Pakistan J. Sci. Ind. Res., Vol. 30, No. 10, October 1987

RELATIONSHIP BETWEEN PHYSICOCHEMICAL CHARACTERS AND COOKING TIME IN CHICKPEAS (*CICER ARIETINUM* L.)

Amal Badshah, Maqbool Ahmad, Aurangzeb, Nazakat Bibi, Tila Mohammad and Ismail Khan

Nuclear Institute for Food and Agriculture, Tarnab, Peshawar

(Received July 1, 1987; revised October 8, 1987)

Physical characters, chemical and mineral composition of some chickpea mutants/varieties were determined and their relationship with cooking time was established. In physical characters more variability was observed in seed size, hydration and swelling capacities and cooking time (18.44 to 23.99%) than in density and hydration and swelling indices (7.43 to 13.61%). Weight (r = 0.752) and volume (r = 0.755) of seeds, and hydration (r = 0.751) and swelling (r = 0.742) capacities were significantly correlated with the cooking time. None of the chemical constituents determined had significant correlation with cooking time of chickpea grains.

Key words: Physical characters, Proximate and mineral composition, Phytic acid.

INTRODUCTION

Chickpea is a crop of economic importance in the rain-fed areas of Pakistan in general and of the North West Frontier Province in particular. It is a rich source of easily available inexpensive proteins. When blended in optimum proportion, it can complement cereal proteins in terms of several essential amino acids [1]. Its inclusion in the diet can thus help in controlling protein calorie malnutrition in most of the developing countries. However, prolonged time generally required for the cooking of chickpea makes its utilization cumbersome and uneconomic. Moreover, excessive cooking of legumes results in protein losses and in a lower availability of lysine [2]. A number of physical [3] and chemical [4-8] characteristics affecting the cooking quality of legumes have been reported. In this study various physical and chemical characteristics of some important chickpea mutants/varieties were investigated and their relationship with cooking time was established.

MATERIALS AND METHODS

Samples of 10 chickpea mutants/varieties were obtained from the Mutation Breeding Division of Nuclear Institute for Food and Agriculture, (NIFA), Peshawar and stored in polyethylene bags at room temperature for evaluation.

Cooking time. Chickpea samples were soaked over night then cooked with 6 times their weight of distilled water for cooking time determination. During cooking, samples at definite time intervals were drawn and tested by experts for uniformity and softness.

Physical measurement. The procedure of Willaims *et al.* [3] was followed for making physical measurement. Fifty seeds were counted and weighed. Seed weight was recorded as the mean weight of fifty seeds. Seed volume was determined by transfering fifty seeds into a 50 ml measuring cylinder and 25 ml distilled water were added to it. The gain in volume divided by 50 was taken as the seed volume. Hydration capacity was recorded as gain in weight after overnight soaking in distilled water. Hydration index was calculated as hydration capacity divided by original seed size. The swelling capacity was determined as gain in volume after overnight soaking in water and swelling index was calculated as swelling capacity/original seed volume.

Chemical analysis. All the samples were ground to pass through 60 mesh screen for chemical analysis. Moisture, protein, ash and fat contents were determined by the methods of American Association of Cereal Chemists [9]. Total carbohydrates were determined by difference. For mineral analysis, wet digestion of different samples was carried out according to the method of O'Dell *et al.* [10]. Calcium was determined in the digested samples by the method of Reitemeier [11] using oxalate precipitation. Phosphorus was determined colorimetrically using the vanadate molybdate method of Hanson as described by Egan *et al.* [12]. Iron was also determined colorimetrically using the thiocyanate method of Wong as described by Ranganna [13]. A sensitive method for the rapid determination of phytate in cereals and cereal products was adopted for the determination of phytic acid [14]. The sample

extract (with 0.2 N HCl) was heated with an acidic iron-III solution of a known iron content. The decrease in iron (determined colorimetrically with 2, 2'-bipyridine) in the supernatant was the measure for the phytic acid content.

Statistical analysis. Coefficient of variability (CV, %) of different parameters was calculated, and correlation coefficients (r) were computed to establish relationships among various physicochemical parameters of seeds [15].

