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<th>Serial No</th>
<th>ISNN: 0963-7486</th>
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<td>Author 1</td>
<td>NNAM, N. M.</td>
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<td>Keywords</td>
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<tr>
<td>Category</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Publisher</td>
<td>International Journal of Food Science and Nutrition</td>
</tr>
<tr>
<td>Publication Date</td>
<td>2001</td>
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<td>Signature</td>
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Comparison of the protein nutritional value of food blends based on sorghum, bambara groundnut and sweet potatoes

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The protein quality of four blends based on sprouted sorghum, bambara groundnuts and fermented sweet potatoes had been evaluated by rat feeding experiments; casein served as a reference protein. The test proteins were incorporated to make up 1.6% total nitrogen. There was an inverse relationship between % nitrogen digestibility and the proportion of sorghum protein in the blend; being highest (89.7%) in the diets based on sorghum: bambara groundnut: sweet potatoes with protein ratios of 52:46:2. This blend proved to be optimum when the biological value (93.6%) and the net protein utilization (84%) were used as protein indices. The findings imply that foods with good protein quality could be formulated from a blend of sorghum–bambara groundnut and sweet potatoes, provided appropriate processing and blending are taken into consideration.

Introduction

Protein deficiency, particularly in the diets of young children, is one of the major nutritional problems facing the developing countries. Poor food quality has been identified as one of the causative factors (WHO, 1997). In Nigeria, the traditional complementary foods consist mainly of unsupplemented starchy staples like sorghum, maize, millet, yams, cassavas, coco yams and sweet potatoes. They are poor in protein and limited in food value due to the presence of antinutrients which chelate or complex with essential nutrients. Adequate processing is necessary to improve their utilization.

Germination and fermentation are two household-level food technologies which have been extensively reviewed as means by which the nutritive value of plant food could be improved (Obizoba, 1998). They increase amino acid and mineral availability, protein and carbohydrate digestibility, nutrient and energy densities of gruels, levels of the B-complex vitamins and decrease toxic and antinutritional factors like phytates, tannins and alpha-galactosides (Obizoba & Nnam, 1992; FAO, 1995; Obizoba, 1998).

In Nigeria, there exist a lot of cheap, nutritious and readily available indigenous foods which when adequately processed and judiciously combined could serve as an improvement of the existing traditional complementary foods. This will help alleviate the protein gap experienced in the country particularly among young children. Sorghum is a popular cereal in Nigeria, particularly in the

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ISSN 0963-7486 printed ISSN 1465-3478 online
01/1010025-05 © 2001 Taylor & Francis Ltd
DOI: 10.1080/0963748002007246
northern part of the country where it is pro-
duced. It constitutes a major source of energy
and protein in areas where it is a staple. The
protein varies from 7.5 to 9.0% and like other
cereal proteins, it is limited in the amino acids,
lysine, threonine, tryptophan and methionine
(Ihekwenye & Ngoddy, 1985). Supplemen-
tation with other foods whose protein would
complement the amino acid composition is
necessary.

Bambara groundnut is an important legume
produced extensively in northern Nigeria. The
legume is sweet and pleasant to eat either as dry
or immature seeds. The protein content in the
forage range from 12-15% and in grains from
20-25% (dry matter basis) (Arora, 1995). It has
more methionine than is found in other grain
legumes and would serve as a good supplement
to sorghum protein.

Sweet potato is a root crop that provides
significant amounts of energy and protein. The
tuber is rich in carotene (particularly the yellow
variety), minerals and the B-complex vitamins.
It has a fair quantity of ascorbic acid. The
protein is rich in the amino acids lysine and
tryptophan (LIFE, 1994) which are low in
sorghum. Combining sweet potatoes with sor-
ghum will provide complementary effect on the
amino acids.

No detailed work had been published on the
protein quality of blends of processed sorghum,
bambara groundnuts and sweet potatoes. The
objective of this study was to evaluate the
protein quality of various combinations of
sprouted sorghum, bambara groundnuts and
fermented sweet potatoes in rats. Nitrogen (N)
digestibility and utilization were the criteria
used for the evaluation.

Materials and methods

Materials
White sorghum (Sorghum bicolor) (S), cream
bambara groundnuts (Vigna subterranea (L)
Verde) (BG) and reddish-purple sweet potatoes
(Ipomoea batatas) (SP) were used as source of
protein for the study. They were all purchased
from the Nsukka market in Enugu State of
Nigeria.

