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Short Communication

Physico chemical and functional properties of six different varieties of cowpea (*Vigna unguiculata* L.)

AA JOSHI, CK BHOKRE and AB RODGE

Dept. of FCN, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani-431402, MS, India

E-mail: anuprita.2013@rediffmail.com

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ABSTRACT

A study was carried out during the year 2012-13 to determine the physicochemical properties of seeds of six different varieties of cowpea obtained from AICRP on Arid legumes at Parbhani centre to assess their potential use in the food industry. Length, width and breadth of seeds were in the range 6.87-8.58; 5.05-6.43 and 3.76-4.78mm respectively while 100 grain weight of seeds varied between 9.25 to 13.50 g. Cooking time ranged from 37to 42 min. Crude protein was in the range of 20.13 to 27.45%. Moisture, fat, ash and crude fibre values were in the range of 8.98 to 10.39%, 0.79 to 2.20%, 2.01 to 3.08% and 1.92 to 4.77% respectively. Carbohydrate content varied between 50.13 to 57.13 %. Cowpea seed flours were good in water absorption capacity and it varied between 0.95 and 1.99 gg^{-1} while oil absorption capacity ranged from 0.40 to 2.0 gg-^{1} Bulk density, foam capacity and foam stability were in the range 0.64 to 0.68 g / ml, 12.6 to 21.0 ml and 12.6 to 21.0min respectively. Swelling capacity and hydration capacity ranged from 0.09 to 0.18ml/ seed and 0.09 to 0.15gseed^{-1} respectively while emulsion capacity and stability varied from 9.0 to 17.0 and 21.69 to 23.0 min respectively. The *In vitro* Protein Digestibility (IVPD) of cowpea flour was in the range of 86.13 to 89.53% and genotype PGCP-15 had the highest IVPD (89.53%). The result of the composition of the different varieties of cowpea seeds showed that the genotype DC-15 had the highest protein content (27.45%) with good functional properties i.e. highest WAC (1.99gg^{-1}), FC (21ml), FS (21min), EA (17min) and highest ES (23min). Next to this the genotype PGCP-16 was at second position in protein content (26.22%) with highest swelling and hydartation capacity i.e. 0.18 and 0.15 g seed^{-1} respectively. Genotype VCP-09-19 had least protein (20.13%), FC (12.6ml), FS (12.6ml), EA (9min), ES (21.69min) and IVPD (86.13%) respectively.

Key words: Cowpea, physicochemical properties, IVPD, swelling capacity, hydration capacity

Cowpea (*Vigna unguiculata* (L.)), like other grain legumes is important in tropical and subtropical countries. Cowpeas constitute about 52% of the total world output of grain legumes. It is widely cultivated and distributed in Africa, Asia, West Indies, Latin America and India. The legume can be grown in marginal soils and in arid or semi arid regions. It is a highly nutritious crop with a dry seed protein content of about 25% and protein digestibility higher than that of other legumes. It is consumed by relatively rural and peri urban people of less developed countries. Rural families derive food protein, animal feed (Tarawali *et al.*1997 and Singh, 1999) and cash from the production of this crop (Quin, 1997). Its deep penetrating root system enables it to withstand very dry conditions. In addition, the crop fixes 80% nitrogen for its growth demand from the atmosphere (Asiwe *et al.*2009), thereby reducing nitrogen fertilizer demand and production cost for the crop. It is also an important companion crop in most cereal-legume cropping systems because of the benefit from the residual nitrogen originating from the decay of its leaf litter, roots and root nodules (Okereke *et al.*2006). Although many new cowpea cultivars are being developed in order to improve yield, resistance, quality of cowpea etc, there are still some wild cultivars that have potentials not harnessed or that its utilization have been neglected. Therefore, information about the physicochemical and functional properties of some underutilized varieties is very important to the food processors and nutritionists. The identification of some functional properties of local varieties of cowpea is essential in determining potential uses of such seeds in the formulation of foods. The objective of this research work was to determine and compare the physicochemical and functional characteristics of different varieties of cowpea seeds. The legume seeds of different genotypes of Cowpea were obtained from All India Coordinated Project on Arid Legume Parbhani. Extraneous matter such as unhealthy seed, infected seed, sand and chaff were removed from the samples. The samples were separately ground with an attrition mill and sieved to a particle size of 1mm. Flour samples were packed and stored in air tight labelled plastic bottles prior to analysis. The colour of beans was determined according to the method of Munshell colour chart. Using vernier caliper, the length, width and breadth of seeds were determined. 100-seed weight was determined by weighing 100 randomly selected raw seeds of each variety as recommended by AOAC (Anonymous, 2000). The bulk density was determined by the method of Onwuka (2005). Seed porosity**:** Seed porosity is a property of grain which depends on its bulk- and kernel densities. Seed porosity (P) was determined using the equation stated by

