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Research Paper

A COMPARATIVE STUDY OF THE PROTEIN AND AMINO ACID COMPOSITION OF COWPEA AND SELECTED MUSHROOM SPECIES IN ABAKALIKI, NIGERIA

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Abstract

Cowpea and mushrooms have been indicated in several studies as rich sources of high quality protein among plant foods.One of such reports remarked that mushroom protein is next only to meat protein while cowpea was described as the poor man's meatin another report. The present study aimed to compare the protein and especially the amino acid composition of the two food resources. Four cowpea subspecies [*Vigna unguiculatasesquipedalis* (*Akidiani*) and *Vigna unguiculatasesquipedalis (Akidiani*), brown and iron beans] and four mushroom species [*Auricularia auricula-judae* (wood ear mushroom), *Pleurotusostreatus* (oyster mushroom), *Lentinusconnatus* and *Lentinussajor-caju*] were used in the study.The protein was quantified using the micro-Kjeldahl method and calculated from total nitrogen multiplied by a factor of 6.25, whilethe amino acids concentration was determined using the Technicon Sequential Multi-Sample Amino Acid Analyzer (TSM). The result revealed the cowpeas and mushrooms to have comparable amounts of protein, with the exception of *Auriculariaauricula-judae*.However, the cowpeas were clearly richer in amino acids including the essential amino acids than the mushrooms. Glutamic acid was the most abundant amino acid in both the cowpea and mushroom proteins while the sulphur-containing amino acids, methionine and cysteine (plus prolinein the mushrooms), were the least abundant. Lysine, leucine and phenylalanine were the most abundant essential amino acids in the cowpeas, but Leucine and threonine in the mushrooms. The Nigerian local vegetable cowpea genotypes, especially *V. unguiculatasesquipedalis*,was found to be most superior in both protein content and amino acid composition.

Key words: *Cowpea, mushroom, protein, amino acid, Abakaliki*.

INTRODUCTION

Cowpea and mushrooms are both consideredrichsources of dietary protein in literatures. Baudoin and Maquet (1999), Mahe*et al*. (1994) and Jansman (1996) wrote that grain legumes are a major source of dietary proteins. The authorsalso noted thatthe quality of cowpea seed proteinsare relatively lower than animal products, because of lower concentrations of the indispensable sulphur-containing amino acids especially methionine and cysteine. Cowpea seedsis a highly valued grain legume in the semiarid tropics of Africa, Asia, southern Europe and

Central and South America because of its high protein content(about25% on the average) making it to be described as the poor man's meat in Africa (Phillips*et al*, 2003; Rangel*et al*, 2003; Aluko and Yada, 1995; Chan and Phillips, 1994; Mwasaru*et al*., 1999; Nielsen *et al*., 1997; Singh *et al*., 1997a and Akpapunam and Sefa-Dedeh, 1997).
Similarly,Ahmed *et al*. 2013; Manjunathan*et al*. 2011; Oyetayo. 2011; Wani*et al*. 2010; Bernaś*et al*. 2006; and Alofe*et al*., 1996described mushrooms as rich sources of dietary protein, while Chang and Miles (1989) ranked mushrooms as being richer than most food sources except meat in terms of protein content. It was also noted that mushrooms are not only high in protein content, but the protein contains all the essential amino acids required by adult man (Bernaś*et al.,* 2006; Hayes and Haddad, 1976).
The literature reports on the protein values of these two groups of food resources are amazing and shows that they are both good sources of proteins. We think there is a need to compare the two foodresources for protein content and especially the essential amino acid (EAA) ˝, hence the present study compared the protein and amino acid composition of some mushroom species and cowpeaavailable in Abakaliki, Southeast Nigeria.