RESULTS AND DISCUSSION

Table 1 gives the physical characteristics of 10 chickpea mutants/varieties. RC-32 and C-141 chickpeas had maximum seed weight, seed volume, density, hydration capacity and swelling capacity while CM-687 grains had the minimum values for the above mentioned characteristics. Maximum time for cooking was taken by the cultivars RC-32 and C-141 (17 min. each) and minimum time was required by mutant CM-88 and CM-687 (8 min. each) for cooking. Among physical parameters of chickpea grains maximum variabilty was recorded in cooking time (23.99%), followed by swelling capacity (23.42%), weight/seed (22.98%), volume/seed (20.65%) and hydration capacity (18.44%). However, the variation observed in grain density (9.62%), hydration index (7.43%) and swelling index (13.61%) was relatively less.

Proximate composition of the chickpeas is given in Table 2. The overall range in protein content was between 24.55% (CM-687) and 20.02% (RC-32). Ash and fat content varied from 3.83% (CM-687) to 3.46% (C-141) and 4.16% (RC-32 to 2.44% (CM-72), respectively; while carbohydrates ranged from 62.15% (CM-1) to 58.85% (CM-687). Results regarding the mineral and phytic acid content are given in Table 3. The highest P content was observed in CM-687 (533.48 mg/100 g) followed CM-72 (533.14 mg/100 g), CM-1913 (512.42 mg/100 g) and C-1918 (507.57 mg/100 g). Mutant CM-687 had the maximum iron content (11.42 mg/100 g). Calcium concentration in chickpea ranged from 190.36 mg/100 g (CM-687) to 80.72 mg/100 g (CM-663). The content of phytic acid in chickpea varied from 257.38 mg/100 g (CM-1913) to 138.45 mg/100 g (C-141). Variation in the proximate composition of chickpea grains was less (2.11 to 17.52%) as compared to that in minerals and phytic acid content (10.21 to 24.90%).

Relationships between characteristics. The results of statistical comparison of all the parameters studied are summarized in Table 4. It is evident from the results that seed size (weight and volume) was correlated with cooking time and several other characteristics studied. Other characteristics of chickpea grain related with cooking time were hydration and swelling capacities. Both size and volume of grains were highly correlated to hydration and swelling capacities. The amount of and degree to which water was imbibed (hydration and swelling capacities) ($r = 0.74$ and 0.75) and seed size ($r = 0.75$) were equally correlated to cooking time, indicating that water absorption was not

Table 1. Physical parameters in chickpeas.

Mutants/ Cultivars	Seed weight (g)	Seed volume (ml)	Density (g/ml)	Hydration capacity (g/seed)	Hydration index	Swelling capacity (ml/seed)	Swelling index	Cooking time (min.)
CM-72	0.183	0.140	1.31	0.25	1.37	0.21	1.50	15
CM-1918	0.194	0.145	1.34	0.25	1.29	0.22	1.52	15
RC-32	0.254	0.190	1.34	0.32	1.26	0.28	1.47	17
E-1289	0.142	0.120	1.18	0.20	1.41	0.16	1.33	16
C-141	0.235	0.180	1.30	0.32	1.36	0.28	1.56	17
CM-1	0.196	0.140	1.40	0.25	1.27	0.22	1.57	15
CM-88	0.145	1.120	1.21	0.20	1.38	0.16	1.33	8
CM-663	0.158	0.100	1.58	0.22	1.37	0.20	2.00	11
CM-687	0.110	0.100	1.10	0.18	1.64	0.12	1.20	8
CM-1913	0.175	0.140	1.25	0.25	1.41	0.20	1.43	16
Mean	0.172	0.138	1.30	0.24	1.38	0.20	1.491	13.8
S.D.	0.041	0.028	0.125	0.045	1.102	0.048	0.203	3.31
C.V. (%)	22.98	20.65	9.62	18.44	7.43	23.42	13.61	23.99

Table 2. Proximate composition of chickpeas.