Mpotokwane *et al*. (2008) as follows:

P = (1-Pb/Pt)*100; Where pb = bulk density (kgm-3) and pt = seed density (kgm^{-3}).

The cowpea varieties were analyzed for moisture, protein, fat, ash, crude fibre, and carbohydrate was determined by difference. All determinations were carried out using standard procedures AOAC (Anonymous, 2000).

The procedure of Coskuner and Karababa (2003) was followed for measurement of swelling capacity. Swelling capacity (SC) of the seeds was calculated as follow and expressed as ml/seed.

$$\text{Swelling capacity (SC)} = \frac{[(\text{volume after soaking}) - (\text{volume before soaking})]}{\text{Seed volume (ml)}}$$

The procedure of Coskuner and Karababa (2003) was followed for measurement of hydration capacity. Hydration capacity (HC) of the seeds was recorded as follow and expressed as g seed^{-1}.

$$\text{Hydration capacity (HC)} = \frac{[(\text{weight after soaking}) - (\text{weight before soaking})]}{100}$$

The procedure of Beuchat *et al*. (1975) was adopted as described by Eke (2000) for determination of Emulsifying activity. The emulsion capacity was expressed as ml of oil emulsified per g of flour. Emulsion Stability was determined using the procedure described by Kinsella (1979). The foaming capacities of flour samples were determined according to Onwuka (2005). The foam capacity was expressed as per cent increase in volume using the formula of Abbey and Ibeh (1988) as reported by Onwuka (2005).

$$\text{Foaming capacity} = \frac{(\text{Volume after whipping}) - (\text{Volume before whipping})}{\text{Volume before whipping}} \times 100$$

Foam stability of samples (flours) was determined using the methods described by Chinma *et al*. (2008). The method of Carcea Benecini (1986) was used for determination of Water and oil absorption capacity. The oil/water absorption capacities were expressed as grams of oil/water absorbed per gram of flour sample. Cooking time of each cowpea variety was determined according to the method of Akinyele *et al*. (1986).

The data obtained were analyzed statistically by Completely Randomized Design (CRD) as per the procedure given by Panse and Sukhatme (1985).

The results of physical properties of the different varieties of cowpea seeds are presented in table 1. The length of the seed ranged from 6.87 to 8.58 mm, width from 5.05 to 6.43 mm and breadth from 3.76 to 4.78 mm. The differences between the length , width and breath of the cowpea varieties were significant (P>0.05).The genotype PGCP-15 was significantly longer (8.58 mm) and had maximum breadth (4.78 mm) than rest of genotypes.

The seed were all reddish yellow to brown in colour, and had black eye. There were, also significant difference among the 100-seed weight of the cowpea varieties which ranged between 9.25 and 13.50g. The cowpea seeds were found to have bulk density values of 0.64 to 0.68gml^{-1} and they were high in comparison with the bulk densities of local varieties of cowpea seeds grown in Nigeria i.e 0.29 and 0.32 gg^{-1} as reported by Chinma *et al*.(2008). Density of cowpea genotypes was found in the range 1 to 1.11 g ml^{-1}. The porosity of the cowpea genotypes ranged from 37.92 to 64.50 per cent with genotype PGCP-15 having maximum porosity (64.45gml^{-1}).

