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<th>OBI, Veronica Eberechukwu</th>
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THE DETERMINATION OF THE PROTEIN AdeQUAcy OF LEGUME-CEREAL MIXTURES IN YOUNG RATS.

A Dissertation submitted in Partial fulfilment of the requirement for the award of Master of Science Degree in Human Nutrition.

TO
The Department of Home Science and Nutrition University of Nigeria, Nsukka.

BY
VERONICA EBERECHUKWU ORI (MRS)
PG/MSC/61/1144

APRIL, 1984.
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This project is hereby approved

by

K. Owusu-Boafo
Project Supervisor

R. J. Niall
External Examiner

Head of Department

This 19 day of June, 1984.
DEDICATION

This study is dedicated to my husband Dr. M.E. Obi and our children without whose co-operation and encouragement this would have been impossible.
ACKNOWLEDGEMENT

The author is very much indebted to her Project Adviser, Dr. I.C. Obizoba for the immense help he gave her throughout the duration of this exercise.

Her gratitude also goes to the Laboratory and Academic Staff of the Department of Home Science and Nutrition for their assistance.
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ABSTRACT

Thirty male weanling rats were divided into six groups of five rats each on the basis of body weight and fed diets in which whole bambara groundnut (BG), dehulled bambara groundnut (DBG) and corn (C) in different combinations provided 1.6g N per 100 g of the diet daily for 35 days. Dehulling increased food intake, digested N, N retention and NPU. DBG:C (70:30) diet produced increases in liver weight and liver N of rats that consumed it - compared with others (3.1g and 85.8mg vs 2.3 - 2.8g and 62.4 - 76.0mg). The DBG:C (70:30) and DBG:C (60:40) diets had best protein quality as judged by N intake, digested N, N retention and NPU values.
INTRODUCTION

In the growing infants the prime nutrient need is protein. Unfortunately animal products which have high quality protein are very expensive in the developing countries. Cereals, however contain high amounts of protein but the nutritive value is limited by lack of one or more essential amino acids (EAA) for example lysine. Consequently, their biological value is much less than that of animal proteins. Legume proteins contain high lysine and show beneficial complementary effect when consumed with cereal proteins which are low in lysine. Cereal proteins are complementary to legume proteins by contributing methionine and cysteine which are limiting in legume proteins.

In several laboratories, the comparative nutritional value of cereals supplemented with legumes have been studied. Daniel et al. (1969), Salourchi et al. (1968) Cowan and Follot (1969) developed Loubina 106 as an infant food mixture for the Middle East. It is a mixture of wheat and lentils in supplementation of a basic cereal diet. Their infant studies with the mixture indicated good tolerance and acceptability. So far little research
has been carried out on the nutritive value of the various combinations of bambara groundnut and corn. Therefore as a continuous investigation in this laboratory on the nutritive value of a combination of cereals and legumes, this study is intended to determine changes if any of changing nitrogen ratios from corn and bambara-groundnut on the protein metabolism of young rats fed these diets. Growth, nitrogen (N) balance, N digestibility, food intake, biological value (BV) and liver composition, were the criteria for evaluation of these mixed protein diets.
Several workers have done some work with corn to determine its effectiveness for use in feeding animals. Bond et al (1968) fed gestating gilts normal corn as the only source of protein for 21 days and reported a decreased 21-day weaning weights. Hawton and Meade (1971) found a significantly reduced rate of gain in growing pigs raised from gilts fed normal corn diets. Alle and Baker (1975) also showed a significant rate of gain in growing pigs raised from gilts fed normal corn diets. However, lysine and tryptophan were the first and second limiting amino acids in normal corn diets fed gravid gilts. These findings were confirmed by Mason and Kodicek (1971), who found that maize is deficient in lysine and tryptophan.

Sumbo ground nut (voandzeia subterarrea) produces a nutritious food and is cultivated throughout Nigeria. Much work has not been done on this legume, but generally the value of legume as protein and lysine supplements to cereals and root-based diets is recognized. It is traditionally consumed in combination with cereals, roots and starchy foods (Aykroyd and Doughty, 1964); thus legume seeds constitute an excellent source of protein and energy to improve diets based on cereals and roots.
In low income countries, Bressani et al. (1961), Odum et al. (1981), Siegel and Pawcett (1976) confirm that the combination of proteins from legumes and cereals come very close to providing ideal source of dietary proteins for human beings.

