Protein quality evaluation and \textit{in vitro} multi-enzyme digestibility of some plant protein isolates and concentrates

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\textbf{SUMMARY}

Plant protein isolates from potato (POPI), soya bean protein isolates (SOPI) and leaf protein concentrate from \textit{glyricidia} and \textit{Manihot esculenta} leaves (LPCs) were bio-nutriently evaluated. They were compared with the reference diet casein using some protein quality evaluation (rat bio-assay) indices and \textit{in vitro} multi-enzyme digestibility. The results showed that all the rats fed the \textit{Glyricidia} leaf protein concentrates (GLPC) or \textit{Manihot} leaf protein concentrate (MALPC) lost weight while those fed soya bean protein isolates (SOPI) or potato protein isolate (POPI) gained more weight than those fed with reference diets. Other protein quality indices such as protein efficiency ratio (PER), net protein ratio (NPR), net protein utilization (NPU), biological value (BV), apparent and true protein digestibility (AD & TD) respectively were significantly higher $P(<0.05)$ in both SOPI and POPI than the leaf protein concentrates (LPCs). It was demonstrated that the LPCs were unsuitable as sole source of dietary protein in rat feeding. The \textit{in vitro} multi-enzyme protein digestibilities of the leaves are 86.29±0.3\%; 99.68±0.6\% MALPC, GLPC respectively while 79.1±0.3 and 86.5±0.5 were recorded for SOPI and POPI respectively.

Keywords: leaf protein concentrates, protein quality evaluation, \textit{in vitro} protein digestibility

\textbf{INTRODUCTION}

There are two main parts to food equation namely, food crop and animal protein components. The world shortage of animal protein, particularly in developing countries of Africa, has necessitated investigation of several novel alternative feeding materials for possible incorporation into human/animal diets (Fasuyi, 2005; Aletor, 2007). Recent study have shown that malnutrition such as kwashiorkor and maramus among children in developing countries is
mainly due to the consumption of cereal-based porridge which is bulky and low in energy and density and high in antinutrient (Aletor, 2010).

The widening gap between the estimated protein requirements and the actual protein consumption in many developing countries of Africa, Nigeria inclusive derives mainly from the phenomenon rise in the cost of the conventional animal protein sources such as eggs, meat, poultry, fish, milk and milk products. Their prices are generally beyond the reach of the lower-paid or resource-poor citizenry that form more than 80% of the population in this region. If, and when available, these items form only a minor and irregular part of normal diets (Fellows, 1987; Aletor, 2007; Aletor, 2010).

Leafy vegetable have long been recognized (Barbeau, 1989) and more recently by Aletor et al., 2002; Agbede et al., 2007 and Aletor, 2010 as the cheapest and most abundant potential source of protein because of its ability to synthesize amino acids from a wide range of virtually unlimited and readily available primary materials such as sunlight, water, carbon-dioxide, atmospheric nitrogen (as in legumes). Results have shown (NRC, 1984; Aletor and Adeogun, 1995; Fasuyi, 2006 and Aletor, 2009) that leaves of several tropical vegetables such as Glyricidia and cassava leaves abound in Nigeria are rich in protein 20 – 30%, minerals (micro and macro) and vitamins.

While a lot of information on the nutritive potential of leaf protein concentrate (Oke, 1973; Aletor & Adeogun, 1995; Fasuyi, 2006; Aletor, 2010) is available, the information on bio-nutritional potentials and digestibility is scanty. The study therefore designed primarily to provide analytical data on various plant protein isolated/concentrate with particular reference to their protein quality evaluation and in vitro multienzyme digestibility.

MATERIAL AND METHODS

The leaves Glyricidia sepium (Glyricidia) and Manihot esculenta (Cassava) were harvested on the campus of the Federal University of Technology, Akure, Nigeria. While the samples of soyabean and potato were purchased from the local market in Akure, Nigeria.

Preparation of leaf protein concentrate (LPC)

The leaves were washed and weighed prior to pulping using Posho mill, followed by pressing with screw press to separate the leaf juice. The separated leaf juice was heated in batches 80 – 90°C for about 10 minutes to coagulate the leaf protein. The protein coagulum was separated from the whey fraction by filtering through cloth filter followed by pressing with screw-press as described for garri making (Aletor, 1993). The LPCs were then washed with water and repressed. The products were pulverized and spread in the sun to
dry prior to analysis. The flowchart for the low-cost fractionation scheme as adapted from Fellows (1987) is shown in Fig. 1.