MATERIALS AND METHODS

Sample materials

Seeds of four cowpea subspecies and four mushroom species, a total of eight samples, were used in the study. The cowpea subspecies include vegetable*Vignaunguiculata*subspecies*sesquipedalis* and*dekindtiana* which are well adapted to the region and are respectively called *Akidienu*and *Akidiani* in the people's local language based on their climbing and prostrate habits respectively (Udensi*et al*., 2007), as well as two other *Vignaunguiculata* subspecies popularly known in the region as brown and iron beans.The four mushroom species used were identified as *Auriculariaauricula-judae* (wood ear mushroom), *Pleurotusostreatus* (oyster mushroom), *Lentinusconnatus* and *Lentinussajor-caju*. The mushrooms were harvested fresh and sundried, the vegetable cowpea seeds were obtained dry from rural farmers whereas the iron and brown bean dry seeds were bought from vendors in Abakaliki. All the samples were further oven dried overnight at 55^{o}C (Sudheepa and Sridharb, 2014).

Protein and amino acid analyses

Protein content was determined using the micro-Kjeldahl method described in the Association of Official Analytical Chemists (AOAC) methods (2006). The crude protein was calculated by multiplying the total nitrogen by a conversion factor of 6.25.The concentrations of the individual amino acids was determined using the Technicon Sequential Multi-Sample Amino Acid Analyzer (TSM) method (Benitez, 1989). The dry powdered samples were defatted and hydrolyzed in 6M HClfor 24 h at 110^{o}C. Tryptophan is destroyed by 6N HCL during the hydrolysis process. After cooling, the hydrolysate was evaporated in a vacuum evaporator, the dry residue was dissolved in acetate buffer (pH 2.0)and the solution was used to assay for amino acids with the amino acid analyzer. The concentration of each amino acid was calculated from an external standard using the area under the peak of the corresponding chromatogram and expressed in g/100g protein.

Statistical analysis

The data were subjected to the One-way ANOVA procedureof SAS software version 9.1. Differences were declared statisticallysignificant at $P \leq 0.05$ and the means were grouped by the least significant difference (LSD) analysis at 0.05 probabilitylevel.

RESULTS AND DISCUSSION

Protein content

Fig. 1 shows themean values of crude protein of the mushrooms and cowpea seeds. The samples varied widely in their protein content ($p<0.0001$). The mushroom species (*Lentinusconnatus*) had the highest amount of protein (24.62%), which was not significantly higher than that of the cowpeasubspecies *V.unguiculatasesquipedalis*(24.11%). Next wasthe mushroom, *Pleurotusostreatus* (21.82%) followed by the other three cowpea subspecies - iron bean (18.29%), brown bean (18.05%) and *V.unguiculatadekindtiana*(15.96%), while

Auriculariaauricula-judae(wood ear) mushroom had the least protein concentration (5.36%)followed by *Lentinussajor-caju*(13.87%).This distribution pattern shows that none of the two food groups was clearly richer than the other and that both are very comparable in terms of protein content. With the exception of *Auriculariaauricula-judae,*the protein values detected in this study (13.87-24.62%) are comparable to the range (17-28%) reported for three wild edible Tanzania mushroom species byMshandete and Cuff(2007) and 18.28-23.83% found in two Indian mushrooms by Sudheepa and Sridharb (2014), but lower than 28.40-32.90% reported for eleven cowpea genotypes including the two Nigerian local cultivars (*V.unguiculatasesquipedalis*and *V.unguiculatadekindtiana*) by Ojimelukwe*et al.* (2014) and28.0 – 31.80% reported for Bangladesh strains of *Pleurotusostreatus*mushroom by Ahmed *et al* (2013). These differences could be accounted for by variations in environmental conditions.