Cereal grain-legume seed combination has also been shown to be nutritionally better than is either ingredient alone. Baptist (1960) found that rats fed a combination of cereal grain with legume seeds grew as well as those fed the stock ration of the colony. Tongue and Urlow (1961) obtained good results in rats by feeding them a mixture of 60 parts of buckwheat, 20 parts of soybean and 16 parts of rice. Desikachar et al. (1961) demonstrated that a legume and rice combination improved rat growth. Recently these workers reported that a combination of ground corn with cowpea can initiate recovery in children with kwashiorkor.

Proteins have been shown to mutually supplement one another when eaten together. The NPU of maize was 55% when eaten alone and the NPU of beans when fed alone was 47%. However, the NPU of their mixture was 70%, thus showing that the NPU of most mixed foods is likely to be higher and better for body-building (King et al., 1972). This was confirmed by Bressani et al. (1961), who found that the mixture of two protein sources of differing nutritive value improved the
protein utilization of the two mixtures and were also found to be higher than was obtained for the individual components.

Edwards and coworkers (1971) used human subjects to determine the nutritional values of a number of all-plant diets in which wheat provided the major source of protein. They observed that a diet providing 46g protein/day of which 76% of the nitrogen was supplied by wheat and the remainder by potatoes and other vegetables and fruits, is adequate for maintenance of adult man.

Devadas et al (1973) studied nitrogen retention in preschool children fed a vegetable protein mixture supplement. The vegetable protein mixture was made from indigenous cereals and pulses mostly found in India. They found that the retention of nitrogen from the supplemented diet was significantly greater than that from the basal diet; the apparent digestibility of the basal supplemented diets was 75 and 83% respectively. The apparent biological value of the supplemented diet was significantly higher than that of the basal diet. Consequently, many workers have suggested the supplementation of common staple food (starchy) in the country with cheap vegetable protein that are of high nutritive value to upgrade the protein quality of these staples (Bressani et al)

Velu et al. (1978) showed that rats fed soy-rice, soy-barley and soy-corn diets performed as well as those fed casein. They attributed this to the fact that the soy provided extra lysine, while corn, rice and barley provided the sulfur amino acids. Akinrele and Edwards (1971) showed that the biological quality of the protein of Ogi (corn starch) was so poor that it did not support growth in rats. However when it was supplemented with heated full-fat soya, the protein efficiency ratio increased tremendously and was comparable to casein. Thus, they found this mixture to be a suitable weaning food. The result obtained by Bunce et al. (1970) showed that the use of 70:30 ratio by weight of rice and mung bean in a 10% protein diet yielded better growth than can be achieved with either component alone. Bressani et al. (1961) found that all combinations of cotton seed flour and corn resulted in better growth, feed and protein efficiency than either ingredient alone.

Since the demand for high quality protein continues to increase with the greater awareness of its importance in Nigeria due to the ever increasing cost of animal protein, it is important to develop foods which provide adequate levels of good quality protein based on cheap, protein-rich local foods.
Objectives of the Study.

This study was undertaken to:

1. Determine whether or not the nutritive value of diets consisting primarily of maize (cereal) could be improved by the addition of bambara groundnut (legume) which could be used to supplement weaning foods.

2. Determine the combination (mixture) that provides better pattern of EAA for optimal growth in young rats.

3. Observe the effect of dehulling on the nutritive value of the diets.
1. PREPARATION OF PROTEIN SOURCES

Bambara groundnut and shelled dried corn were purchased from Ngukka Market. The cornflour was obtained by first washing the grains, soaking them in lukewarm water for twenty-four hours. After this the grains were washed again with water to remove foreign matter, milled, sieved and the starch was extracted. The starch was dried in the oven at about 170°F or 60°C until dried to 99% dry matter. The dried starch was remilled to fine powder. Whole bambara groundnut was divided into two equal halves. One half was washed and cooked for 40 minutes at 100°C until soft enough for consumption, dried and milled. The other half was cracked with machine, soaked in water for about 16 hours, dehulled to remove the husk and cooked for 35 minutes at 100°C until it was judged soft enough for consumption. The soft material was dried to 99% dry matter, milled and packaged in polythene bags until used for formulation.
ANIMALS AND HOUSING

