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Correlation Among Physiochemical, Milling and Cooking Quality Traits in Chickpea (*Cicer arietinum* L.) Whole Grains and *Dal*

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Abstract

The present investigation aimed to assess the *dal* milling quality, cooking efficiency and nutritional composition of sixteen chickpea cultivars obtained from Pulse Improvement Project, M.P.K.V., Rahuri. Significant genetic variation was observed among the cultivars, particularly in proximate composition, milling qualities and physical parameters. Results obtained in the present study showed a positive correlation of grain weight with grain hardness and *dal* recovery. There is a positive correlation between grain hardness and various parameters, including cooking time, crude protein in whole chickpeas and *dal*. Crude protein showed negative correlation with total carbohydrates, crude fat and crude fiber. Cooking time exhibited positive correlation with seed weight and indicated that cooking time increased with increase in seed weight.

Key words : Correlation Physiochemical, Milling and Cooking Quality Traits, Chickpea

Pulses, classified as leguminous crops, have become essential in tackling food security issues. Known for their rich protein content, they provide an important nutritional source, especially in areas where access to animal-based proteins is scarce. Among pulses, chickpea (*Cicer arietinum* L.) stands out for its adaptability and nutritional benefits. Widely cultivated in various agro-climatic zones, chickpeas are a key dietary staple due to their high protein content, as well as their rich supply of fiber, vitamins, and minerals. Their ability to thrive in diverse environmental conditions makes them an important crop in regions vulnerable to food insecurity (Muehlbauer and Sarker, 2017). Additionally, chickpeas are not only vital for human nutrition but also serve as a valuable component of animal feed, further underscoring their significance in global food systems (Bampidis and Christodoulou, 2011). Chickpea is an essential legume crop that plays a key role in supporting food security in developing countries while also aligning with the global shift towards plant-based diets. Gaining insights into the milling and cooking qualities of various chickpea cultivars is crucial for optimizing processing methods and improving consumer acceptance. Furthermore, assessing the nutritional profile, including antinutrients and amino acids, as well as understanding the impact of milling on antinutritional properties, is vital for enhancing the health benefits of chickpea-based diets. Thus, the present study was conducted to evaluate the relationships between physiochemical properties, milling and cooking quality traits of 16 chickpea genotypes.

Materials and Methods

The present study was conducted at Department of Biochemistry, M.P.K.V., Rahuri. Correlation coefficients are used to evaluate the relationship between multiple variables. The correlation coefficient quantifies the association between different traits due to various factors. Now, correlation coefficients were worked out according to formula described below.

Correlation coefficient (rxy) = Cov (x, y) / $\sqrt{V}$ (x) x $\sqrt{V}$ (y)

Where, rxy =Correlation coefficient between character x and y, Cov (x,y) =Co-variance of character x and y, Vx =Variance of character x, and Vy =Variance of character y

To test the significance of correlation coefficients, the estimated values were compared with the tabulated values of Fisher and Yates (1938) at n-2 df at two levels of probability, *viz*., 5% and 1%.

Result and Discussion

The correlation coefficient (r) for various chemical constituents in chickpea whole grain and *dal* is depicted in Table 1 and Table 2. Results obtained in the present study showed a positive correlation of grain weight with grain hardness and *dal* recovery having correlation coefficients (r = 0.406) and (r = 0.522) respectively. There is a positive correlation between grain hardness and various parameters, including cooking time (r = 0.299), crude protein in whole chickpeas (r = 0.480), and crude protein in *dal* (r = 0.353). This indicates that harder grains require longer cooking times and tend to have higher crude protein content in both whole chickpeas and *dal*.

The analysis revealed a significant negative correlation between crude protein with both carbohydrates (r = -0.680) and crude fat (r = -0.609) in whole chickpeas. Similarly, in chickpea *dal*, crude protein exhibited a stronger negative correlation with carbohydrates (r = -0.826) and a moderate negative correlation with crude fat (r = -0.468). These findings suggest that as protein content increases, the levels of carbohydrates and fats tend to decrease, particularly in the processed *dal* form, highlighting the inverse relationship between macronutrient composition in chickpeas.

The correlations between various parameters of chickpeas reported in previous studies are outlined below. Protein content showed significant and positive association with seed weight. Similar results are reported by Anuradha

Table 1. Correlation coefficient (r) between physio-chemical constituents and antinutrients of chickpea cultivars

