake contributed by cowpeas	26·3	10·5	10·5	12·9	26·9	28·3	11·8
Percentage of RDA met by cowpeas	16·2	5·73	5·73	16·9	232·8	21·4	3·6

* Uncorrected values for retinol.
† National Academy of Sciences/National Research Council (1980).

Table 5. *Height, weight, triceps skinfold thickness and arm circumference of rural children, in Ibadan*

(Mean values and standard deviations)

Age	Group *n*	Height (m) Mean	Height (m) SD	Weight (kg) Mean	Weight (kg) SD	Triceps skinfold thickness (mm) Mean	Triceps skinfold thickness (mm) SD	Arm circumference (mm) Mean	Arm circumference (mm) SD
30 months to 3 years									
Control	23	0·810	0·044	11·4	1·6	8·3	1·7	143	10
Reactor	24	0·828	0·096	11·1	2·6	8·1	1·7	143	15
4–6 years									
Control	9	1·003	0·078	15·9	2·2	7·9	1·9	156	14
Reactor	8	0·975	0·074	14·3	2·4	7·7	1·3	154	9

Table 6. *Nutritional status of rural children from Ibadan with no reaction to cowpeas* (Vigna unguiculata) (*controls*) *classified by weight, height and age*

Classification and age group	*n*	Protein–energy malnutrition: Absent *n*	Absent %	Mild *n*	Mild %	Moderate *n*	Moderate %	Severe *n*	Severe %
Weight-for-height									
30 months to 3 years	21	19	90·5	1	4·8	1	4·8	—	—
4–6 years	9	9	100	—		—		—	
Weight-for-age									
30 months to 3 years	21	12	57·1	7	33·3	2	9·5	—	—
4–6 years	9	5	55·5	4	44·5	—	—	—	—
Height-for-age									
30 months to 3 years	21	7	33·3	10	47·6	2	9·5	2	9·5
4–6 years	9	4	44·4	3	33·3	2	22·2	—	—

0·05) lower among reactors compared with non-reactors. A similar but non-significant difference was also observed for all nutrients when the nutrient intakes from cowpea foods were considered. Reactor children still had lower intakes of all nutrients studied (Tables 1 and 2).

The same pattern was observed among 4- to 6-year-olds where reactor children had a lower (though not significant) intake of energy, protein, riboflavin and thiamin, but significantly ($P < 0·05$) lower vitamin A and Fe intakes compared with the non-reactor controls (Table 3 and 4). The reactor children were also lighter and shorter than the non-reactors, and many more suffered from mild to moderate forms of malnutrition when compared with non-reactors (Tables 5–7).

These results also show that not all subjects could meet their protein and energy needs from the total diet consumed. The non-reactor control group of 3-year-olds and under were able to meet 78·2% of their protein needs and 69·5% of their energy needs while the corresponding values for children who reacted to cowpea diets were 83·9 and 62·5%. Cowpeas accounted for 36·2% of the protein intake for the control and 30·3% for the reactor group. Corresponding values for energy were 17·3 and 17·2% respectively. Dif-

Table 7. *Nutritional status of rural children from Ibadan with reaction to cowpeas* (Vigna unguiculata) (*reactors*) *classified by weight, height and age*

		Protein–energy malnutrition							
		Absent		Mild		Moderate		Severe	
Classification and age group	*n*	*n*	%	*n*	%	*n*	%	*n*	%
Weight-for-height									
30 months to 3 years	22	15	68·2	6	27·3	1	4·5	—	—
4–6 years	10	6	60	4	40	—	—	—	—
Weight-for-age									
30 months to 3 years	22	9	40·9	5	22·7	8	36·4	—	—
4–6 years	10	2	20	5	50	2	20	1	10
Height-for-age									
30 months to 3 years	22	8	36·4	6	27·3	4	18·2	4	18·2
4–6 years	10	2	30	4	40	2	20	1	10

ferences between intake and requirements were high, being significantly different in all cases ($P < 0{\cdot}01$).

The requirements for Fe and thiamin were adequately met by the control group, but, in contrast, the reactor group had an adequate thiamin intake but could only meet 92% of Fe requirements. Contributions from cowpeas only represented 19·7 and 22·2% of requirements for Fe, and 34·3 and 41·1% for thiamin for control and reactor groups respectively. Riboflavin intakes from all foods were 43·8 and 40% of RDA while the contributions from cowpeas were only 17·1 and 21·9% for control and reactor groups respectively. Vitamin A intake was adequate in this age group with cowpeas contributing 37·7% of RDA for the control and 43·6% for the reactor group (Tables 1 and 2).

The daily intakes of 4- to 6-year-olds were much lower than their requirements for protein and energy. In this group 63·8 and 61·7% of protein needs were met for control and reactor groups respectively with 25·9 and 26·3% being obtained from cowpeas. Energy intakes represented 62·2 and 54·7% of the daily requirements with 9·3 and 10·5% being attributable to cowpea diets.

Intakes for Fe were adequately met by both groups but riboflavin intakes were inadequate being only 48·2 and 30·9% of requirements respectively; contributions from cowpeas were minimal being 9·4 and 11·8% for the control and reactor groups respectively. Thiamin intakes were adequate for the control group but the reactor group had an intake of 75·7% of RDA. Cowpeas contributed similarly to thiamin intake being 28·3% in the reactor group and 21·1% in the control (Tables 3 and 4). In both groups, vitamin A intakes were adequate for all subjects with cowpeas contributing 13·0 and 26·9% for the control and reactor children respectively.

