Cooking Quality and Chemical Composition of Some Early, Medium and Late Maturing Cultivars of Pigeon Pea (*Cajanus cajan* (L.) Mill)

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Twenty pigeon pea (red gram) cultivars belonging to early, medium and late maturity groups grown during two seasons were studied for the cooking quality and chemical composition. Although no clearcut differences in cooking time, water absorption, solids dispersion, texture (extrusion force) and chemical constituents of cultivars of different maturity groups were observed, the cooking quality of early cultivars appeared to be better than those of the medium and late ones. Of the various physicochemical characteristics, water absorption, solids dispersion and texture were highly and significantly correlated with the cooking time. This shows that these characteristics can be conveniently used as objective tests to study the cooking quality of pigeon pea cultivars.

Traditional processing practices have been followed for many years to convert grain legumes into the consumable forms. Such processes not only improve the digestibility and palatability of food legumes but also help to remove deleterious effects of some antinutritional constituents. Pigeon pea is an important food legume of several countries in semi-arid tropical and semi-tropical regions of the world. In India, it is consumed in the form of dhal (decorticated dry spilt seeds) cooked with water until it becomes soft. Efforts have been made to study the association between the cooking quality and physicochemical properties of pigeon pea[1-3].

Baesd on the maturity period, pigeon pea cultivars can be broadly grouped into three groups: early, medium and late cultivars requiring 90-130, 130-170 and 170-280 days, respectively. Little information is available on the cookin quality and nutritional aspects of pigeon pea cultivars belonging to different maturity groups. Recently, it was reported that late cultivars were superior to early ones in seed yield, 100-seed weight, dhal yield and seed protein content[4]. We examined the cooking quality and chemical composition of early, medium and late maturing cultivars and the results are reported in this paper.

Materials and Methods

Pigeon pea cultivars belonging to different maturity groups grown in two successive years were evaluated. The pigeon pea was grown on black soils at ICRISAT Centre, Patancheru, near Hyderabad (17°N). India, during the rainy seasons of 1975–76 and 1976–77. The cultivars studied are given in Tables 1 and 2. Dhal (decorticated split cotyledons) were prepared by removing seed coat manually after soaking the whole seed in water overnight at 5°C. These were dried for 16 hr in an even at 65°C. For various chemical analyses dhal

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samples were ground in a Udy cyclone mill using a 0.4 mm screen and defatted in a Soxhlet apparatus using hexane.

Cooking time: Cooking time was determined by boiling the dhal in distilled water using a BD-20 heating block digestor (Tecator, Sweden). Suitable amount (10.0±0.5 g) of dhal was boiled in 75 ml of distilled water and the volume of water was maintained during cooking by adding boiling water. Boiled samples were removed at an interval of 1 min and examined for their softness by pressing between the forefinger and thumb, to determined its cooking time. Cooking time was the minimum time interval at which dhal was considered to be completely cooked by two persons out of a panel of three persons.

Water absorption: A suitable quantity (5.0 g±0.5 g) of dhal was taken in a digestion tube and boiled in excess distilled water (35 ml) for 25 min using the BD-20 block digestor. The excess water, after boiling, was decanted and the dhal was weighed. The amount of water taken up by the dhal was calculated and the results are expressed as per cent water absorption.

Solids dispersed: The percentage of solids dispersed into the cooking water was determined by boiling 5 g dhal for 25 min. The boiled material was passed through a 10 mesh sieve and the residue was thoroughly washed with distilled water. After washing, residue was dried at 110°C for 3 hr. The loss in weight of dhal after boiling was calculated and termed as per cent solids dispersion into cooking water.

Texture (extrusion force in kg): The texture was determined by using the back extrusion cell in the Instron

TABLE 1. COOKING TIME AND PHYSICO-CHEMICAL CHARACTERISTICS OF DHAL OF EARLY, MEDIUM AND LATE MATURING CULTIVARS GROWN DURING 1975–76

