Nutritive Quality of Blends of Corn with Germinated Cowpeas (*Vigna unguiculata*), Pigeon Pea (*Cajanus cajan*), and Bambarra Groundnut (*Voandzeia subterranea*)

IKEMEFUNA C. OBIZOBA[1]

Cereal Chem. 67(3):230-232

ABSTRACT

Two germinated varieties of cowpea, Oraludi (OR) and *akidi ani* (AK), pigeon pea (PP), and bambarra groundnut (BG) were combined with sprouted yellow corn in various blends to evaluate their nutritive quality in young rats (45-60 g). Blends of 30% corn with 70% OR, AK, BG, or PP, and a casein control provided 1.6 g of N/100 g of diet to the rats for the study period. Nitrogen was much better utilized in rats fed casein than the test blends except for biological value. AK and BG blends consistently showed nutritional superiority to the other blends as judged by nitrogen balance and mineral utilization. These blends were also superior to casein in mineral utilization. The blends possessed acceptable characteristics similar to blends already tested and developed in this laboratory as the sole source of nutrients for infants or supplements for adults.

In Nigeria, many nutritious foods are produced from cowpeas, which are widely cultivated. The popularity of many varieties of cowpeas in different localities has tended to obscure the importance of other legumes (Ezueh 1977). Legumes are known to contain antinutritional factors that limit their nutritional quality, especially digestibility (Desikachar 1947). Any procedure that would upgrade the nutritional quality of legumes would be of value in Nigeria.

Finney (1983) extensively reviewed the processess of germination and cooking as means by which the nutritional quality of legumes might be improved. Germination has been studied as a means of reducing antinutritional factors in legumes (Bates et al 1977, Kakade and Evans 1966). There has not been any published work to evaluate the nutritive quality of mixtures of germinated cowpeas, pigeon pea, and bambarra groundnut in Nigeria. This study was undertaken to evaluate the nutritive quality of germinated cowpeas, pigeon pea, and bambarra groundnut. Growth, protein, and mineral utilization were the criteria selected for evaluation.

MATERIALS AND METHODS

Animals and Housing

Thirty weanling albino male rats (45-60 g) were divided into five groups of six rats each on the basis of body weight. The rats were weighed prior to access to the test diets and at weekly intervals to estimate the change in body weight. The rats were housed in individual metabolism cages equipped to separate urine and feces. The rats were fed their respective diets and deionized water ad libitum for 21 days.

Diets

Two cowpea varieties, *Vigna unguiculata* (L.) Walp., 'Oraludi' (OR) and *akidi ani* (AK); bambarra groundnut (BG), *Voandzeia subterranea* (L.); pigeon pea (PP), *Cajanus cajan*; and corn, *Zea mays*, were bought from local retailers. The grains were soaked overnight in deionized water in a ratio of 1:3 after thorough cleaning. The soaked grains were spread on wet jute bags and covered with moistened muslin cloth to germinate. The grains were washed twice daily with deionized water to avoid the growth of mold at an average room temperature of 29°C. After germination (two days for corn and three to four days for legumes) the grains were hulled, boiled, and dried at 55°C to 96% dry matter. Ungerminated grains were not included because of earlier poor results.

The grains were separately hammer-milled into a fine powder (70 mesh) and stored in separate polyethylene bags and frozen until used for diet formulation.

Table I shows the ingredients and diet compositions. Test diets had 70% dietary protein from OR, AK, BG, or PP, and 30% from corn. Casein served as the control diet (CA 100). Oil, mineral and vitamin mixes, sucrose, and corn starch were added to balance the diets. Food intake was recorded for 21 days to calculate protein efficiency ratio and seven days to calculate nitrogen (N) and mineral intakes for each rat.

Laboratory Analysis

All the procedures for collection, treatment, and storage of feces and urine; estimation of N content of foods, diets, feces, and urine; and all statistical methods applied in this study were described elsewhere (Obizoba 1985, 1987). Estimation of mineral content of foods, diets, feces, and urine followed the method of Ranjiham and Gopal (1980).

RESULTS AND DISCUSSION

Table II presents the mean values for growth, protein efficiency ratio (PER), food intake, and N balances of the rats fed legume-based diets. The food intake for all groups was influenced by source of N and varietal differences. The PP group had the lowest intake (186.2 g). The somewhat higher intake for the BG blend (still comparable compared with other test diets) might be because of improved flavor or palatability or both.

