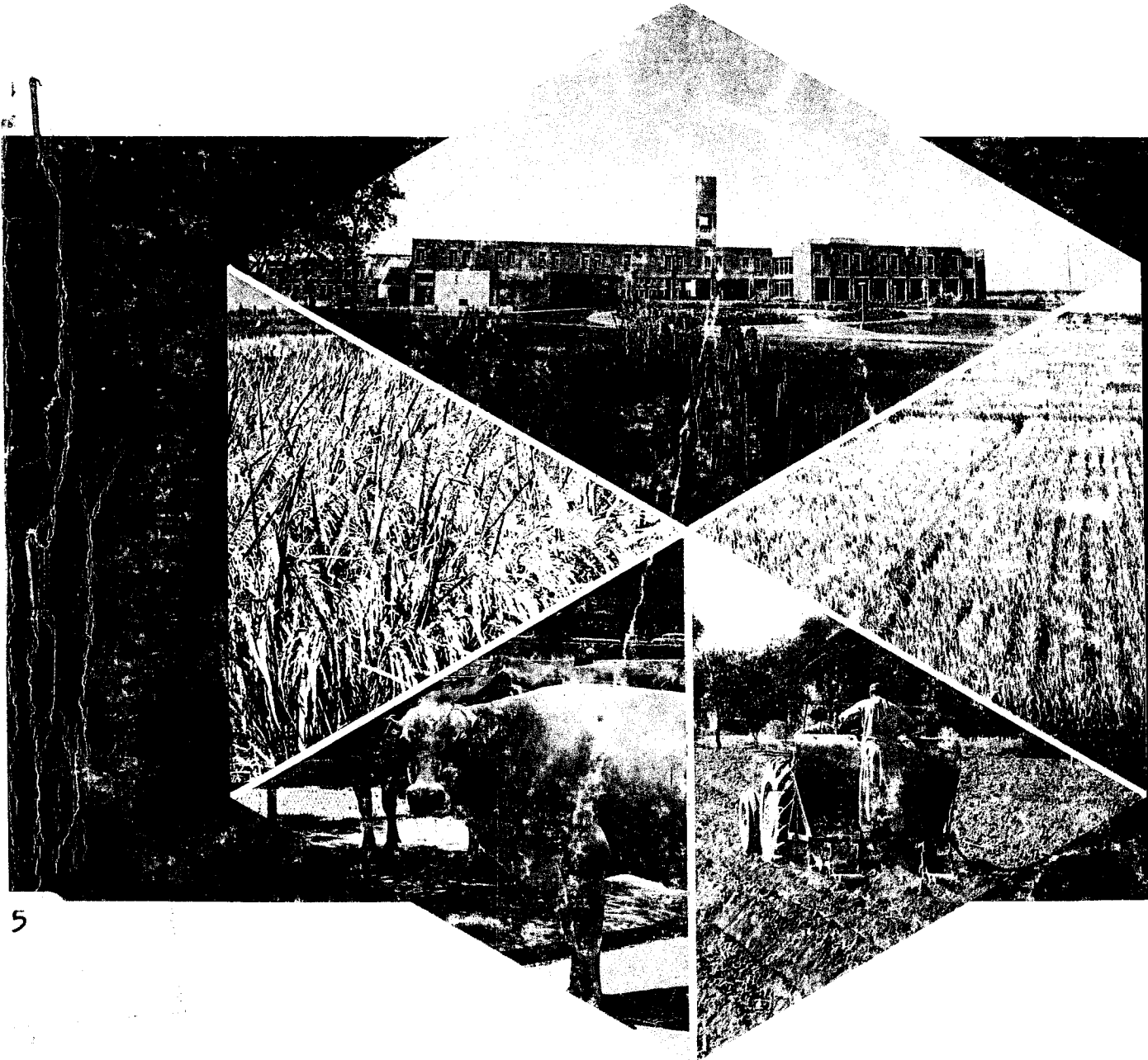


ANNUAL REPORT
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**Pakistan Agricultural Research Council
Islamabad**

Nutrition and Food Quality

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

Screening of Germplasm Collection of Wheat and Barley for Protein Content

As many as 242 wheat and 40 barley germplasm samples, collected from Plant Genetics Resources (Gene Bank), NARC, were screened. The protein content ($N \times 5.7$) on dry basis ranged between 12.1 and 19.6 percent with an average of 16.9 percent in wheat and between 10.4 and 16.6 percent with an average of 13.7 percent in barley (Figure 1).