Preparation of materials
Five kg of sorghum and 2 kg of bambara
groundnuts were soaked separately in cold
denized water for 8 h in a ratio of 1:3 (w/v) to
grain to water. The soaked grains were drained
at the end of the soaking period. They were
separately spread on wet jute bags and covered
with moistened muslin cloth to sprout for 48 h
at an average room temperature of 28.0 ± 2°C.
The grains were washed twice daily to avoid the
growth of mold. The sprouted grains were
dehulled mechanically using PRL mini-roller
dehuller (Nutana Machine Co., Saskatoon, Can-
ada). All the sprouted samples were milled
separately in a laboratory hammermill (Thomas
Wiley Mill, Model E3-5) to a fine powder
(70 mm mesh screen).

One kg of sweet potatoes were hand-peeled,
wet-milled using a Gallenkamp mixer Ken-
wood-MPR201 and fermented in a bell jar for
48 h by the microflora present in the paste. The
fermented sweet potato (FSP) sample was dried
and remilled using the same procedure as for
sorghum and bambara groundnuts.

Animal feeding experiments
The composition of the diets is presented in
Table 1. The diets were formulated based on the
N content of the foods. The ratios of 60:40:0,
57:42:1, 55:44:1, 52:46:2 (protein basis) of
sorghum, bambara groundnuts and sweet pota-
toes were used in the formulation. All the diets
were formulated to provide 10% protein or
1.6 gN/100 g diet. Casein served as the control.
Oil, sucrose, vitamin and mineral mixes were
added to balance the diets.

Animal housing and feeding
Thirty male adult rats weighing from 80-150g
were obtained from the Department of Veteri-
nary Pathology, University of Nigeria, Nsukka.
The wide range in the weight of the rats was
because of a long period (over 6 months) of a
scarcity of rat feed in the country, which led to
lack of rats. The animals were divided into five
groups of 6 rats each on the basis of body
weight. They were housed individually in
stainless steel metabolic cages equipped to
separate urine and feces. The rats were fed the
diets and denized water ad libitum for 12
Table 1. Composition of the four experimental diets (g)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Protein content</th>
<th>Reference</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casein</td>
<td>90.80</td>
<td>11.01</td>
<td>59.77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sproted sorghum (SS)</td>
<td>8.70</td>
<td>68.49</td>
<td>65.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sproted groundnut (SBG)</td>
<td>19.44</td>
<td>20.58</td>
<td>21.60</td>
<td>22.63</td>
<td>23.66</td>
<td></td>
</tr>
<tr>
<td>Fermented sweet potatoes (FSP)</td>
<td>2.98</td>
<td>0.00</td>
<td>3.36</td>
<td>3.36</td>
<td>6.71</td>
<td></td>
</tr>
<tr>
<td>Vitamin mix</td>
<td>1.00</td>
<td>3.5</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral mix</td>
<td>1.00</td>
<td>3.5</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose</td>
<td>1.00</td>
<td>3.5</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein ratio: SS:SBG:FSP</td>
<td>79.49</td>
<td>1.43</td>
<td>1.43</td>
<td>1.73</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Nitrogen %</td>
<td>1.60</td>
<td>1.60</td>
<td>1.50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Protein quality indices

Three protein quality indices, namely the apparent nitrogen digestibility (ND), the biological value (%BV) and the net protein utilization (%NPU) were assessed according to the following equations:

\[
\text{Nitrogen Balance} (\text{NB}) = (\text{I} - (\text{F} + \text{U}))
\]

\[
\text{ND} = \frac{(\text{I} - \text{F}) \times 100}{\text{I}}
\]

\[
\text{BV} = \frac{(\text{I} - (\text{I} - \text{F} - \text{U}))}{(\text{I} - \text{F})} \times 100
\]

\[
\text{NPU} = \text{ND} \times \text{BV}
\]

\[
\text{whereby I = nitrogen intake; F = fecal nitrogen; U = urinary nitrogen.}
\]

