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Full Length Research Paper

Seed protein content variation in cowpea genotypes

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The level of variation in seed protein content in a population of 101 cowpea genotypes obtained from the Genetic Resources Unit of IITA Ibadan, Nigeria, was studied using the micro-Kjeldahl method. The aim of this study was to understand the protein variability of cowpea genotypes for better management of its breeding programs for improved protein cultivars. The analysis of variance on the obtained data showed highly significant genotypic differences (P<0.0001) among the cowpea cultivars. The detected seed protein values ranged from (15.06 to 38.50%) with a mean of 25.99 ± 4.82% in dry seeds. Out of the 101 genotypes analysed, only 20 genotypes (representing 19.80%) had protein values greater than 30%, which were considered high protein lines in this study. As high as 73 genotypes (72.28%) were of medium protein content (20 to 30% protein), whereas 8 genotypes (7.92%) were of low protein (less than 20% protein). This distribution suggests a need for more breeding efforts to increase the proportion of high protein cowpea genotypes and provides information for selecting superior parental genotypes in breeding programs for improved cowpea varieties based on protein content.

Key words: Cowpea, protein content variability, cowpea breeding.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp) is one of the most important food legume crop grown in semi - arid tropics covering Africa, Latin America, West Indies, India, South-east Asia and the southern United States (Badiane et al., 2004). West Africa produces about 80% of the world's total cowpea production, with Nigeria, Niger and Senegal as the principal producers (Ogbonnaya et al., 2003). In Nigeria, the grain legume is mostly grown in the drier climate of the North than in the humid South, where high humidity causes diseases and drying problems (Aggarwal et al., 1982).

As a drought tolerant and warm weather crop, cowpea is well adapted to the drier regions of the tropics and is therefore an important famine food producing significant grain in dry years when all other crops fail to produce (Ehlers and Hall, 1997).

Cowpea belongs to the family *Leguminosae*, subfamily Faboideae, tribe *Phaseoleae*, genus *Vigna*, subgenus *Ceratotropis* and species *unguiculata* (Mahalakshmi et al., 2007). It has a number of common names including crowder pea, black eyed pea and southern pea (Verdcourt, 1970) and is generally called beans in Nigeria.

Because of its high protein (about 25%), vitamins and minerals content, cowpea plays an important role in both human and animal nutrition (Li et al., 2001; Nielsen et al., 1997; Singh et al., 1997). Cowpea is generally consumed

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in many forms. The young leaves, green pods and green seeds are eaten as vegetables whereas dry seeds are used in a variety of food preparations (Nielsen et al., 1997). The haulms are also very nutritious, containing about 15 to 17% protein, which is highly digestible and useful as a fodder for livestock (Singh, 2007; Tarawali et al., 1997a and Tarawali et al., 1997b). It also has the useful ability to fix atmospheric nitrogen through its root nodules, and grows well in poor soils (Singh, 2003).

Cowpea protein is rich in the amino acids, lysine and tryptophan, compared to cereal grains; however, it is deficient in methionine and cystine when compared to animal protein. Therefore, its seed is valued as a nutritional supplement to cereal and an extender of animal protein (Steel, 1985).

However, most studies on cowpea characterization for variation in protein content were carried out on relatively few varieties of cowpea. In this study, a fairly large population of cowpea (101 varieties) was screened to obtain a better estimate of the variability in seed protein content among cowpea varieties, which is useful for selecting good parental lines in cowpea breeding programs for improved protein varieties.

MATERIALS AND METHODS

Sample collection

A total of 101 cowpea genotypes, comprising of 97 Nigerian landraces and four exotic lines, were used. Two of the exotic cultivars have their origin in Sudan; one was from Cote d Ivoire, while one was from Mozambique. All the seeds were obtained from the Genetic Resources Unit of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria.

Sample preparation

The dry cowpea seeds were de-hulled manually with a sharp laboratory knife and ground into fine powder with a mortar and pestle.

Determination of seed protein content

The seed protein content was estimated using the Kjeldahl method described in AOAC (1984). This method involves protein digestion, distillation and determination of % nitrogen content of the distillate by titration and then multiplying the % nitrogen by a factor of 6.25 to obtain the corresponding protein content in %.

Data analysis

The data were analysed for differences in protein content among the cowpea genotypes using the ANOVA procedure of SAS Software Version 9.1 and differences were declared significant when p-value is less than 0.05. Differences for means of various genotypes were computed using least significance differences test (LSD) also at 0.05 level of probability.