Cultivar	Cooking time (min)	Solids dispersed (%)	Water absorption (g/g dhal)	Texture (extrusion force, kg)	Phytic acid (mg/g)	Ca (mg/100g)	Mg (mg/100g)	Pectin (mg/100g)
				Early				
UPAS-120	26	50.6	1.8	150	14.5	68	120	31.0
Pant A-2	24	45.0	2.0	125	16.4	70	127	35.9
Prabhat	41	34.4	1.6	220	13.9	70	152	48.0
T-21	34	34.3	1.7	175	12.5	73	125	37.5
DL-74-1	28	38.1	1.9	135	14.6	76	127	31.9
				Medium				
C-11	32	31.7	1.7	180	15.1	72	133	35.4
No-148	35	46.2	1.6	200	14.5	90	160	37.0
Hy-3c	47	28.8	1.5	285	12.3	73	132	36.4
ICP-1	29	45.6	1.9	165	13.0	71	140	38.3
BDN-1	38	36.2	1.7	205	15.9	90	129	34.5
Mukta	48	30.8	1.5	278	12.2	87	168	35.8
Hy-2	47	34.6	1.5	270	11.9	89	163	34.2
PM-1	28	39.2	1.9	148	13.5	68	112	42.5
AS-71-37	40	36.6	1.6	215	12.9	90	133	34.8
ST-1	52	30.4	1.4	305	10.7	79	170	46.5
				Late				
NP(WR)-15	54	28.3	1.5	300	10.6	87	145	52.3
Gwalior-3	35	37.0	1.7	185	12.8	80	154	46.5
KWR-1	26	50.2	2.1	140	16.3	63	130	30.6
T-7	30	37.9	2.0	150	13.2	83	149	35.4
T-17	43	30.5	1.8	280	11.8	75	128	36.0
Mean	36.8	37.3	1.7	205.6	13.4	77.7	139.9	38.0
E[a]	9.2	6.9	0.2	60.4	1.7	8.7	16.8	5.9

a: Standard error of the mean.

TABLE 2. COOKING TIME AND PHYSICO-CHEMICAL CHARACTERISTICS OF DHAL OF EARLY, MEDIUM AND LATE MATURING CULTIVARS GROWN DURING 1976–77

Cultivar	Cooking time (min)	Solids dispersed (%)	Water absorption (g/g dhal)	Texture (extrusion force, kg)	Phytic acid (mg/g)	Ca (mg/100g)	Mg (mg/100g)	Pectin (mg/100g)
Early								
BR-172	28	39.6	2.0	145	15.3	74	125	40.6
T-21	32	33.5	1.9	160	13.6	80	120	30.6
Hy-1	40	31.0	1.5	205	12.5	87	165	50.4
Pusa-4–84	36	32.8	1.7	190	13.0	76	170	49.9
DL-74-1	35	36.0	1.7	210	13.5	75	128	41.2
HPA-1	38	39.6	1.5	225	13.4	72	135	51.0
BS-1	30	42.5	1.8	155	12.9	81	130	37.5
Medium								
C-11	36	33.4	1.6	195	14.2	83	142	37.2
No-148	42	28.5	1.6	230	13.0	74	158	48.7
ST-1	43	28.0	1.5	230	12.6	98	135	35.4
BDN-1	34	35.7	1.8	205	13.8	74	154	47.0
ICP-1	30	43.4	1.8	165	14.0	68	130	30.8
EB-38-70	52	26.7	1.4	245	10.5	82	165	59.0
PM-1	36	35.8	1.8	205	13.2	80	127	37.9
Late								
BDN-2	35	37.0	1.7	200	13.0	88	140	38.0
NP(WR)-15	41	29.5	1.7	240	12.3	81	153	47.5
Gwalior-3	42	30.5	1.5	240	12.0	80	150	38.9
KWR-1	32	40.8	1.8	165	13.6	76	142	50.3
T-7	38	34.7	1.7	185	12.8	83	148	52.0
ICP-7065	49	25.8	1.5	255	11.5	85	135	43.6
Mean	37.0	34.2	1.7	202.5	13.0	79.8	142.6	43.4
SE[a]	6.2	5.4	0.2	35.6	1.1	6.7	14.7	7.7

a: Standard error of the mean.

food testing instrument (Model 1140, High Wycombe, Berkshire, UK) according to the method described by Voisey and Nonnecke[5]. Each dhal sample (20 g) was put in a digestion tube and boiled in distilled water for 15 min; excess water was decanted and traces of water removed. The boiled material (30.0g±0.5 g) was transferred to a back extrusion cell and compressed by a loose fitting plunger until it was extruded through the gap between the plunger and container. The point where extrusion of compressed dhal started was measured from the peak recorded on the chart run on a 0-500 scale and termed as extrusion force[5].

Chemical constituents: Defatted and finely ground dhal was used for the estimation of chemical constituents. Fat, crude fiber and ash were estimated by AOAC procedures[6]. Nitrogen was determined by Technicon auto analyser procedure as described by Singh and Jambunathan[7], and the protein values were obtained by multiplying the nitrogen value with 6.25.

Souble sugars were extracted from the defatted sample using 80 per cent ethanol in Soxhlet apparatus. Extracts were evaporated and the residue was taken in distilled water. Aliquots were used for estimation of soluble sugars by phenol sulphuric acid method[8]. The starch content in the residue was determined by enzymatic hydrolysis[9], with minor modifications[10]. Previously described procedures were followed for the determination of phytic acid[11], calcium and magnesium[12] and pectin[13].