Thirty male weanling rats weighing 45-55g were randomly assigned to six experimental groups of five rats each on the basis of body weight. The animals were weighed prior to access to test diets and at weekly intervals to determine the gain in body weight. The rats were kept in individual metabolism cages equipped to separate urine and faeces of the animals. They were fed diets and tap water ad libitum for 35 days.
DIETS

The dietary protein level was 0.016mg/N/g sample. Six mixed protein diets were used for the experiment. As shown in Table 1, two of the diets had their protein from BG and C in the ratio of 60:40 and 70:30. The other three derived their protein from BBG and C in the ratios of 70:30, 60:40, and 50:50, respectively. Oil, vitamins, minerals, corn starch and sucrose were added to balance the diets. Diet six contained casein (100%) and served as control. After a 2-day adjustment period on the test diets, the 35-day study period started. Twenty eight of the thirty five days were for growth study period and the remaining seven days were for N balance study. Food intake was recorded every other day and the data were used for calculation of protein intake of each animal during the N balance study.

Carmine red was fed on the twenty eighth and thirty fifth days of the N balance period. The collection of faecal droppings of each rat was for seven days and it started with the appearance of the red faeces. The red faeces excreted on day twenty nine was included while those excreted on day thirty six was excluded. Urine was also collected from the morning of day 29 through the morning of day 36. Food consumption was recorded during the seven-day period. A few drops of 0.1N hydrochloric acid was added to the individual urine samples for
TABLE 2: DRIET COMPOSITION IN GRAMS.

| Source               | Contribution (%) | Casein | Bg | DEPC | DEBC | DEBC | DEPC | Location
|----------------------|------------------|--------|----|------|------|------|------|-----------
|                      |                  |        |    |      |      |      |      | 1.69g/100g net
|                      |                  |        |    |      |      |      |      | 0.62g/100g net
|                      |                  |        |    |      |      |      |      | 0.06g/100g net
|                      |                  |        |    |      |      |      |      | 0.04g/100g net
|                      |                  |        |    |      |      |      |      | 0.02g/100g net
|                      |                  |        |    |      |      |      |      | 0.00g/100g net

**TABLE 2:** DRIET COMPOSITION IN GRAMS.

**Ingrdients:**

- Bg = Whole Bumbers Ground
- DEPC =_logo Bumbers Ground
- DEBC =_oii purchased from local

**Table:**

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<thead>
<tr>
<th>Source</th>
<th>Contribution (%)</th>
<th>Casein</th>
<th>Bg</th>
<th>DEPC</th>
<th>DEBC</th>
<th>DEBC</th>
<th>DEPC</th>
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<td>0.00g/100g net</td>
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preservation. These urine samples were refrigerated until analyzed for N. Individual faecal collections were dried and weighed before being ground into fine powder.

At the end of the experiment, the rats were sacrificed and their livers were removed, weighed and refrigerated. The diets, liver, urine, and faeces were analyzed for nitrogen content using the A.O.A.C. procedures (1975).

**STATISTICAL ANALYSIS**

Analysis of variance was used to test the differences in nutritional value of the protein mixtures. Duncan's multiple range test (Steel and Torrie, 1960) was used to determine which of the protein mixtures was significantly different in food intake, weight gain, nitrogen retention, liver weight and liver nitrogen levels.
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The protein content of the food protein sources were 23.8%, 25.8% and 11.3% for whole bambara groundnut (BG) dehulled bambara groundnut (DBG) and Corn (C) respectively. The protein level of the diets were 10% (1.6gN/100g diet).

The calculated amino acid pattern of the diets showed that methionine and cystine were the most limiting amino acids as compared to those of FAO (1970). The chemical scores ranged from 25-28 for methionine and 19-20 for cystine. Diet DBG:C 50:50 was the most limited in all the essential amino acids.

Table 2 presents food intake, weight gain, nitrogen intake, faecal N, digested N, urinary N and N balance of rats.