The genotype GC-911 had the highest bulk density (0.68 gml^{-1}). The high bulk density (0.64-0.68 gml^{-1}) indicates that their flours are heavy. The high bulk densities of the flours suggest their suitability for use in various food preparations. According to Padmasshree *et al*. (1987), higher bulk density is desirable for greater ease of dispersibility of flours. In contrast however, low bulk density would be an advantage in the formulation of complementary foods (Akpata and Akubor, 1999). Since PGCP-15, PGCP-16 and DC-15 genotypes had the least bulk density (0.64gcm^{-3}) these could be the most suitable for production of complementary foods.

Table 2 includes the data of the proximate composition of the six varieties. The moisture content of

Table 1. Physical properties of cowpea varieties.

Variety	Parameters							
	Length (mm)	Width (mm)	Breadth (mm)	100 kernel wt (g)	Density gml^{-1}	Bulk Density gml^{-1}	Porosity (%)	Colour
VCP-09-19	6.87	5.53	3.99	9.30	1.11	0.66	40.0	5YR 4/6 Yellowish red
GC-911	7.35	5.05	4.58	10.15	1.11	0.68	37.92	10YR 7/4 Very pale brown
PGCP-16	8.25	6.43	4.58	13.36	1.11	0.64	41.89	10YR 8/2 white
PGCP-15	8.58	6.28	4.78	13.50	1.00	0.64	64.50	10YR 8/3 Very pale yellow
DC-15	8.08	5.89	4.36	10.10	1.11	0.64	41.89	2.5YR 4/6 Red
KBC-5	7.64	5.33	3.76	9.25	1.11	0.66	41.89	7.5YR 6/6 Reddish yellow
SE	0.25	0.16	0.14	0.02	0.01	0.002	0.03	-
CD	0.78	0.50	0.44	0.06	0.03	0.008	0.11	-

the different varieties of cowpea was found to be in range 8.98 to 10.39%. The crude protein for the different varieties of cowpea expressed significant different (P < 0.05). The seed of cowpea variety DC-15 had the highest protein content (27.45%). Since the cowpea varieties were grown under similar conditions, their differences could be mainly genetic. The fat content for the different varieties of cowpea were significant (P < 0.05) with values ranging from 0.79 to 2.20. The crude fiber for these varieties of cowpea was in the range of 1.92 to4.77%. The carbohydrate content for the different varieties of cowpea was found to be in the range 50.13 to 57.13%.

The results of analysis on the functional properties of seeds of different cowpea varieties are reported in Table 3. The swelling capacity of the cowpea seed significantly differed from each other and ranged between 0.09 and 0.18 with PGCP-16 having the greatest swelling capacity (0.18) and KBC-5 having the least. Hydration capacity of seed were found in range between 0.09 to 0.15.The hydration capacity of genotype PGCP-16 was significantly high (0.15) while genotype KBC-5 recorded lowest (0.09) hydration capacity. Water absorption capacity ranged between 0.95 and 1.99 gg^{-1}. The DC-15 genotype had significantly higher water absorption capacity as compared to other genotypes. The high water absorption capacity of the flours suggests that they would be useful functional ingredients in bakery products.