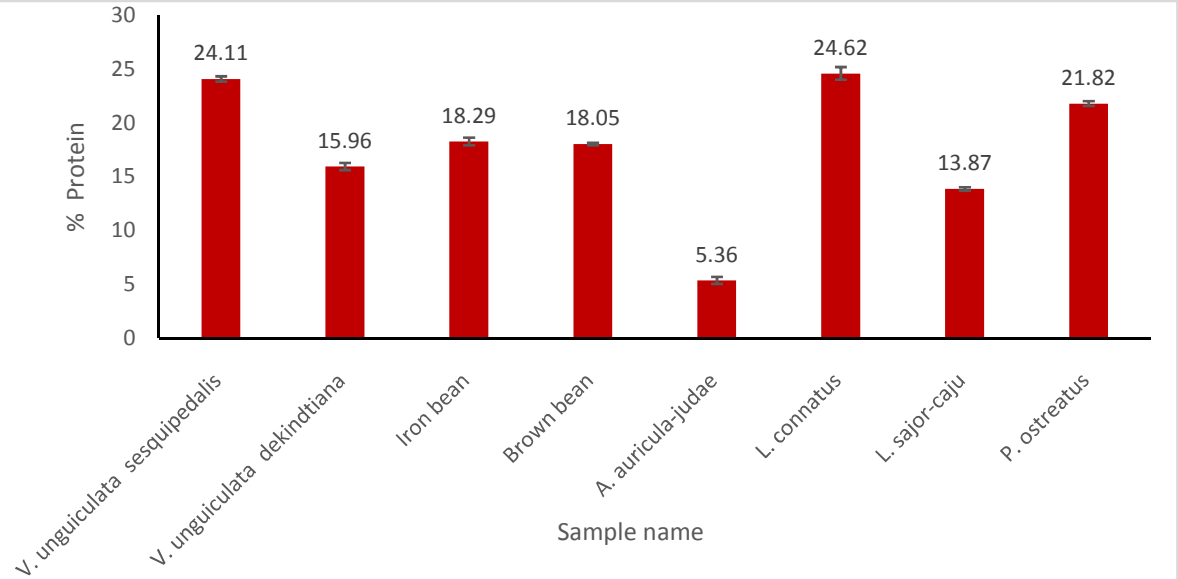

Fig. 1: Mean Protein Concentration in Cowpea and Mushroms in Abakaliki, Nigeria

Amino acid profile

There were very wide differences among the samples in their composition of the amino acids assayed for (p-values ranged from <0.0001 – 0.0210).Table 1 shows the mean concentrations of the amino acids in the proteins from the evaluated cowpea and mushroom samples. According to the result, the cowpea genotypes were generally higher in fifteen out of the seventeen amino acids tested including all the essential amino acids required by man. The amino acids viz; lysine, histidine, threonine, proline, cysteine, isoleucine, leucine,tyrosine, phenylalanine, aspartic acid, valine, methionine, serine, glutamic acid and glycine were more abundant in the cowpea seed proteins compared to the mushroom species despite the apparently comparable quantity of crude protein in the mushrooms and cowpeas. Three of the four mushroom species (*Pleurotusostreatus*, *Lentinusconnatus* and *Lentinussajor-caju*) were found to contain significantly higher quantities of arginine than all of the cowpeas. Both food groups had comparable alanine concentrations in their proteins.The result showed that the protein of the Nigerian local cowpea subspecies*V. unguiculatasesquipedalis*was the most superior ofall the samples tested.It contained the highest amount of thirteen(76.47%) of the seventeen amino acids assayed for including the EAA. It was immediately followed by the cowpea subspecies*V. unguiculatadekindtiana*.

The pattern of distribution of the amino acidsin the two food groups (cowpeas and mushrooms) differed slightly. Glutamic acid was found to be the most abundant amino acids across all the samples tested,it was consistently followed by Aspartic acid in the cowpea proteins but by