The food intake values varied. The values ranged from 129.6g - 148.5g for the study period. The food intake value for rats fed DBG:C 50:50 diet was highest when compared with other test groups. However, the differences were not statistically significant. The animals fed dehulled bambara groundnut and corn diets had higher food intake than the others (p < 0.05).

The animals fed DBG:C 70:30 diet gained more than any other test groups. However, there were not significant differences when compared with other groups (p > 0.05). Comparable weight gain was observed among animals fed BG:C 70:30, DBG:C 50:50, DBG:C 60:40 and DBG:C 70:30 diets and this appears to indicate that the protein quality of these diets were equally utilized for synthesis of tissue protein.
<table>
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<tr>
<th>Diet</th>
<th>Feed C</th>
<th>CASIN</th>
<th>100</th>
<th>77.5±5.1</th>
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<th>0.10±0.06</th>
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Notes:
- The food intake, weight gain, 
- DIET = 2
- The food intake, weight gain, 
- DIET = 1
- The food intake, weight gain, 
- DIET = 0
The animals fed DBG:C 70:30 and DBG:C 60:40 diets had higher food N during the N balance period compared with other groups of rats. However, the differences in N intake values for rats fed DBG:C 70:30 and DBG:C 60:40 diets were not significantly different from other groups of rats.

The rats fed BG:C 70:30 diet had highest faecal N excretion while the animals fed DBG:C 50:50 diet had the least faecal N value. The faecal N excretion of animals fed BG:C 60:40, DBG:C 50:50, DBG:C 60:40 and DBG:C 70:30 diets were comparable (p > 0.05).

The digested N values for rats fed diets DBG:C 60:40 and DBG:C 70:30 were significantly higher than for those fed other test diets. However, there were no significant differences in digested N values for rats fed BG:C 60:40; BG:C 70:30 and DBG:C 50:50 diets.

The urinary N excretion values for rats fed test diets were similar (p > 0.05). However, the animals fed DBG:C 50:50 diet had the highest urinary N excretion and those fed BG:C 60:40, BG:C 70:30, DBG:C 60:40 and DBG:C 70:30 diets had comparable values.

The N retention values varied. The animals fed DBG:C 50:50 blend consumed more and retained more than those fed BG:C 60:40 blend (p < 0.05). However, there were no significant differences
in N retention of rats fed DBG:C 60:40 blend when compared with other test groups (.46 vs. .30, .35, .44), respectively. The comparable N retention values observed in some groups of rats in this study appear to suggest that these blends (BG:C 70:30, DBG:C 50:50 and DBG:C 70:30) produced optimal pattern of EAA which the animals utilized to synthesize tissue protein. However, the control group had N retention value that was significantly higher than for any of the test groups (p < 0.05).

Table 3 presents BV, liver weight, liver N and NPU of the rats.

The animals fed diets BG:C 60:40 and DBG:C 60:40 had the highest BV values that were significantly different from those of rats fed DBG:C 50:50 diet (p < 0.05). However, their BV values were not significantly different when compared with those fed diets DBG:C 70:30 and BG:C 70:30.

Rats fed DBG:C 60:40 and DBG:C 70:30 diets had the highest N retention and NPU values which were statistically different from those fed BG:C 70:30 diet (p<0.05). The NPU value for rats fed DBG:C 60:40 mixture was statistically different from those fed BG:C 60:40 diet (p<0.05). However, the animals fed BG:C 60:40, BG:C 70:30 and DBG:C 50:50 diets had comparable NPU values (p>0.05).