The oil absorption capacity of the flours of the cowpea varieties ranged between 0.40 to 2.00 gg^{-1}. The differences between DC-15 and GC-911 were not significant (P>0.05), however PGCP-16 was significantly superior to other genotypes. PGCP-16 genotype could, therefore, be superior to other cowpea genotypes as flavour retainer since it had significantly higher oil absorption capacity (2 gg^{-1}). The ability of the proteins of these cowpea varieties to bind oil makes them useful in food systems where oil imbibition is desired. The flours could, therefore, have functional uses in foods such as sausage production. The high oil absorption capacity also makes the flours suitable in facilitating enhancement in flavour and mouth feel when used in food preparations. The foaming capacity of the 6 varieties varied from 12.6 to21.0 ml, while DC-15 genotype foamed most (21.0 ml), followed by PGCP-16 (20.8ml). The foaming stability of DC-15 genotype (21min) was recorded the highest followed by PGCP-16(20.8 min) and KBC-5(18.9 min). Since the DC-15 genotype produced significantly more foam and had the highest stability than both other cowpea genotypes, it would be most useful as foam enhancer in food systems. The emulsifying activity of the 6 varieties varied from 9.0 to17.0 min and emulsifying stability varied between 21.69 to 23.0min. The differences were also observed in cooking time. GC-911 genotype had the shortest cooking time of 37 min, followed by DC-15 (38 min) and PGCP-16 (39 min). Short cooking time is desirable as it reduces duration and energy used in cooking as well as saves labour cost. The genotype VCP-09-19 had maximum cooking time (42min). Modern trend towards convenience foods with reduced cooking time makes genotype GC-911 superior to the other genotypes of cowpea, therefore, could be more acceptable to consumers and processors with limited time and resources. *In vitro* protein digestibility of

Table 2. Proximate composition (%) of cowpea varieties

Variety	Parameters (%)						
	Carbohydrates	Protein	Fat	Crude Fiber	Ash	Moisture	Tanninn
VCP-09-19	57.13	20.13	0.79	1.92	2.91	9.50	0.65
GC-911	56.53	21.43	**1.23**	2.36	3.01	10.39	0.65
PGCP-16	50.13	26.22	1.00	4.77	2.53	9.83	0.83
PGCP-15	52.14	20.97	1.26	2.80	2.80	9.15	0.78
DC-15	52.22	27.45	2.01	4.30	2.01	9.79	0.63
KBC-5	51.40	25.91	2.20	2.15	3.08	8.98	0.34
SE	0.12	0.35	0.08	0.04	0.04	0.11	0.02
CD	0.37	1.08	0.25	0.12	0.15	0.35	0.09

Table 3. Functional properties of cowpea varieties

Variety	**Parameters**									
	SC ($mlseed^{-1}$)	**HC ($gseed^{-1}$)**	**WAC (gg^{-1})**	**OAC (gg^{-1})**	**FC (ml)**	**FS (min)**	**EA (min)**	**ES (min)**	**Cooking Time (Min)**	**Digestibility (%)**
VCP-09-19	0.12	0.11	0.95	1.45	12.6	12.6	9.0	21.69	42.0	86.13
GC-911	0.11	0.10	1.87	0.48	16.0	16.0	13.0	22.10	37.0	86.73
PGCP-16	0.18	0.15	1.94	2.00	20.8	20.8	16.8	22.83	39.0	88.40
PGCP-15	0.16	0.14	1.65	0.59	15.5	15.5	12.5	22.07	40.0	89.53
DC-15	0.12	0.10	1.99	0.40	21.0	21.0	17.0	23.00	38.0	87.50
KBC-5	0.09	0.09	1.93	1.18	18.9	18.9	16.0	22.68	40.0	88.38
SE	0.005	0.003	0.09	0.12	0.58	0.49	0.40	0.34	0.76	0.46
CD	0.017	0.009	0.29	0.38	1.79	1.52	1.24	1.07	2.34	1.42

SC-swelling capacity, HC-hydration capacity, WAC-water absorption activity, OAC-oil absorption capacity, FC-foaming capacity, FS-foaming stability, EA-emulsion activity, ES-emulsion stability.

cowpea genotype PGCP-15 was highest (89.53 %), while lowest value was recorded for genotype VCP-09-19 (86.13%).

The results of the composition of six different varieties of cowpea seeds tested in the present study shows that the genotype DC-15 with highest protein content of 27.45 also have good functional properties i.e. highest WAC (1.99gg^{-1}), FC (21.0ml), FS (21.0min), EA (17.0min) and highest ES (23.0min) which could be exploited for nutrition and food formulation therefore has great potential in combating the protein-energy malnutrition in developing countries. The good functional properties make it useful in foods such as koose, sauces and stews where they could play functional roles. Nonetheless, the DC-15 variety could be most suitable among the all the varieties of cowpea under study for food uses since it had the best functional properties.

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