**Preparation of protein isolates**

The procedure for isolate preparation was described by Lqari *et al.*, 2001 with some modifications which involved the use of different extractants as mentioned below. The milled samples were sieved to pass a 0.5mm mesh and kept in air-tight plastic container in a refrigerator at 4°C prior to use. The fraction collected (<0.5mm) referred to as flour were defatted by extracting with n-hexane in a Soxhlet extractor for 9 hours, followed by air-drying in the fume cupboard for 24 hours.

The slurry (1:20, flour to water ratio) at pH 6.37 and 28°C were first extracted for 10 min as indicated in Fig. 2. Thereafter, the slurries were stirred for 2 hrs with a Gallenkamp magnetic stirrer and the pH was adjusted to pH 6.5 with 1M NaOH or 1M HCl. Different extractants [ascorbic acid (0.5%) W/v; EDTA + 0.25% ascorbic acid; Cystein (0.5%); Sodium sulphite (0.25%)] and water were added singly.
Fig. 2: Flowchart for protein isolate extraction

1M NaOH

H₂O/flour (20:1)

Extraction 10 min; 28±2°C

1M HCl or NaOH

Extraction 2 hrs

Using different extractant

Centrifugation at 10,000 rpm, 30 min

Residue

Soya bean/potato flour

Acidification to isoelectric pH

1M HCl

Centrifugation at 10,000 rpm, 30 min

Supernatant

1M NaOH

Water (1:2 w/v)

Washing x 2

neutralization, pH 7

PROTEIN SOLUTION

Lyophilisation

PROTEIN ISOLATE

PROTEIN PRECIPITATE

*Extractants: ascorbic acid (0.5w/v); EDTA x 0.25% Ascorbic acid; cystein (0.5%); sodium sulphite (0.25%) and water
Each extract was centrifuged in a Sorvall RC5C automatic super speed refrigerated centrifuge at 10,000 xg for 30 minutes at 5°C. After centrifugation and recovery of supernatant, three additional extractions were carried out with half of the volume of the initial water. The supernatants were pooled and precipitated at pH 5.0, the isoelectric point (IEP). The precipitates were subsequently recovered by centrifugation at 10,000 xg for 15 minutes at 5°C. The precipitates were washed twice with distilled water adjusted to pH 5.0 with HCl and then freeze-dried. The precipitate was neutralized by the addition of 1M NaOH.

**Experimental animals**

Thirty (15 males + 15 females) clinically healthy weanling albino rats at approximately 3 weeks of age were purchased from a Research rat colony, University of Ibadan, Ibadan. They were thereafter divided into 6 groups of 5 rats each on the basis of initial weight, sex and litter origin. The weights of the rats in each group were adjusted such that the initial mean group weights were identical (43.2±0.1 g). The rats were individually housed in separate cubicles in a metabolic cage with facilities for separate faecal and urinary collection.

**Management of experimental animals**

The rats were offered water and the diets *ad libitum* for 10 days. Records were kept of the weight gain/loss and the total food intake. A 6-day faecal and urine collection was done for rats during the trial. The urine from each cage was collected in a small urine cups containing 1 cm³ of concentrated sulphuric acid as preservative and stored in screw-capped bottles at -4°C. Faecal samples were collected daily, bulked for each rat, weighed, dried, milled prior to laboratory analyses. Duplicate samples of urine, faeces and diets were taken for nitrogen determination (AOAC, 1995).

**Experimental diets**

The composition of the basal diet 1 (nitrogen free diet), reference diet (casein) diet 2 and the other diets containing the 4 test ingredients (diets 3 – 6) are shown in Table 1. The nitrogen free diet 1 was formulated such that there was no nitrogen furnished by any of the ingredients used. The reference diet 2 contained 10% crude protein on dry matter basis supplied by nutritional casein. Test diets 3 – 6 were formulated to furnish 10% crude protein using the two protein isolate (soybean protein isolate SOPI and potato protein isolate POPI) and leaf protein concentrates (glyricidia and manihot leaf protein concentrate (GLPC, MLPC). The SOPI, POPI, GLPC and MLPC were the major protein sources to be evaluated and were added at the expense of maize
starch to give 10% crude protein on a dry matter basis. One group of 5 rats was
given the N-free basal diet 1, another group of five was kept on reference diet
2 while the four groups were randomly allocated to the diets containing the
test ingredients (SOPI, POPI, GLPC and MLPC).