The liver weight values for the animals varied. The animals fed DBG:C 70:30 diet had the highest liver weight,
<table>
<thead>
<tr>
<th>DIET</th>
<th>1 NPU</th>
<th>1 BV</th>
<th>LIVERWT (g)</th>
<th>Total LIVER N (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASEIN TOO</td>
<td>80.9±6.0</td>
<td>89.9±2.7</td>
<td>3.7±1.0</td>
<td>123.4±35.6</td>
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<tr>
<td>BG: C 60:40</td>
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<td>94.8±2.6</td>
<td>2.3±0.9</td>
<td>62.4±25.5</td>
</tr>
<tr>
<td>BG: C 70:30</td>
<td>58.5±8.9</td>
<td>89.5±7.4</td>
<td>2.8±0.8</td>
<td>76.0±21.1</td>
</tr>
<tr>
<td>DBG: C 50:50</td>
<td>65.9±7.8</td>
<td>83.6±10.6</td>
<td>2.5±1.0</td>
<td>74.0±32.9</td>
</tr>
<tr>
<td>DBG: C 60:40</td>
<td>77.5±4.7</td>
<td>93.6±1.1</td>
<td>2.7±1.5</td>
<td>71.5±30.0</td>
</tr>
<tr>
<td>DBG: C 70:30</td>
<td>74.7±9.6</td>
<td>92.8±3.4</td>
<td>3.1±2.9</td>
<td>85.8±29.8</td>
</tr>
</tbody>
</table>

1 Apparent
but the value was not statistically different from others \( (p > 0.05) \). However, the control group had liver weight values that were significantly higher than others \( (p < 0.05) \).

Regardless of treatment, the rats fed BG:C 70:30 diet produced highest concentration of liver N than other groups of rats. The other test groups had comparable liver nitrogen concentrations \( (p > 0.05) \). These diets seem to contain similar pattern of EAA for optimal growth. However, the liver N concentration of the control group was significantly higher than the other test groups \( (p < 0.05) \).
The DBG:C 50:40 and DBG:C 70:30 diets have the best pattern of amino acid when compared with the rest of the diets but, however, their chemical scores were relatively low. Based on the observation, it appears that if the cereal contributed more food N than the legume, the sulfur amino acid deficiency would have been corrected and evidently led to improved quality of the diets. However, the amino acid composition of a protein seldom gives its intrinsic nutritional value (Eggum, 1968). This value depends upon the presence of inhibitors of digestive enzymes, toxic factors, digestibility and absorption. Eggum (1968) recognizes biological evaluation of a protein as a 'test criterion'.

The food intake values ranged from 129.5g-148.5g during the study period. The low food intake observed in this study implies a concomitant low protein and energy intake. Miller (1973) points out that the efficiency of utilization of a dietary protein is less influenced by its amino acid composition than by the energy value of the diet, so that the low food intake observed in this study would have adversely affected growth and N balance of the animals. Dehulling however, improved food intake of the rats.

The food intake had varied effects on weight gain of the rats. The animals that consumed more food (148.5g) gained
less than those that consumed less (9.4g vs 13.2g). The lower weight gain of the rats that consumed more food appears to suggest that the essential amino acid (EAA) pattern of the diet was not optimal for growth when compared with animals fed BG:C 70:30 diet that ate less and gained most. The higher weight gain of rats receiving diet BG:C 70:30 compared with those receiving other test diets suggests that this blend appears to be more efficient than the rest of the diets in supporting growth. This observation is not surprising in view of the fact that amino acid composition of a protein determines its quality. Diet BG:C 70:30 has about the best pattern of amino acid for growth. Based on work done by Mattil (1974) it was shown that soy concentrate (sc) which had good pattern of amino acid supported better growth than wheat flour. The results of this study were similar to those of Bressani et al. (1961) who showed that the best growth and feed efficiencies were obtained when cottonseed and corn were either fed in ratio of 80:20 or 75:25. The same proportions were best when corn was replaced with grain sorghum. All combinations of cottonseed and corn resulted in better growth, feed and protein efficiency than either ingredient alone. Some other studies have shown that various supplemented mixtures have effectively supported growth in subjects. Kabanathan et al. (1970) reported
the effects of a blend of peanut meal, sesame meal and
horsegram on the nutritional status of children in India. The
supplemented mixture was mixed with sugar by-products and made
into balls and fed to children. The protein supplement
improved the nutritional content of the basal cereal diet and
resulted in significant height and weight gain among the
children that consumed it. The result obtained by Bunce et al
(1970) showed the use of 70:30 ratio by weight of rice and mung
bean in a 10% protein diet yielded better growth than can be
achieved with either component alone. Also Sirinit et al (1965)
fed a corn:bean 70:30 mixture at 10% dietary protein level and
reported a 47g weight gain during a two-week study period.