Argininein the mushrooms. Methionine and cysteine were the most limiting amino acids in both sample groups and proline is equally limiting in the mushrooms. Glutamic acid accounted for lower proportions of total amino acids in the cowpea compared to mushroom proteins. Its values in the cowpeas were 15.07% for*V. unguiculatasesquipedalis*, 15.90% for*V. unguiculatadekindtiana*, 15.57%for iron bean and 15.52% for brown bean, whereas the corresponding values in the mushrooms were 24.22% for*L. sajor-caju,*24.04% for*P. ostreatus*, 23.90% for*L.conatus* and18.55% for*A. auricula-judae.*Jaworska and Bernaś (2011); Tsai *et al*. (2008); Ahmed *et al.* (2013) and Kim *et al.* (2009) have also reported glutamic acid as the predominant amino acid in mushrooms.Muneb*et al.*(2013) and Vasconcelos*et al.* (2010) also reported glutamic acid followed by aspartic acid as the predominant amino acids in cowpea, while Seidu*et al.* (2015) reported same for lima bean (*Phaseoluslunatus* L. Walp).

The proportion of essential amino acids (EAA) were generally higher in the cowpea proteins compared to the mushrooms. The values were 49.60% in *V. unguiculatasesquipedalis*, 49.00% in *V. unguiculatadekindtiana*, 47.13% in iron bean and 47.73% in brown bean (cowpeas), butwere 33.04% in *Auriculariaauricula-judae-judae*,30.96% in *Lentinusconnatus*, 29.49% in *Lentinussajor-caju*and 29.88%in*Pleurotusostreatus*mushrooms.With the exception of tryptophan (not determined), the sum of the essential amino acids ranged from 32.77 – 40.02 g/100g protein in the cowpeas but only 12.33 – 14.38 g/100g in the mushrooms, excluding the very poor *A. auricula-judae*that scored only 9.83 g/100g. This shows that cowpea proteins are of better quality in terms of essential amino acid composition compared to those of the evaluated mushrooms.However, the range of essential amino acids in both food resources are generally lower compared to the FAO/WHO prescribed standard composition of 49.47-51.07 g/100g protein quoted in Seidu*et al.* (2015). The predominant essential amino acids in the cowpea proteins were lysine (6.64 – 7.59g/100g), leucine(6.01 – 7.26g/100g) and phenylalanine (5.57 – 7.43g/100g), while it was leucine (1.94 – 2.29g/100g) and threonine (1.74 – 2.64g/100g) in the mushrooms.Seidu*et al.* (2015) has also indicated lysine, leucine and phenylalanine as the most occurring essential amino acids in cowpea and Leucine has equally been reported as the most abundantEAA in mushrooms by Bernaś and Jaworska (2010).

CONCLUSION

The study revealed that cowpea seeds and some mushroom species like *Lentinusconnatus* and *Pleurotusostreatus* possess comparable amounts of crude protein and that cowpea seed protein is obviously richer in essential amino acids than the mushroom proteins. We found also that glutamic acid was the most abundant amino acid in both cowpea and mushrooms while the sulphur-containing amino acids, methionine and cysteine (plus proline in the mushrooms), were the least occurring.Lysine, leucine and phenylalanine were found to be the most abundant essential amino acids in the cowpeas, but Leucine and threonine in the mushrooms. The result also pictured the Nigerian local vegetable cowpea genotypes, especially *V. unguiculatasesquipedalis*,to be superior to the other cowpea subspecies and the mushrooms in both protein content amino acid composition.

Table 1: Mean Concentrations of Amino Acids in Four Cowpea Subspecies andFour Mushroom Species in Abakaliki, Nigeria