Table 1. Composition of Experimental Diets (g/100 g) for soya protein (SOPI), potato
protein isolate (POPI), Glyricidia leaf protein concentrate (GLPC) and Manihot leaf
protein concentrate (MALPC)

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>N-free Diet 1</th>
<th>Casein Diet 2</th>
<th>SOPI Diet 3</th>
<th>POPI Diet 4</th>
<th>GLPC Diet 5</th>
<th>MALPC Diet 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn starch</td>
<td>66.80</td>
<td>55.90</td>
<td>54.97</td>
<td>53.86</td>
<td>48.09</td>
<td>39.35</td>
</tr>
<tr>
<td>Casein</td>
<td>10.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOPI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.83</td>
<td></td>
</tr>
<tr>
<td>POPI</td>
<td></td>
<td></td>
<td>12.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLPC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.71</td>
<td></td>
</tr>
<tr>
<td>MALPC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27.45</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Sucrose</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
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<tr>
<td>Cellulose</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
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<td>Groundnut oil</td>
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<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Bone meal</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
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<td>2.00</td>
</tr>
<tr>
<td>Oyster shell</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Vitamin premix</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>NaCl</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
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</tbody>
</table>

Protein quality measurement

Based on the Nitrogen balance data, the following definitions were used
as basis for computing the various quality indices as earlier described by Apata
and Ologhobo (1990).

(i) Nitrogen retention (NR): The nitrogen retained in the experimental rat
trials calculated as the algebraic difference between the feed and the sum
of both the faecal and urinary nitrogen for the collection period.

\[ NR = NI - (FN + UN) \]

NR, nitrogen retention; NI, nitrogen intake in feed; FN, faecal nitrogen;
UN, urinary nitrogen.

(ii) Protein efficiency ratio (PER): The PER in the rat growth assay was
determined by dividing the gain in the body weight by the protein intake
of each rat.

\[ PER = \frac{\text{gain in body weight (g)}}{\text{protein intake (g)}} \]

(NAS/NRC, 1977; Agbede et al, 2007)
(iii) Net protein ratio (NPR)

\[
NPR = \frac{\text{weight gain of test - protein group} + \text{weight loss N - free diet group}}{\text{protein intake}}
\]

(Bender & Doell, 1957; Agbede et al, 2007)

(iv) Apparent nitrogen digestibility % (AND): The AND was determined by dividing the NR by the NI on a percent basis

\[
\text{AND} = \frac{\text{NI} - (\text{FN} - \text{UN})}{\text{NI}} \times 100
\]

NI, nitrogen intake; FN, faecal nitrogen; UN, urinary nitrogen

(v) True digestibility (TD): The true digestibility of nitrogen

\[
\text{TD} = \frac{1 - (\text{F} - \text{M})}{1} \times 100
\]

(Dreyer, 1968; Agbede et al, 2007)

(vi) Biological value (BV): The biological value of nitrogen in the diet was calculated thus:

\[
\text{BV} = \frac{1 - (\text{F} - \text{M}) - (\text{U} - \text{E})}{1 - (\text{F} - \text{M})}
\]

(Phillip et al, 1981)

(vii) Net protein utilization (NPU): The NPU was determined thus:

\[
\text{NPU} = \frac{1 - (\text{F} - \text{M}) - (\text{U} - \text{E})}{1} \times 100
\]

(Phillip et al, 1981)

where I – nitrogen intake (mg); F = nitrogen excreted in the faeces (mg); M = metabolic faecal nitrogen (from basal diet) (mg); U = nitrogen excreted in the urine (mg); E = endogenous urinary nitrogen (from basal diet) (mg).

**Determination of in vitro multi-enzyme protein digestibility**

*In vitro* multi-enzyme digestibility was carried out by the method of Hsu *et al* (1977). 50 ml of aqueous suspension of the protein concentrates (6.25 mg sample per cm³) in distilled water was adjusted to pH 8.0 with 0.1M HCl and/or 0.1M NaOH, while stirring on water bath maintained at 37°C. The multi-enzyme solution (mg cm⁻³) containing 1.6 mg trypsin (EC 3.4.21.1 PN, T1005); 3.1 mg chymotrypsin (EC 3.4.21.1; PN, C4129); and 1.3 mg peptidase (EC 3.4.23;1; PN, P6887) all from Sigma-Aldrich Ireland Ltd., Dublin was maintained in an ice bath and adjusted to pH8 with 0.1M HCl and/or 0.1M NaOH. A 5 cm³ sample multi-enzyme solution was added to the sample suspension with constant stirring at 37±2°C. The pH of the suspension was recorded 15 minutes after the addition of the multi-enzyme solution. *In vitro* digestibility was calculated using a regression equation of Hsu *et al.* (1977).

\[
Y = 210.46 - 18.10x
\]

where Y is the *in vitro* digestibility in (%) and, x is the pH of the sample after 15 minutes digestion with the multiple-enzyme solution.
**Statistical analysis**

All data were means for duplicate determinations. Mean values within the different protein multi-enzyme digestibility were assigned coefficients of variation (Steel & Torrie, 1960). One way ANOVA (SPSS 11.0 for windows, SPSS Inc. Chicago IL, USA) was used to analyse the mean differences between the dietary treatments. A significant difference was considered at a level of P≤0.05.