The animals fed DBG:C 70:30 and DBG:C 60:40 diets consumed
more food N during the N balance period compared with the other
groups of rats. This observation is similar to what Obizoba
(1984) observed in adult rats fed dehulled white pear rice (DWP:R)
diet. The study showed that rats fed DWP:R 70:30 diet had
higher N intake when compared with those fed other test diets.

The digested N values for rats fed diet DBG:C 60:40 and
DBG:C 70:30 were significantly higher than for those fed other
test diets. The N intake of the animals had varied effects on
the digested N. The digested N tended to increase with increase
in N intake. The animals fed DBG:C 50:50, DBG:C 60:40 and
DBG:C 70:30 had lower faecal N excretion which significantly
tended to induce higher digested N than those fed diets BG:C 60:40 and BG:C 70:30. This observation appears to suggest that dehulling improved digestibility of BG and agrees with that reported by Obizoba (1984) who observed that rats fed dehulled bambara groundnut and rice blend had higher N digestibility than those fed unde hull ed bambara groundnut and rice. The increased N digestibility was attributed to increased exposure of more protein to proteolytic enzyme by dehulling. Devadas et al. (1973) also found that the digestibility of supplemented diet was significantly higher than that of the basal diet.

The comparative nutritional studies by Graham and Baerfl (1974) brought out the great importance of digestibility in determining utilization. They found that despite the fact that most of their products had PER values that were close to that of casein, their utilization in human infants and children were lower than would have been predicted. In this study, the higher digestibility observed in rats fed BG:C 60:40 and BG:C 70:30 diets suggests that supplementation of corn with dehulled bambara groundnut improved its protein digestibility. These values were comparable to those reported by Clark et al. (1973) who found coefficient of apparent digestibility between 87.3 and 83.3 in adult human subjects fed combinations of wheat, beans, corn, milk, and rice. However, the generally lower digestibility for rats fed these diets when compared to that
observed by Obizoba (1984) (.50, .49 vs .57, .56) was probably due to contamination of faeces with spilled diets which led to over-estimation of apparent faecal nitrogen of the rats.

The urinary N excretion values for rats fed test diets were similar (p>0.05). However, the animals fed DBg:C 50:60 diet had the highest urinary N excretion value than the rest of the test groups. One would expect that the animals that excreted less urinary N would significantly have higher N retention. Surprisingly, this phenomenon was not observed in this study. The explanation for this observation is difficult. The animals that had the least urinary N excretion (BG:C 60:40) had about the least N retention. This might be attributed to low N intake. The comparable N retention values observed in some groups of rats in this study appear to suggest that these blends (BG:C 70:30, DBg:C 50:50 and DBg:C 70:30) produced optimal pattern of EAA which the animals utilized to synthesize tissue protein. The result of N retention studies with Laubina conducted by Asfour et al (1965) as determined during a three-day period in four infants who had recovered from marasmus showed that laubina 105 - which contained Burghol a cereal (68%) and chick pea - a legume (27%) and oil (2%) at 14.7% protein - induced positive N retention in the children. Their work further confirms that an adequate mixture of cereals and legumes could
furnish the EAA required for body protein synthesis. Devadas et al. (1973) studied N retention in preschool children fed a vegetable protein mixture supplement. The vegetable protein mixture was made from indigenous cereals and pulses mostly from India. They found that the retention from the supplemented diet was significantly greater than that from the basal diet.

Henry and Kon (1967) pointed out that when BV was measured with young growing human subjects, the value represented the capacity of the protein both to provide the EAA to promote growth and to build up the protein reserves of the body. In this study, the group of rats that had the highest BV value (94.8%) reflected greater utilization of nutrient present in limited amount. Generally, values for BV were based on N retention. The lower urinary N excretion of these rats was probably a reflection of greater efficiency of utilization of a nutrient present in limited supply - a commonly observed phenomenon. In this study, diets BG:C 60:40 and D&BG:C 60:40 had the highest BV which disagrees with that observed by Obizoba (1984) who found that the rats fed brown pea: rice (BP:R) 70:30 mixtures had highest BV values. The probable reasons for these differences might be attributed to the degree of protein depletion, the energy intake and protein intakes of the animals. The BV values of the animals were higher than would be expected as judged from the calculated amino acid profile of the diets. This observation agrees with the results reported by Henry and Kon (1967) who observed that BV values were lower as protein intake increased. However, the extent of change was a function of the
amino acid composition of the protein under study. In this study the rats consumed little food N which might have induced high BV values of the rats.