Mutants/ Cultivars	Moisture (%)	Protein (%)	Ash (%)	Ether extract (%)	Carbo-hydrate (%)
CM-72	10.26	23.71	3.82	2.44	59.77
CM-1918	10.20	23.75	3.68	3.47	58.90
RC-32	10.48	20.02	3.54	4.16	61.78
E-1289	10.46	22.61	3.82	2.45	60.66
C-141	9.78	21.38	3.46	3.24	62.14
CM-1	10.49	20.48	3.50	3.38	62.15
CM-88	10.30	21.52	3.50	3.37	61.31
CM-663	10.19	23.67	3.60	2.48	60.12
CM-687	9.98	24.55	3.83	2.79	58.85
CM-1913	10.14	21.55	3.58	2.76	61.97
Mean	10.23	22.32	3.58	3.05	60.76
S.D.	0.22	1.47	0.14	0.53	1.23
C.V. (%)	2.11	6.59	3.88	17.52	2.03

Table 3. Important mineral and phytic acid content of chickpeas.

Mutants/ Cultivars	Phospho-rus (mg/ 100 g)	Phytic acid (mg/ 100 g)	Iron (mg/ 100 g)	Calcium (mg/ 100 g)
CM-72	533.14	209.45	8.38	164.84
CM-1918	507.57	198.80	9.52	150.23
RC-32	417.37	166.85	9.65	165.70
E-1289	498.95	225.43	9.54	172.01
C-141	390.33	138.45	8.38	183.84
CM-1	428.96	225.43	5.24	184.66
CM-88	444.76	221.88	5.23	145.39
CM-663	489.58	237.85	8.22	80.72
CM-687	533.48	244.95	11.42	190.36
CM-1913	512.42	257.38	5.51	188.47
Mean	475.66	212.65	8.12	162.62
S.D.	48.55	34.49	2.02	31.04
C.V. (%)	10.21	16.22	24.90	19.90

Table 4. Interrelationships among various physical and chemical characters of chickpeas.

	Seed volume	Density	Hydration Capacity	Hydration Index	Swelling Capacity	Swelling Index	Moisture	Ash	Protein	Fat	Carbo-hydrate	Cooking time	Ca	Fe	P	Phytic acid
Seed weight	0.9462**	0.4056	0.9794**	−0.0196	0.9843**	−0.2998	0.0601	−0.5757	−0.6476*	0.6613*	0.5338	0.7524*	0.1233	−0.0898	−0.6737*	−0.7939**
Seed volume		0.0907	0.9511**	−0.2088	0.8968**	−0.0074	−0.0016	−0.4863	−0.6663*	0.6850*	0.5437	0.7553*	0.3703	−0.0245	−0.6446*	−0.8238**
Density			0.3367	−0.6204	0.5067	0.9681**	0.1650	−0.4054	−0.1071	0.0569	0.0241	0.2008	−0.7077*	−0.2300	−0.2414	−0.0697
Hydration capasity				−0.6403*	0.9769**	0.2690	−0.1075	−0.5519	−0.6007	0.5837	0.5394	0.7506*	0.1868	−0.0482	−0.4756	−0.8067**
Hydration index					−0.7561*	−0.4710	−0.4890	0.5672	0.6030	−0.2248	−0.4629	−0.6053	0.2195	0.3841	0.1320	0.4572
Swelling capasity						0.4337	−0.0290	−0.5919	−0.5828	0.5631	0.5199	0.7424*	0.0170	−0.0928	−0.6666*	−0.7922**
Swelling index							−0.0140	−0.3428	0.0184	−0.1189	0.0819	0.1492	−0.7459	−0.1738	−0.1784	−0.0918
Moisture								0.0498	−0.3664	0.2127	0.1626	0.1653	−0.1143	−0.2282	−0.0258	0.2161
Ash									0.7640*	−0.6066	−0.7699**	−0.1570	0.0888	0.6269	0.8409**	0.3897
Protein										−0.4347	−0.9255**	−0.4569	−0.2941	0.5445	0.8073**	0.3855
Fat											0.3677	0.2042	0.1745	−0.0676	−0.6754*	−0.5690
Carbohydrate												0.4430	0.2727	−0.6529*	−0.7574**	−0.2887
Cooking time													0.0666	−0.0161	−0.2933	−0.5027
Ca														0.0143	−0.0745	−0.1233
Fe															0.3087	−0.2322
P																0.6960*