RESULTS AND DISCUSSION

Improvement of grain quality is a major objective of most breeding programs and the presence of diverse source material has been associated with progress in plant breeding (Mangova and Rachovska, 2004).The variability in protein content among the vast number of different cultivars grown in Nigeria need to be properly documented for better management of cowpea breeding programs for improved protein cultivars.

Most of the previous similar studies on cowpea generally involved few genotypes. In this study, a total of 101 accessions, including 97 Nigerian landraces and 4 exotic lines, were analyzed for variation in total seed protein content using the Kjeldahl method. The cowpea accessions showed very high degree of variability in protein content ($p < 0.0001$). The seed protein content of the 101 accessions ranged from 14.81 to 40.97% with a mean value of 25.99 ± 4.82% (Table 1).

For easy comprehension of protein variability in the cowpea population, cowpea varieties with mean protein values greater than 30% were considered high protein lines, 20 to 30%)were regarded as medium protein lines and < 20% were classified as low protein lines in this study. Based on the above grouping, the result showed that majority of the cowpea genotypes were of medium protein content. Only 20 genotypes out of the 101 genotypes (19.80%) were high protein lines with protein values ranging from 29.65 to 40.97%, as high as 73 genotypes (72.28%) were of medium protein with values ranging from 19.95 to 31.20%, whereas only 8 genotypes (7.92%) were of low protein (14.81 to 22.07%). The highest protein values were found in genotypes TVu-4045 (38.50%), TVu-7112 (37.41%), 11979 (36.82%), TVu-9176 (33.75%), and TVu-9357 (33.69%), while the least values were obtained in genotypes TVu-7846 (15.055%), TVu-8586 (15.64%), TVu-9776 (15.68%), TVu-4007 (16.01%) and TVu-9036 (16.37%).

Several literature reports indicated that cowpea seed protein content range from 21 to 30% (Aluko and Yada, 1995; Chan and Phillips, 1994; Mwasaru et al., 1999). Our results in this study were highly consistent with those literature reports. Based on the result, only 21 out of the 101 cowpea accessions (20.79%) deviated from the commonly reported range, with just about 6.93% showing lower and 13.86% showing higher protein compared to the commonly reported range. The relatively large population of cowpea varieties used in this study may account in part for the observed deviation from literature

Table 1. Mean protein content of some cowpea varieties determined by the Kjeldahl method (n = 4).

S/No	Category	Genotype	% Protein	No. of genotypes
1	High (> 30%)	TVu-4045	38.50 ± 2.47	
2		TVu-7112	37.41 ± 1.55	
3		TVu-11979 [¥]	36.82 ± 2.38	
4		TVu-9176	33.75 ± 1.15	
5		TVu-9357 [*]	33.69 ± 1.55	
6		TVu-1455	32.79 ± 1.33	
7		TVu-4100	32.75 ± 2.20	
8		TVu-9773	32.60 ± 0.30	
9		TVu-4049	32.12 ± 0.25	
10		TVu-7109	31.90 ± 2.67	
11		TVu-9790	31.61 ± 0.16	
12		TVu-9780	31.28 ± 0.62	
13		TVu-4034	30.74 ± 0.09	
14		TVu-4015	30.63 ± 0.49	
15		TVu-6318	30.43 ± 0.89	
16		TVu-6819	30.21 ± 0.03	
17		TVu-8387	30.10 ± 1.48	
18		TVu-6932	30.10 ± 0.44	
19		TVu-7848	30.02 ± 1.73	
20		TVu-3910	30.02 ± 0.37	
			32.48 ± 2.92	20
21	Medium (20-30%)	TVu-930	29.97 ± 1.23	
22		TVu-3960	29.95 ± 0.28	
23		TVu-7995	29.71 ± 0.56	
24		TVu-9779	29.60 ± 0.28	
25		TVu-4260	29.58 ± 0.56	
26		TVu-160	29.51 ± 2.14	
27		TVu-1197	29.38 ± 0.16	
28		TVu-9774	29.34 ± 0.64	
29		TVu-561	29.31 ± 0.63	
30		TVu-729	29.20 ± 5.11	
31		TVu-442	29.20 ± 2.63	
32		TVu-1138	29.16 ± 0.28	
33		TVu-3919	29.07 ± 0.65	
34		TVu-331	28.46 ± 3.75	
35		TVu-4047	28.37 ± 1.46	
36		TVu-6320	28.07 ± 1.27	
37		TVu-1262	27.57 ± 6.12	
38		TVu-6815	27.39 ± 1.17	
39		TVu-12348 [§]	27.19 ± 1.33	
40		TVu-7110	27.11 ± 0.04	
41		TVu-1260	27.02 ±0.0 9	
42		TVu-8042	26.97 ± 3.31	
43		TVu-4044	26.69 ± 0.06	
44		TVu-9772	26.65 ± 0.56	
45		TVu-7097	26.43 ± 0.56	
46		TVu-4095	26.39 ± 0.64	
47		TVu-4415	26.25 ± 0.31	
48		TVu-7117	26.17 ± 0.25	
49		TVu-6847	26.04 ± 0.93	