The supplementation of corn with bambara groundnut improved the digestibility of the diets. The DBG:C 60:40 and DBG:C 70:30 diets had the highest N retention and NPU values when compared with the other test diets. The study by Ballester et al (1968) on 5 high protein mixtures based on wheat, and wheat flour derived from a variety of durum wheat, fish flour, breads, skim milk and sunflower presscake, mixed in different proportions showed that the NPU of the mixtures at the 10% level of protein calories gave values ranging from 66 to 76% in rats. On the other hand, Graham et al (1972) evaluated wheat soy blend (W.SB) in the diets of convalescent malnourished and normal infants and children. They found that the utilization of proteins from the mixtures was significantly limited in digestibility despite satisfactory biological values.

The variations observed in the liver weights were probably due to the variations in the food intake. Even though the DBG:C 50:50 diet had the highest food intake it did not have the highest liver weight. As was observed in the amino acid pattern, it had the least desirable pattern for optimal growth than the rest of the diets.

It does appear that food intake did affect the liver N levels. With the exception of the food intake value of 148.5g, the rats fed DBG:C 70:30 had the highest food intake which induced the highest liver N value.
The rats fed DG:C 60:40 diet had the least food intake, weight gain, N intake, urinary N, liver weight and liver N values when compared with the other groups. Dehulling of BG improved its nutritive value as judged by higher food intake, N intake, digested N, N retention and NPU values.

The animals fed BG:C 70:30 blend had about the lowest food intake value. They also had a low N intake and the least N retention values. But they gained the most weight suggesting that the pattern of EAA was adequate for protein synthesis. This diet also induced about the highest liver weight. However, when compared with DBG:C 70:30 blend, it was observed that the DBG:C 70:30 had a higher N intake, digested N, N retention, NPU, liver weight and liver N values and thus showing that dehulling improved the nutritive value of those mixtures.

From the result it is shown that the DBG:C 60:40 and DBG:C 70:30 diets provided the best pattern of EAA for growth of the weanling rats as judged by food intake, body weight gain, digested N, N retention and NPU values.
CONCLUSION

The rats fed DBG:C (70:30) and DBG:C (60:40) diets had the highest N intake and highest digested N, while the animals fed DBG:C (60:40) diet had highest BV and NPU values. Dehulling increased N digestibility and utilization values probably by exposing the protein more to proteolytic enzymes. The DBG:C (70:30) blend produced highest liver weight for the animals that consumed it. The DBG:C (70:30) and BGC (70:30) diets induced increased liver N value. Thus DBG:C (70:30) and DBG:C (60:40) diets had best protein quality as seen from food intake, body weight gain, digested N, N retention and NPU values.

Thus based on the results of this experiment, the DBG:C (70:30) and DBG:C (60:40) mixtures appear to possess the most potential protein source for possible infant feeding. However, further studies are needed to estimate the effect of this type of diet on bioavailability of various micronutrients. This product should also be organoleptically evaluated for texture, palatability, acceptability and flavour before any large scale production is embarked upon.
Reliability of materials and methods used to measure the quality of the diets.

RATS: The results of this experiment could have been affected by the size and age of the rats. There was scarcity of feed throughout the nation due to austerity measures. As a result the rats were underfed and could not attain the expected size when they were weaned. They were thus undersize for age. They were also not from the same colony since we could not get litter mates.

FEEDS: After the diets were formulated they were refrigerated until used. It was generally observed that the animals did not eat much food during the study period.

Nitrogen retention in this study could be an unreliable method for evaluating the protein quality of these diets. They would overestimate the protein quality as shown by waste of food, urine and feces by the animals. The liver weights and liver N could also have been affected by the food intake and poor N utilization as shown by high urinary N values.
REFERENCES