Results and discussion

Table 2 presents the results of the rat feeding experiment. The average gain in body weight was highest (P < 0.05) among the rats consuming diet 4 based on SS: BG: FSP with the protein ratios (55:46:2) compared to the other three experimental diets. On the other hand, mean food intake was highest (99.83 g) among the rats consuming diet 1 based on the above
Table 2. Indices of protein quality of four food blends based on different combinations of sprouted sorghum, barnsbara groundnuts and fermented sweet potatoes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Reference casein diet</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain in body weight (rats)</td>
<td></td>
<td>20.10 ± 1.57</td>
<td>30.00 ± 8.27</td>
<td>16.67 ± 0.46</td>
<td>33.33 ± 1.07</td>
<td></td>
</tr>
<tr>
<td>Food intake (g)</td>
<td></td>
<td>99.83 ± 5.50</td>
<td>97.67 ± 4.46</td>
<td>94.02 ± 7.09</td>
<td>97.42 ± 5.62</td>
<td></td>
</tr>
<tr>
<td>Nitrogen intake (g)</td>
<td></td>
<td>1.60 ± 0.14</td>
<td>1.36 ± 0.36</td>
<td>1.51 ± 0.24</td>
<td>1.50 ± 0.30</td>
<td></td>
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<tr>
<td>Fecal nitrogen (g)</td>
<td></td>
<td>1.07 ± 0.09</td>
<td>1.02 ± 0.22</td>
<td>0.54 ± 0.24</td>
<td>0.56 ± 0.31</td>
<td></td>
</tr>
<tr>
<td>Apparent digestibility (%)</td>
<td></td>
<td>64.61 ± 0.34</td>
<td>69.67 ± 5.74</td>
<td>77.48 ± 1.01</td>
<td>89.74 ± 2.12</td>
<td></td>
</tr>
<tr>
<td>Urinary, Nitrogen (g)</td>
<td></td>
<td>0.13 ± 0.01</td>
<td>0.17 ± 0.09</td>
<td>0.28 ± 0.04</td>
<td>0.34 ± 0.12</td>
<td></td>
</tr>
<tr>
<td>Nitrogen balance (%)</td>
<td></td>
<td>92.96 ± 0.12</td>
<td>87.11 ± 0.24</td>
<td>83.46 ± 0.41</td>
<td>76.07 ± 0.21</td>
<td>93.57 ± 0.42</td>
</tr>
<tr>
<td>Protein ratio (SS:SBG:FSP)</td>
<td></td>
<td>65.71 ± 0.09</td>
<td>56.64 ± 0.31</td>
<td>57.50 ± 0.36</td>
<td>58.84 ± 0.36</td>
<td>83.97 ± 0.51</td>
</tr>
</tbody>
</table>

Mean values are significantly different (*P < 0.05*) if they do not share the same superscript within the same row (Student’s t-test).

SS = sprouted sorghum; SBG = sprouted barnsbara groundnut; FSP = fermented sweet potatoes.

The highest food intake among the group consuming diet 4 was associated with a higher mean N intake. However, the differences in the N intake did not attain statistical significance (*P > 0.05*). The mean N excretion was lowest among the rats consuming the casein diet, which had an apparent N digestibility (D) of 92.2%. The mean D of 89.74% obtained among the animal group consuming diet 4 did not differ significantly from the respective figure obtained with the reference casein diet (*P > 0.05*), and was significantly higher (*P < 0.05*) when compared with the respective mean figures obtained with the other experimental diets. There was an inverse relationship between the proportion of sorghum protein in the blends and their %N digestibility. Diet 4 with the lowest proportion of sorghum 52% had the highest mean %N digestibility (89.74%). This might be attributed to the presence of tannin in sorghum. Tannins are known to bind both exogenous and endogenous proteins including enzymes of the digestive tract, thus affecting the utilization of protein (Griffiths, 1985). Eggum et al. (1983) reported higher true protein digestibility in decorticated sorghum grain (low tannin) than in whole grain with higher tannin level. The urinary N excretion of the groups of rats differed. The group consuming diet 4 and the reference casein diet had comparable (*P > 0.05*) lower (*P < 0.05*) figures than the groups that consumed the other three experimental diets. Nitrogen balance showed a trend similar to that of the D and was highest and of the same magnitude among the group of animals consuming the reference casein diet or the experimental diet 4. Both figures were significantly higher (*P < 0.05*) when they were compared with the respective figures obtained after consuming diets 1, 2 and 3. This appears to indicate that the essential amino acid patterns of both diets were equally utilized by the animals for the synthesis of body protein. The higher (*P < 0.05*) N retention of the animals on diet 4 than the other experimental diets suggests that the amino acid patterns of both diets are better than the other diets. The net protein utilization reveals that diets 1, 2 and 3 were significantly (*P < 0.05*) inferior to diet 4 or the reference casein diet. This result supports
Okeke and Obizoba (1986) whose findings suggested that substituting cereal and legume protein with tuber at low levels (2%) produced good-quality protein comparable to casein. The result is also in accordance with Obizoba (1990) who observed that when plant proteins are carefully selected and judiciously combined, the protein so produced could be equal to or better than animal protein.

Conclusion

The results of the study were revealing. Diet 4 showed superiority in protein quality over the other experimental diets in all the parameters tested and compared favorably with the reference casein diet. This has serious implications particularly with the current trend in dietary diversification to combat protein and other nutrient deficiencies in Nigeria. The use of the experimental diet based on 52% : 46% : 2 protein ratios of processed sorghum, bambara groundnuts and sweet potatoes should be encouraged both in infant and young child feeding programs because of its good protein quality.

Acknowledgements—The financial assistance for this work was provided by the University of Nigeria Senate Research Grant, No. 94/137. The support is acknowledged.

References