Change in body weights was influenced by the same factors as the food intake. The casein diet increased body weight more than the test diets ($P < 0.05$). Except for casein, food intake

TABLE I
Composition of Diets (g)

	Sources of Protein and Ratios[a]				
Component[a]	OR-Corn 70:30	AK-Corn 70:30	BG-Corn 70:30	PP-Corn 70:30	Casein Control 100
OR[b]	462.8	···	···	···	208.15
AK[b]	···	575.5	···	···	···
BG[b]	···	···	560.0	···	···
PP[b]	···	···	···	438.5	···
Corn[b]	303.4	303.4	303.4	232.0	···
Oil[b]	75.6	75.6	75.6	75.6	75.6
Mineral mix[c]	52.9	52.9	52.9	52.9	52.9
Vitamin mix[c]	15.1	15.1	15.1	15.1	15.1
Corn starch[c]	301.1	244.75	252.2	186.04	400.125
Sucrose[b]	301.1	244.75	252.2	186.04	400.125

[a]OR = Oraludi cowpea (22.87% protein), AK = *akidi ani* cowpea (18.39% protein), BG = bambara groundnut (14.86 protein), PP = pigeon pea (18.39% protein), and corn (14.95% protein). All values were based on 6.25 × N.
[b]Purchased from local retailers.
[c]Purchased from Teklad Harlan Sprague Dawley Inc., Madison, WI.

[1]Department of Home Science and Nutrition, University of Nigeria, Nsukka, Nigeria.

had an inverse effect on body weight. The BG blend had higher intake than the PP blend, which had a lower but similar value. This might be due to type of legume and differences in essential amino acid content of proteins.

The PER results were influenced by weight gain and source of N. The casein group PER was higher than the test groups ($P < 0.05$). Weight gain or source of N or both might be the cause of the slight differences between the PP and BG blend diets.

N intake varied. The PP blend diet had the lowest, the BG and AK diets the highest. Neither varietal differences nor source of N affected N intake. Fecal N was a function of source of N and intake. Casein had the least (0.16 g).

The digested N varied and was a function of N intake and fecal output. The casein group had the highest because it had the least fecal N. Despite the higher N intake of BG compared with PP, the latter had a similar value. This might be due to lower fecal N, which reflects better quality protein in the PP blend.

Urinary N of the group fed BG was the least and differed from the AK blend and casein groups ($P < 0.05$). The N retention for casein was the highest and different from test groups ($P < 0.05$) except for BG blend ($P > 0.05$).

The BG diet had the highest biological value, although it was similar to other test groups ($P > 0.05$). The slightly higher value for the BG diet than for other test groups might be due to lower N output. The biological value for all groups was generally high. The AK blend had the lowest, and it differed significantly from the other test and casein groups ($P < 0.05$).

N intake had varied effect on net protein utilization (NPU); the PP blend, which had the least intake (1.1 g), had the highest NPU. The casein NPU value differed from those of the OR and AK blends ($P < 0.05$). The lower NPU for the AK diet might be due to high N output.

The food intake over seven days and the mineral balances of the rats are shown in Table III. The PP diet showed the lowest intake and AK- and BG-fed groups the highest.

The mineral intake from the diets was calculated after corrections were made for the mineral mix in the diets. Iron (Fe) intake was influenced by many factors including varietal differences and food source. The OR group, which had higher food intake than the PP group, had the lowest Fe intake. The AK blend had the highest intake; its value was similar to both casein and other test groups ($P > 0.05$).

The fecal Fe followed the same trend as the intake. The OR and PP groups had the highest output. This observation could be solely attributed to varietal differences. The AK and BG groups ate more and excreted more. When absorbed Fe was expressed as a percentage of the intake, casein had the highest (95.5%). The test groups had equal values ($P > 0.05$), which ranged from 85.1 to 88.5%. The higher value for casein was not surprising, because Fe in animal foods is more easily absorbed than that in in plant foods (INACG 1982) even though milk and its products are poor sources of Fe.

Urinary Fe was a function of varietal differences and group variations. The AK group had the least output, which led to increased Fe retention. Urinary Fe of the OR and PP groups followed the same pattern as for fecal Fe. Casein had the highest output, with a value similar to those of the test groups.