Amino Acid	*V. unguiculatasesquipedalis*	*V. unguiculatadekindtiana*	Iron bean	Brown bean	*A. auricula-judae*	*L.connatus*	*L.sajor-caju*	*P.ostreatus*	LSD 0.05
*Lysine	7.59±0.04[a]	7.20±0.13[b]	6.65±0.08[c]	7.15±0.09[b]	1.22±0.04[g]	2.15±0.06[d]	1.51±0.11[f]	1.72±0.06[e]	0.19
*Histidine	3.62±0.02[a]	3.58±0.03[a]	3.17±0.11[b]	3.24±0.06[b]	0.96±0.07[e]	1.45±0.09[c]	1.25±0.02[d]	1.20±0.09[d]	0.16
Arginine	5.70±0.00[b]	5.44±0.12[b]	5.61±0.13[b]	4.92±0.13[c]	3.37±0.12[d]	6.39±0.25[a]	6.22±0.12[a]	6.09±0.30[a]	0.36
Aspartic acid	11.20±0.13[a]	10.81±0.02[b]	10.67±0.17[b]	10.19±0.16[c]	3.00±0.02[g]	5.00±0.13[d]	4.31±0.12[e]	3.97±0.09[f]	0.28
*Threonine	3.12±0.11[a]	3.01±0.11[ab]	2.64±0.38[bc]	2.54±0.31[bc]	1.74±0.11[d]	2.64±0.064[bc]	2.20±0.21[cd]	2.62±0.20[bc]	0.48
Serine	3.39±0.11[a]	3.14±0.18[ab]	3.12±0.04[b]	3.20±0.16[ab]	2.07±0.08[e]	2.54±0.09[c]	2.23±0.08[de]	2.34±0.09[cd]	0.27
Glutamic acid	13.03±0.21[a]	13.22±0.16[a]	11.97±0.11[b]	11.40±0.16[c]	5.53±0.11[e]	11.10±0.16[c]	10.15±0.21[d]	10.45±0.21[d]	0.39
Proline	3.16±0.15[a]	3.00±0.07[a]	2.70±0.22[bc]	2.65±0.00[c]	0.20±0.00[d]	0.31±0.15[d]	0.41±0.00[d]	0.46±0.07[d]	0.26
Glycine	3.42±0.09[a]	3.27±0.13[ab]	3.09±0.09[bc]	2.97±0.12[c]	1.32±0.10[e]	1.55±0.16[e]	1.55±0.05[e]	2.14±0.17[d]	0.26
Alanine	3.69±0.05[a]	3.54±0.16[a]	3.50±0.22[ab]	3.08±0.16[c]	3.44±0.08[abc]	3.74±0.35[a]	3.65±0.16[a]	3.84±0.05[a]	0.41
*Cysteine	1.13±0.09[a]	1.00±0.09[a]	0.96±0.04[a]	0.76±0.14[b]	0.30±0.05[c]	0.43±0.04[c]	0.37±0.05[c]	0.33±0.20[c]	0.19
*Valine	5.48±0.29[a]	5.10±0.16[b]	4.40±0.12[c]	4.07±0.18[c]	1.25±0.12[e]	1.62±0.09[d]	1.51±0.21[de]	1.48±0.04[de]	0.37
*Methionine	1.13±0.06[a]	1.00±0.16[a]	1.03±0.06[a]	0.97±0.11[a]	0.35±0.01[c]	0.55±0.07[b]	0.59±0.02[b]	0.56±0.01[b]	0.17
*Isoleucine	3.28±0.16[a]	3.14±0.13[ab]	2.76±0.13[cd]	2.47±0.27[d]	1.03±0.07[e]	1.35±0.16[e]	1.22±0.07[e]	1.30±0.14[e]	0.34
*Leucine	7.26±0.16[a]	7.05±0.23[a]	6.50±0.20[b]	6.01±0.27[c]	1.94±0.08[d]	2.29±0.16[d]	2.27±0.12[d]	2.17±0.10[d]	0.43
Tyrosine	2.86±0.00[a]	2.70±0.23[ab]	2.38±0.23[bc]	2.30±0.11[c]	1.03±0.11[e]	1.43±0.23[d]	1.03±0.11[e]	1.19±0.11[de]	0.35
*Phenylalanine	7.43±0.23[a]	7.01±0.12[a]	5.78±0.18[b]	5.57±0.48[b]	1.06±0.06[d]	1.90±0.06[c]	1.44±0.12[cd]	1.61±0.12[c]	0.47

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