### Table 2. Protein quality evaluation of different protein concentrates

<table>
<thead>
<tr>
<th>Treatments</th>
<th>WG, in 10 days (g)</th>
<th>FC, in 10 days (g)</th>
<th>PI, in 10 days (g)</th>
<th>PER</th>
<th>NPR</th>
<th>AD</th>
<th>TD</th>
<th>BV</th>
<th>NPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casein</td>
<td>8.2±3.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44.9±10.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.22±0.05</td>
<td>4.4±1.0&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.7±0.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.0±0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>99.4±0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>92.9±5.4</td>
<td>98.4±0.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>SOPI</td>
<td>12.1±3.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>52.9±12.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.20±0.06</td>
<td>5.3±1.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.6±0.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.3±0.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>99.3±0.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>96.6±11.1</td>
<td>90.8±5.8&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>POPI</td>
<td>11.3±2.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>64.6±8.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.19±0.09</td>
<td>6.5±0.9&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.7±0.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.7±0.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>98.3±0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>94.9±0.6</td>
<td>97.1±2.1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>GLPC</td>
<td>-5.1±1.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32.2±3.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.16±0.04</td>
<td>3.2±0.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>-0.6±0.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.8±0.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>64.1±0.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>72.9±0.7</td>
<td>53.9±1.9&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>MALPC</td>
<td>-6.5±1.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.9±4.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.18±0.02</td>
<td>2.9±0.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.9±0.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.6±0.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>97.6±3.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>65.8±3.8</td>
<td>55.6±2.6&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Casein = reference diet; WG, weight gain; FC, feed consumed; PL, protein intake; PER, protein efficiency ratio; NPR, net protein utilization; BV, biological value; AD, apparent digestibility; TD, true digestibility; Means with different superscripts in the same vertical rows are significantly (P≤0.05); Means for 5 rats per diet; SOPI, soy bean protein isolate; POPI, potato protein isolate; GLPC, Glyricidia leaf protein concentrate; MALPC, Manihot esculenta leaf protein concentrate.

### RESULTS AND DISCUSSION

Table 1 showed the compositions of the experimental diets. The data on rat growth assay and protein quality evaluation as presented in Table 2. The results showed that rats fed Glyricidia leaf protein concentrate (GLPC) and Manihot protein concentrate (MLPC) lost weight (-5.1±1.1, -6.5±1.7 g) respectively; while those fed the protein isolates, soya protein isolates (SOPI), potato protein isolates (POPI) and reference diets gained 12.1±3.1, 11.3±2.4 and 8.2±3.2 g, respectively. The feed consumed differed significantly (P<0.05) with the highest consumed feed being rats fed SOPI-containing diets while rats fed GLPC-containing diets consumed the least (28.9±4.8 g) during the 10-day period. The protein retention value of the reference diet varied significantly from the values obtained from other diets (P≤0.05). However, other experimental diets had similar nitrogen values P>0.05. Rats on reference diet had the highest nitrogen retention value 0.22±0.05 g while rats on GLPC diet had the least retention value of 0.16±0.04 g. The protein efficiency ratio (PER) of SOPI and POPI were highest 3.6±0.4 and 2.7±0.3 respectively while those of the LPCs were negative, being -0.60 and -0.90 for GLPC and MLPC respectively. The net protein retention for the reference diet was significantly higher (P<0.05) than those of POPI and GLPC. The net protein utilization (NPU) mean value of reference diet SOPI and POPI had high values of 91.6±5.7, 88.7±5.4 and 95.9±1.4%, respectively while GLPC and MLPC had lower values of 27.4±7.3 and 55.3±6.7, respectively. The mean biological value (BV) of the
casein reference was similar to those of SOPI and POPI but significantly (P≤0.05) higher than those of GLPC and MLPC. The apparent and true digestibility of the casein reference was similar to that of SOPI and POPI but significantly (P≤0.05) higher than that of GLPC and MLPC. The true digestibility (TD) ranged from 65.8% in MLPC to 91.6% in SOPI while the apparent digestibility ranged from 61% in GLPC to 98.3% in POPI.