Classification into different degrees of malnutrition using weight-for-height, showed that the majority of the subjects were 'normal' while a small proportion of the population suffered from mild and moderate malnutrition. There were no cases of severe malnutrition. When weight-for-age was the classification used, many more of the subjects were classified as being malnourished with 10% of 4 to 6-year-old reactor children being severely malnourished. When height-for-age was the classification used, a number of those suffering from chronic severe malnutrition became evident (Tables 6 and 7).

DISCUSSION

The importance of adequate nutrition during infancy and childhood is evident since the early period in an individual's life encompasses rapid growth and development. As a result, it demands optimal intake of energy and essential nutrients (Spady, 1977). The adequacy of these intakes are assessed through dietary intake studies.

The present study showed that the types and quantities of foods consumed by the infants and children varied widely. This was reflected in the intakes of the nutrients studied. The quantities consumed were not sufficient to meet their requirements, especially for protein and energy. This was also reflected in the nutritional status classification of the subjects where some of the children were suffering from mild and moderate degrees of malnutrition. There were many more malnourished children amongst the reactors than amongst the non-reactors to cowpea foods. This is an indication that the reaction to cowpea foods had a detrimental effect on the utilization of nutrients for optimal well-being.

The diets of the children were mostly starchy roots and cereals with a small intake of legumes such as cowpeas. If intakes of existing foods are increased to satisfy energy requirements using cereal–legume-based diets, the protein requirement should be more than satisfied. It is thus essential that measures which would help achieve these objectives are followed. Intakes of cowpea-based foods should be increased along with cereals, with a corresponding reduction in the intake of starchy roots.

Seoane & Latham (1971) suggested three distinct categories or types of malnutrition, using weight and height measurements of children. This classification was discussed by Waterlow (1972, 1973) who suggested that acute malnutrition be termed wasting, chronic malnutrition be termed stunting and that the combined condition of acute and chronic be labelled wasting and stunting. In the present study, some of the subjects in all groups suffered from acute or chronic malnutrition with weight-for-age, height-for-age and weight-for-height all being low. There were also distinctions between the reactor and control groups in nutritional status. Reactor children were in all age-groups shorter in height and lighter in weight than the controls, with more reactors suffering from malnutrition irrespective of the system of classification used (Tables 5–7).

The functional significance of mild or moderate protein–energy malnutrition (PEM) is still unknown. Conflicting conclusions have been suggested by different studies reporting fatality rates according to nutritional status. Chen *et al.* (1980), in a study of Bangladeshi preschool children, reported that there was increased mortality with severe PEM as judged by anthropometry. Findings from the Narangwal study in India (Kielman & McCord, 1978) suggested that children with moderate PEM also have higher mortality rates. Kielman & McCord (1978) also suggested that there is an inverse relation between fatality rates and anthropometric nutritional indices.

There were no fatalities among the children studied. Mothers of children classified as suffering from moderate or severe PEM were educated as to the type and amount of foods to be fed in order to reverse the trend. Parasitic infestations were a problem, with *Ascaris lumbricoides* and hookworm (*Ancylostoma duodenale*) and *Necator americanus* being identified as the most frequently occurring parasites.

The pattern and quantity of food intake were found to be similar between the two groups, there being a preponderance of energy-rich foods and little animal protein. Cowpeas provided a substantial part of the protein intake with the rest being derived from other vegetable sources. This is a characteristic feature of diets of low-income groups in most developing countries.

There was a significant correlation ($r = 0.8$) between protein and energy intakes with body-weight of the subjects. Energy and protein intakes were found to be inadequate, in agreement with observations by other workers (Gopalan & Belavady, 1961; Collis *et al.* 1962; McFie, 1967; Geissler *et al.* 1978).

The nutritional status classification using weight-for-height (Waterlow, 1972) showed that at the time of the study, most of the children in the non-reactor group were normal while the reactor group had children suffering from mild to moderate malnutrition. Using height-for-age (Waterlow, 1972) it was found that both control and reactor children were suffering from chronic malnutrition with various degrees of growth retardation, including some severe cases. A weight-for-age classification (Gomez *et al.* 1956) showed a similar trend.

It would thus appear that the feeding pattern of these children was inadequate to meet riboflavin, energy and protein needs. The children, however, had adequate intakes of Fe, vitamin A and thiamin up to 6 years of age. The inability of the subjects in the present study to meet their nutrient requirements from cowpea-based diets is in agreement with surveys reported elsewhere in Nigeria (Nnanyelugo *et al.* 1985). In the latter study, deficits were shown in energy, niacin, riboflavin and calcium with an almost adequate protein intake. Fe, thiamin and vitamin A were adequate.

It would appear that the reactor group suffered more digestive upsets and consumed less food than the non-reactors. This had the effect of providing less nutrients for growth among the reactors which was reflected in the growth rate and nutritional status classification of the subjects. These effects need to be investigated further.

The general adequacy of Fe intake in the present study agrees with the published reports on the Fe contents of Nigerian diets (Health Education and Welfare, 1968). The very high intake of vitamin A in the study area was due to the consumption of red palm oil, one of the richest sources of provitamin A. Whether this high intake is deleterious is unknown, especially in children. This high intake also showed considerable variation among the children in the two groups, indicating the possibility of deficiency in some children.

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