Table 1 Contd.

50		TVu-7983	25.86 ± 0.25	
51		TVu-9784	25.84 ± 0.04	
52		TVu-8164	25.82 ± 1.36	
53		TVu-7838	25.53 ± 0.21	
54		TVu-6325	25.42 ± 0.13	
55		TVu-11986[¥]	25.25 ± 0.80	
56		TVu-461	25.20 ± 0.99	
57		TVu-4408	25.09 ± 0.03	
58		TVu-4009	24.94 ± 0.06	
59		TVu-9185	24.79 ± 0.46	
60		TVu-1263	24.74 ± 0.16	
61		TVu-6674	24.63 ± 0.50	
62		TVu-3933	24.55 ± 1.18	
63		TVu-9167	24.55 ± 0.13	
64		TVu-7962	24.41 ± 1.48	
65		TVu-4046	24.28 ± 1.72	
66		TVu-4089	24.22 ± 0.09	
67		TVu-4028	24.02 ± 1.36	
68		TVu-848	23.72 ± 0.12	
69		TVu-8580	23.39 ± 0.22	
70		TVu-9769	23.35 ± 0.09	
71		TVu-6833	23.34 ± 0.03	
72		TVu-7920	23.04 ± 0.35	
73		TVu-7083	22.91 ± 0.22	
74		TVu-7898	22.91 ± 0.22	
75		TVu-6830	22.91 ± 0.09	
76		TVu-7491	22.90 ± 0.16	
77		TVu-7531	22.86 ± 0.16	
78		TVu-8546	22.82 ± 0.22	
79		TVu-4068	22.75 ± 2.24	
80		TVu-6778	22.60 ± 0.77	
80		TVu-764	22.38 ± 0.09	
81		TVu-7870	22.27 ± 0.55	
82		TVu-7488	22.20 ± 0.34	
84		TVu-7833	22.20 ± 0.16	
84		TVu-4083	21.88 ± 2.17	
85		TVu-867	21.77 ± 1.39	
87		TVu-9788	21.38 ± 0.28	
88		TVu-9787	21.15 ± 0.16	
89		TVu-939	21.05 ± 0.06	
90		TVu-6804	20.96 ± 0.68	
91		TVu-7815	20.70 ± 0.80	
92		TVu-7853	20.65 ± 1.43	
93		TVu-6822	20.57 ± 0.62	
			25.26 ± 2.82	73
94	Low (<20%)	TVu-10112	19.91 ± 2.16	
95		TVu-702	18.75 ± 0.52	
96		TVu-839	16.50 ± 0.74	
97		TVu-9036	16.37 ± 1.55	
98		TVu-4007	16.01 ± 1.17	
99		TVu-9776	15.68 ± 0.72	

Table 1 Contd.

100	TVu-8586	15.64 ± 1.46	
101	TVu-7846	15.06 ± 0.25	
		16.98 ± 2.35	8
	P-value	< 0.0001	
	CV (%)	5.31	
	LSD-value	2.74	

*From Cote d Ivoire, ¥ Sudan, § Mozambique and others Nigeria.

reports as most of the previous studies involved fewer varieties, while experimental error may also play a part. According to Chan and Phillips (1994) and Oliveira *et al*. (2004), cowpea protein content vary widely among cultivars owing to differences in genetic attributes, as well as methods of extraction and determination.

Although majority of the cowpea accessions were of medium protein as revealed in this study, the proportion of the cowpea population that were of high protein content based on the employed grouping (19.80%) was very low. This therefore suggests a need for more breeding efforts to increase the proportion of high protein cowpea genotypes. The study also provided information for selecting superior parental genotypes in breeding programs for improved cowpea varieties based on protein content.

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