Results and Discussion

Variation in cooking time and physicochemical characteristics: Cooking quality was measured as a function of cooking time, amount of water absorbed, solids dispersed and texture in early, medium and late cultivars of pigeon pea grown during 1975–76 (Table 1) and 1976–77 (Table 2). The cooking time of dhal showed a large variation between cultivars, but, early, medium and late maturity groups did not differ significantly with respect to cooking time and other characteristics for both the years. The mean cooking time was 30, 40 and 38 min for early, medium and late cultivars, respectively, during 1975–76 and was 34, 39 and 39 min during 1976–77. It appears that the cookability of early cultivars is better than the medium and late ones. The differences between the groups were larger in 1975–76 than in 1976–77. This observation was substantiated by the amount of solids dispersed into cooking water and the texture of boiled dhal as measured by Instron Food Tester. The mean extrusion force was 161, 225 and 211 kg for early, medium and late cultivars, respectively, during 1975–76 and this trend was also observed for 1976–77. The water absorbing capacity of early, medium and late cultivars did not show large differences.

The interaction between phytic acid, calcium and magnesium and pectin has been suggested to influence the cooking quality of grain legumes[14]. Noticeable differences were observed (Tables 1 and 2) in the phytic acid content of cultivars belonging to different maturity groups, whereas the variation, for calcium, magnesium and pectin were small. Comparison of cooking quality of 12 common cultivars grown during both seasons, showed noticeable differences. Ranking between years based on cooking time differed to a larger extent for quick cooking cultivars (26 to 34 min) than the slow cooking cultivars (36 to 52 min) indicating large differences in the latter ones. For some cultivars, the cooking time was longer in 1975–76, and for others in 1976–77, but the effect of year was more pronounced in case of 'ST-1' and 'NP (WR)-15'. Similar differences were observed for other constituents when results of two years were compared. It is difficult to point out the reasons for such variation. However, the effect of environmental factors such as soil, moisture, temperature and humidity at the time of seed development may play an important role.

Proximate composition of early, medium and late cultivars: The results on proximate composition of cultivars of different maturity groups are given in Tables 3 and 4. Protein and starch together constituted about 75 per cent of the total dhal weight. Only a small variation was observed between cultivars in the starch content. Protein content of cultivars ranged between 19.7 and 24.8 per cent during 1976–77 and between 20.6 and 24.9 per cent during 1975–76. The mean protein content of early, medium and late cultivars did not show any noticeable differences during 1975–76, whereas mean protein per cent was highest for late cultivars and lowest for early cultivars during 1976–77, and this observation agreed with earlier reported results[4]. There was a small variation in soluble sugars, fat, crude fibre and ash contents among early, medium and late cultivars. Variation in phytic acid, calcium, magnesium and pectin content of cultivars belonging to different maturity groups was larger than that in proximate compositions.

TABLE 3. PROXIMATE COMPOSITION (% DRY MATTER) OF EARLY, MEDIUM AND LATE MATURING CULTIVARS GROWN DURING 1975–76

Cultivar	Protein	Starch	Solube sugars	Fat	Crude fiber	Ash
Early						
UPAS-120	21.4	54.5	4.8	2.2	1.5	3.5
Pant A-2	24.0	51.4	5.2	2.1	1.6	4.0
Prabhat	20.1	54.9	4.5	1.8	2.0	3.7
T-21	20.2	54.2	4.6	1.7	1.7	3.9
DL-74-1	23.4	54.2	3.9	1.8	1.4	4.6
Medium						
C-11	23.7	57.6	4.2	2.0	1.6	3.5
No-148	22.7	54.2	4.3	1.7	1.8	3.2
Hy-3c	20.3	58.2	5.0	1.8	1.9	3.5
ICP-1	21.6	54.8	5.5	1.5	2.0	4.0
BDN-1	23.2	52.9	5.1	1.6	1.5	2.8
PM-1	19.7	58.2	4.9	2.1	1.6	3.1
AS-71-37	20.9	56.9	5.0	2.0	1.3	3.5
ST-1	21.8	55.7	5.2	1.9	1.7	3.7
Late						
NP (WR)-15	23.7	54.7	4.8	2.2	1.9	3.0
Gwalior-3	24.8	51.5	5.5	2.0	1.8	4.1
KWR-1	22.6	55.0	4.3	1.8	1.4	3.6
T-7	22.2	53.7	4.5	1.6	1.5	3.9
T-17	22.0	54.5	5.0	1.9	1.3	3.8
Mean	21.1	54.8	4.8	1.9	1.6	3.6
SE[a]	1.46	1.90	0.4	0.2	0.2	0.4

a: Standard error of the mean.