* = Significant at 5% level; ** = Significant at 1 % level.

related to seedsize but to the actual amounts imbibed. The present results support the hypothesis of Williams *et al.* [3] that the phenomenon is associated probably with permeability and water absorption of the starch and seed coat components. This view is further supported by the high correlation of seed (weight and volume) with swelling (r = 0.897 to 0.984) and hydration (r = 0.951 to 0.979) capacities and correspondingly low correlations with swelling (r = – 0.007 to – 0.300) and hydration (r = – 0.019 to – 0.209) indices. None of the other characteristics studied had a significant correlation with cooking time of chickpea grains. The correlations of phosphorus with swelling capacity (r = – 0.667) and phytic acid with hydration capacity (r = – 0.807) and swelling capacity (r = – 0.792) were significant. Although nonsignificant the relationship of phosphorus (r = – 0.29) and phytic acid (r = – 0.50) among minerals with cooking time was relatively strong. This supports the view that phytic acid and phosphorus

might have a probable role in the cooking quality of legumes [4, 5, 8, 16-18].

REFERENCES

1. L.E. Liener, Toxins in Legumes: *Their Possible Nutritional Significance in the Diet of Man in Quality Attributes of Edible Plant Tissues* (Academic Press, New York, 1978), p. 348.
2. K. Almas and A.E. Bender, J. Sci. Fd. Agr., **31**, 448 (1980).
3. P.C. Williams, H. Nakoul and K.B. Singh, J. Sci. Fd. Agr., **34**, 492 (1983).
4. F. Mattson, E. Akenberg, E. Eriksson, E. Koutler – Andersson and K. Vahtras, Acta Agr. Scand., **1**, 40 (1950).
5. F.M. Muller, J. Sci. Fd. Agr., **18**, 292 (1967).
6. N. Wassimi, S. Abu-Shakra, R. Tanhous, and A.H. Hallab, Can J. Plant Sci., **58**, 165 (1978).
7. M.M. Yousuf, W. Bushuk, E.D. Murray, R. Zillman, A.M. El-Tabey-Shehta, J. Fd. Sci., **47**, 1695 (1982).
8. R.S. Bhatty, M.A. Niclsen, A.E. Slinkard, Can. J. Plant Sci., **64**, 17 (1984).
9. *AACC, Cereal Laboratory Methods* (American Association of Cereal Chemists, St. Paul, Minnesota, 1983), 8th ed.
10. B.L. O'Dell, A.R. Deboland and S.R. Koirtyohanu, J. Agr. Fd. Chem., **20**, 718 (1972).
11. R.F. Reitemeier, *Semimicroanalysis of Saline Soil Solution,* Ind. Engng. Chem. Analyt. ed., **15**, 393 (1943).
12. H. Egan, R.S. Kirk and R. Sawyer, *Pearson's Chemical Analysis of Food* (Churchil, Livingstons, Edinburgh, London, Melbourne and New York, 1981), 8th ed., pp. 29-30.
13. S. Ranganna, *Manual of Analysis of Fruit and Vegetables Products* (Tata Mc-Graw-Hill Publishing Co. Ltd., New Dehli, 1978), pp. 109-10.
14. W. Hang and H.J. Lantzsch, J. Sci. Fd. Agr., **34**, 1423 (1983).
15. R.G.D. Steel and J.H. Torrie, *Principles and Procedures of Statistics* (McGraw Hills Book Publishing Co., New York, 1980).
16. S. Kon, D.W. Sanshuck, J. Fd. Process Preserv., **5**, 169 (1981).
17. I.O. Fasidi, Nahrung, **25**, 949 (1981).
18. J. Chang, S.T. Ali Khan, B.B. Chubey and B.H. Gubbels, Can. J. Plant Sci., **63**, 1071 (1983).