Fe retention was generally high and positive; values were lowest in the OR- and PP-fed rats. When Fe retention was expressed as a percentage of Fe absorbed, the AK diet was the highest (98.1%) and the OR diet was the least (76.5%), significantly different from others ($P < 0.05$). The AK and BG blends had

TABLE II
Mean Values[a] for Growth, Protein Efficiency Ratio (PER), Food Intake, and N Balances of Rats Fed Legume-Based Diets[b]

Parameter	Casein Control	OR-Corn	AK-Corn	BG-Corn	PP-Corn
Food intake[c], g	217.8 ± 19.0	202.1 ± 18.0	202.3 ± 13.5	211.0 ± 14.7	186.2 ± 14.3
Body weight, g	48.8 ± 5.5	29.5 ± 5.2	28.5 ± 2.1	26.7 ± 4.6	29.9 ± 2.6
PER[d]	2.5 ± 0.2	1.6 ± 0.2	1.6 ± 0.1	1.4 ± 0.2	1.8 ± 0.1
N intake, g	1.3 ± 0.2	1.2 ± 0.4	1.3 ± 0.1	1.3 ± 0.1	1.1 ± 0.1
Fecal N, g	0.16 ± 7.03	0.39 ± 0.1	0.46 ± 0.1	0.36 ± 0.1	0.24 ± 0.03
Digested N[e], g	1.14 ± 0.1	0.84 ± 0.1	0.84 ± 0.1	0.94 ± 0.1	0.86 ± 0.1
Urinary N, g	0.05 ± 0.2	0.04 ± 0.03	0.05 ± 0.04	0.01 ± 0.003	0.03 ± 0.01
Retained N, g	1.09 ± 0.13	0.80 ± 0.1	0.79 ± 0.2	0.93 ± 0.1	0.83 ± 0.1
Biological value	0.98 ± 0.01	0.96 ± 0.02	0.79 ± 0.2	0.99 ± 0.002	0.97 ± 0.01
Net protein utilization	0.83 ± 0.02	0.65 ± 0.03	0.59 ± 0.1	0.72 ± 0.03	0.76 ± 0.03

[a]Means ± SEM (six rats).
[b]Diets were 30:70 blends of corn and Orlaudi (OR) or *akidi ani* (AK) cowpea, bambarra groundnut (BG), or pigeon pea (PP).
[c]Based on 21-day intake for PER calculation.
[d]PER was based on a standard value of 2.5 for casein.
[e]Apparent.

TABLE III
Mineral Balances of Rats Fed Legume-Based Diets[a]

Parameter	Casein Control	OR-Corn	AK-Corn	BG-Corn	PP-Corn
Food intake[b], g	78.2 ± 9.3	77.0 ± 6.8	80.1 ± 4.7	80.2 ± 6.1	70.7 ± 4.4
Iron intake, mg	36.2 ± 4.3	12.0 ± 1.1	43.8 ± 2.6	37.6 ± 2.9	15.6 ± 1.0
Fecal iron, mg	1.7 ± 2.45	1.0 ± 0.3	5.3 ± 0.3	4.3 ± 0.6	2.3 ± 0.3
Absorbed iron, mg	34.5 ± 4.1	10.5 ± 0.9	38.5 ± 2.6	33.3 ± 2.5	13.2 ± 0.9
Urinary iron, mg	3.2 ± 1.5	2.5 ± 0.7	0.8 ± 0.6	1.3 ± 0.5	1.7 ± 0.6
Retained iron[c], mg	31.3 ± 4.5	8.0 ± 1.3	37.8 ± 2.3	32.0 ± 2.7	11.6 ± 1
Phosphorus intake, mg	84.8 ± 10.1	74.6 ± 6.6	95.2 ± 5.6	98.4 ± 7.5	56.5 ± 3.5
Fecal P, mg	3.1 ± 0.4	5.1 ± 0.8	7.7 ± 0.4	7.9 ± 1.0	6.1 ± 0.9
Urinary P, mg	8.3 ± 3.8	3.7 ± 1.1	4.0 ± 3.1	1.3 ± 0.5	2.8 ± 0.8
Retained P[c], mg	73.5 ± 2.5	65.3 ± 6.3	83.4 ± 4.4	90.0 ± 6.9	48.1 ± 3.2

[a]Means ± SEM (six rats). Diets were 30:70 blends of corn and Orlaudi (OR) or *akidi ani* (AK) cowpea, bambarra groundnut (BG), or pigeon pea (PP).
[b]Seven-day intake for mineral and N balance.
[c]Apparent.