Relationship between cooking time and physicochemical factors: Highly significant and positive correlation was observed between cooking time on one hand and texture (extrusion force) and water absorption on the other hand (Table 5). The amount of solids dispersed into cooking

TABLE 4. PROXIMATE COMPOSITION (% DRY MATTER) OF EARLY, MEDIUM AND LATE MATURING CULTIVARS GROWN DURING 1976–77

Cultivar	Protein	Starch	Solube sugars	Fat	Crude fiber	Ash
Early						
BR-172	21.8	55.4	5.5	2.0	2.1	3.4
T-21	22.0	54.3	5.0	1.9	2.0	2.8
Hy-1	21.5	55.8	5.4	1.5	1.8	3.6
Pusa-484	21.7	55.6	4.8	1.7	2.2	4.0
DL-74-1	20.6	53.4	4.9	1.3	1.9	2.9
HPA-1	21.6	55.0	5.0	1.9	1.8	2.9
BS-1	21.2	54.5	5.1	1.8	2.0	3.1
Medium						
C-11	21.2	55.7	5.4	1.7	1.9	3.4
No-148	21.8	56.8	5.3	2.0	1.8	3.5
ST-1	21.6	55.3	5.0	1.6	1.7	2.9
BDN-1	22.3	54.5	5.1	1.5	2.0	3.4
ICP-1	21.0	54.7	5.3	1.7	2.1	4.0
EB-38-70	22.5	55.4	5.7	1.9	1.8	4.2
PM-1	21.5	56.8	4.9	1.4	1.6	4.1
Late						
BDN-2	21.0	57.4	4.9	1.7	1.9	3.9
NP (WR)-15	23.2	56.8	4.8	1.8	2.0	4.0
Gwalior-3	24.9	50.6	5.0	2.1	1.8	3.7
KWR-1	22.4	53.4	5.1	1.9	2.2	3.5
T-7	22.6	54.1	5.2	1.4	2.1	4.1
Mean	22.0	55.0	5.1	1.0	1.9	3.5
SE[a]	0.4	1.5	0.2	0.2	0.2	0.5

a: Standard error of the mean.

water was negatively correlated with the cooking time, and was in agreement with the results obtained by earlier work[2]. Of the chemical constituents, phytic acid was negatively correlated with the cooking time in both the years. Calcium, magnesium and pectin showed low positive correlations with the cooking time. However, earlier workers had reported that these constituents were not correlated with the cookability of pigeon pea dhal[1]. Protein, starch, soluble sugars, fat, crude fiber and ash contents did not show any correlations with the cooking time.

A stepwise multiple regression analysis was carried out to relate physico-chemical factors to cooking time. Texture alone accounted for nearly 90 per cent of the variation in cooking time. But there was no noticeable improvement in the R^2 value when water absorption and solids dispersed were further used in the multiple regression of cooking time on above variables, indicating that texture alone explains most of the variability. A significant improvement in R^2 value was noticed when the combination of calcium, magnesium and pectin was tested against cooking time, whereas the addition of phytic acid as another variable did not help much. None of the combinations from protein, starch, soluble sugars, ash, fat and crude fibre resulted in significant improvement in R^2 values.

Based on these results, it appears that cooking time is highly correlated with water absorption, solids dispersed and texture (extrusion force). Further, no clear cut distinction could be made between early, medium and late maturing cultivars on the basis of these characteristics. Early cultivars required shorter cooking time

TABLE 5. CORRELATION COEFFICIENTS AMONG VARIOUS COOKING QUALITY PARAMETERS

Parameter	Solids dispersed	Water absorption	Texture	Phytic acid	Calcium	Magnesium	Pectin	Season
Cooking time	−.79**	−.88**	.98**	−.77**	.55**	.69**	.50*	1975–76
	−.87**	−.86**	.90**	−.87**	.45*	.60**	.50*	1976–77
Solids dispersed		.67**	−.75**	.67**	−.37	−.30	−.45*	1975–76
		.66**	−.78**	.69**	−.53*	−.49*	−.30	1976–77
Water absorption			−.84**	.64**	−.56**	−.59**	−.44*	1975–76
			−.82**	.75**	−.43	−.51*	−.42	1976–77
Texture				−.76**	.48*	.55**	.42*	1975–76
				−.73**	.33	.42	.37	1976–77
Phytic acid					−.35	−.46*	−.54*	1975–76
					−.46*	−.49*	−.44*	1976–77
Calcium						.55**	.10	1975–76
						.08	−.09	1976–77
Magnesium							.36	1975–76
							.73**	1976–77

* and ** significant at 5 and 1 per. cent respectively.

in comparison with medium and late cultivars and this could possibly be due to differences in environ ment.

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