	Grain weight	**Grain density**	**Grain hardness**	***Dal* recovery**	**Cooking time**	**Crude fat**	**Crude fiber**	**Crude protein**	**Total carbohydrate**	**Methionine**	**Tryptophan**	**Tannin**	**Phytate**
Grain weight	1.000												
Grain density	0.401	1.000											
Grain hardness	0.406	0.298	1.000										
Dal recovery	0.522*	0.075	0.352	1.000									
Cooking time	0.036	-0.060	0.299	-0.005	1.000								
Crude fat	-0.387	-0.139	-0.231	-0.777**	-0.148	1.000							
Crude fiber	-0.071	0.202	-0.272	-0.374	-0.188	0.605*	1.000						
Crude Protein	0.304	-0.007	0.480	0.591*	0.078	-0.609*	-0.507*	1.000					
Total carbohydrate	-0.266	-0.102	-0.346	-0.113	-0.170	-0.032	-0.072	-0.680**	1.000				
Methionine	0.082	0.113	-0.474	-0.084	0.475	-0.196	-0.027	-0.217	0.227	1.000			
Tryptophan	0.289	-0.144	0.148	-0.008	0.281	-0.208	-0.249	0.319	-0.175	0.029	1.000		
Tannin	-0.777**	-0.535*	-0.160	-0.269	0.022	0.252	-0.114	-0.090	0.121	-0.059	-0.134	1.000	
Phytate	-0.213	0.404	-0.083	-0.192	0.347	0.021	-0.025	0.085	-0.228	0.349	-0.425	0.071	1.000

*Significant at the 5 % level. ** Significant at the 1 % level.
(Crude protein, crude fiber, crude fat and total carbohydrates were, dal recovery expressed as % (%), cooking time expressed in min, tryptophan and methionine were expressed as g/16 N, tannin and phytate were expressed as mg/gm, grain weight expressed as gm, grain density was expressed as gm/ml, grain hardness was expressed an N (Newton))

Table 2. Correlation coefficient (r) between physio-chemical constituents and antinutrients of chickpea *dal*

	Grain weight	**Grain density**	**Grain hardness**	***Dal* recovery**	**Cooking time**	**Crude fat**	**Crude fiber**	**Crude protein**	**Total carbohydrate**	**Methionine**	**Tryptophan**	**Tannin**	**Phytate**
Grain weight	1.000												
Grain density	0.401	1.000											
Grain hardness	0.406	0.298	1.000										
Dal recovery	0.522*	0.075	0.352	1.000									
Cooking time	0.036	-0.060	0.299	-0.005	1.000								
Crude fat	-0.380	-0.184	-0.111	-0.702**	-0.266	1.000							
Crude fiber	0.104	-0.081	-0.397	-0.232	-0.146	0.003	1.000						
Crude Protein	0.265	-0.080	0.353	0.613*	0.047	-0.468	-0.356	1.000					
Total carbohydrate	-0.125	0.142	-0.281	-0.227	0.068	-0.006	0.161	-0.826**	1.000				
Methionine	-0.267	-0.255	0.003	-0.316	-0.177	0.135	0.655**	-0.245	-0.019	1.000			
Tryptophan	0.295	-0.166	0.087	-0.010	0.314	-0.276	-0.060	0.339	-0.181	-0.255	1.000		
Tannin	-0.710**	-0.499*	-0.177	-0.247	0.033	0.182	-0.131	-0.119	0.097	0.321	-0.137	1.000	
Phytate	-0.158	0.046	-0.122	-0.310	0.054	0.174	-0.184	-0.133	0.183	-0.171	0.008	0.122	1.000

*Significant at the 5 % level. ** Significant at the 1 % level.
(Crude protein, crude fiber, crude fat and total carbohydrates were, dal recovery expressed as % (%), cooking time expressed in min, tryptophan and methionine were expressed as g/16 N, tannin and phytate were expressed as mg/gm, grain weight expressed as gm, grain density was expressed as gm/ml, grain hardness was expressed an N (Newton))

et al. 2009, Kauthar and Salah, 2015 for significant positive correlation of protein content with seed weight and seed volume and Williams *et al*. (1983) reported significant positive correlation between cooking time and weight of seeds, seed diameter. Reports for positive and significant association of 100 seed weight with seed volume are also reported by Malik *et al*. (2011) [13]. Carmo *et al*., (2017) reported a negative correlation between fat and fiber content (r = -0.76) as well as fat and protein content (r = -0.65), indicating that as fat levels increase, both fiber and protein levels tend to decrease. Gil *et al*., (1996) also reported a positive relationship between grain weight and protein content, for chickpea cultivars. However, Badshah *et al*. (2003) reported a negative correlation between grain weight and protein content in chickpea.

Kaur *et al*. (2005) found that grain weight and volume in chickpeas were positively correlated with fat and carbohydrate content, while they were negatively correlated with fiber content. Ozer *et al*., (2010) found that fiber content was negatively correlated with protein content (r = -0.637), and moisture %age (r = -0.772), also found significant and positive correlations between grain weight and protein content (r = 0.548) and between grain weight and moisture content (r = 0.687) and negative correlation between grain weight and fiber level (r = -0.751). The correlation of cooking time with various parameters shows that cooking time is positively correlated with protein content (r = 0.238) and grain weight (r = 0.232), while it is negatively correlated with fat content (r = -0.174). This indicates that chickpeas with higher protein and grain weight take longer to cook, whereas higher fat content reduces cooking time.

Conclusion

Results obtained from the above experiment signify differences in correlation between

different parameters. There were significant differences found in correlation coefficients between various physiochemical, milling and cooking qualities of both the chickpea whole grains as well as *dal*. Thus, data obtained from the current investigation can be utilized for further studies.

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