The results of the protein quality showed that rat fed SOPI and POPI had the highest weight gain followed by the rat fed reference diet while rat fed GLPC and MLPC lost weight. This was expected since protein isolate and the reference diet is a pure protein source with well-balanced amino acid profile (Aletor, 2010) and hence the choice with which other leaf protein concentrates (LPCs) can be compared. The WG values obtained from SOPI and POPI based diets were similar. It has long been established that green plants are excellent sources of β–carotene and protein (Barbeau, 1989; Fasuyi & Aletor, 2005; Aletor, 2010). The favourable amino acid profiles of the isolates (Aletor, 2010) may have accounted in part for the relatively remarkable weight gain and feed consumed. The consistent low feed consumption, protein retention and protein intake of the rat fed LPCs suggest that GLPC and MLPC cannot be used as a sole source of dietary protein as it will not support growth. This finding is consistent with earlier report of Oke (1973), Fasuyi (2000), Agbede and Aletor (2003), Agbede et al. (2007) who reported that leaf protein is a poor source of methionine (Oke, 1973) a sulphur-amino acid, which ideally means that such a diet needs to be supplemented with another protein source relatively rich in this amino acid.

The NR results from the experiment indicated the rats retained the similar amount of Nitrogen in the reference (casein) diet and the SOPI diet but the NR values are lower in all other diets. However, the utilization of the nitrogen retained varied considerably as was evident from the values obtained for protein efficiency ratio (PER), net protein ratio (NPR), apparent nitrogen digestibility (AND), total digestibility (TD), biological value (BV) and net protein ratio (NPR). Nevertheless, the above parameters had significantly higher and better values for rats on the reference diet (casein), SOPI and POPI, rats of GLPC and MLPC had values comparable with the result for soybean-based diet (Agbede & Aletor, 2003) and surpassed those reported by Fasuyi, 2006 on Amaranthus and Telfaria leaf meals. The results agreed with the Oke (1973) that leaf protein is highly digestible and may in fact be better than the animal protein.

Table 3 shows the multi-enzyme protein digestibility (%) of the Glyricidia and Manihot leaf protein concentrates and isolates from soya bean and potato. The protein digestibility ranges from 79.1±0.03 in SOPI to 99.68±0.6% in GLPC.
This report shows that the multi-enzyme in vitro protein digestibility of the LPCs compare favourably with those protein isolates. The values were higher (except for SOPI) than those reported for some legumes such as *P. vulgaris* (78.5%), *Lentil esculenta* (80.3%), *Cajanus cajan* (59.9%), *Carnavalia ensiformis* (78.8%) (Hsu et al., 1977; Mba, 1980; Oshodi et al., 1995).

### Table 3. In-vitro digestibility of some conventional protein concentrates (n = 2)

<table>
<thead>
<tr>
<th>Plant source protein isolate</th>
<th>% digestibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casein (reference diet)</td>
<td>78.4±0.2</td>
</tr>
<tr>
<td>SOPI</td>
<td>79.1±0.3</td>
</tr>
<tr>
<td>POPI</td>
<td>86.5±0.5</td>
</tr>
<tr>
<td>GLPC</td>
<td>99.7±0.6</td>
</tr>
<tr>
<td>MALPC</td>
<td>86.3±0.3</td>
</tr>
<tr>
<td>Mean</td>
<td>86.0</td>
</tr>
<tr>
<td>S.D.</td>
<td>8.6</td>
</tr>
<tr>
<td>CV (%)</td>
<td>10</td>
</tr>
</tbody>
</table>

Means are for duplicate determinations; SOPI = Soya bean protein isolate; POPI = Potato protein isolate; GLPC = Glyricidia leaf protein concentrate; MALPC = Manihot leaf protein concentrate; S.D = standard deviation; CV = coefficient of variation

The digestibility of protein and bioavailability of its constituent amino acids are important factors that determine protein quality. This is because not all proteins are digested, absorbed and utilized to the same extent. Differences in the protein digestibility may arise from inherent differences in the nature of food protein constituents which may modify digestion. Differences can also arise from the presence of some anti-physiological factors or from the processing conditions that alter the enzymatic processes (Sandrez-Vioque et al., 1999).

Digestibility of plant protein is usually limited by the presence of anti-nutritional factors, such as trypsin inhibitors, phytates and polyphenols (Aletor, 1993). Processing operations like washing of the protein concentrates several times are expected to minimize the effects of anti-nutritional factors leading to enhanced digestibility of the plant protein concentrates/isolates.

### CONCLUSIONS

The present study clearly indicates the high potential of LPCs as alternative protein resources for either man/livestock. However, protein quality studies indicated that the isolates may support growth while LPCs may not be suitable for use as sole protein resources. Moreover, the results on digestibility of the protein indicated that the constituent amino acids may be available to the body.
REFERENCES