Quality Characteristics of Some Advanced Lines of Wheat Grown in Sind

As many as 19 advanced lines of wheat grown in Sind, supplied by the AEARC, Tandojam, were tested for their quality characteristics (Table 1). Data revealed that all samples had amber or creamy-coloured grains except in lines 005 and 153. There was wide-spread variation in size of grain in all samples of wheat having bold kernels. The moisture content ranged from 8.6 to 9.7 percent with an average of 9.09 percent. The protein content ranged from 12.4 to 16.8 percent, indicating widespread protein in samples. Line 130 had the lowest flour yield i.e., 74.0 percent as compared to line 117 (79.0 percent) which produced the highest flour percentage. The ash content ranged from 0.6 to 1.0 percent. Slightly higher ash values might be due to untempered wheat kernels. With a moisture content of 9.7 percent or lower, one can expect some contamination of flour with outer layers of kernel i.e., bran containing high ash

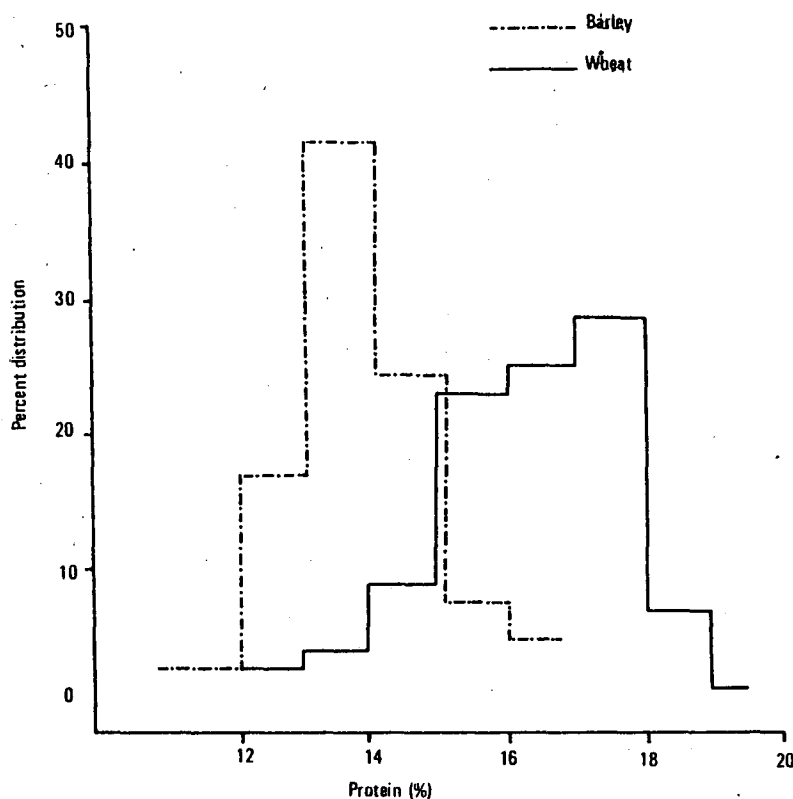


Fig 1. Distribution of protein in wheat and barley germplasm

value. Wet gluten values ranged from 40.9 (line 179) to 51.0 (line 005) with the exception of line 207 and 208 containing extremely low values of 26.6 and 25.2, respectively. This could be attributed to some genetic factor as the physical quality of these samples did not show any drastic difference in other characteristics when compared with rest of the samples. However such a low percentage of gluten is not suitable for the production of good quality bread. In general, soft wheat lines had weaker glutes. Overall quality of these lines presented some good quality samples which should be considered for commercial production.

Technological Value and Nutritional Quality of Some Commercial Wheat Varieties

As many as 17 commercial wheat varieties, from Wheat Programme, NARC, were analyzed for their physical and rheological characteristics. The 1000 kernel weight varied between 29.0 in 'Punjab-83' and 45 in 'Sonalika', indicating the size and density of kernels. 'Sonalika' had medium hard kernels with particle size index (PSI) of 48 percent while 'Punjab-81' and 'Pavon' had the hardest kernels with 38 percent PSI (Table 2). Majority of wheat varieties had kernels of medium to hard type.

Table 1. Quality characteristics of some advanced lines of wheat grown in Sind

Wheat Line	005	089	094	108	115	117	130	132	153	154	166	169	172	176	179	186	187	207	208
Test weight (kg/hl)	76.8	72.7	77.7	79.9	72.6	75.8	70.9	74.2	75.8	78.3	67.9	71.4	69.3	75.6	78.9	71.8	75.1	75.7	72.7
Grain colour	R	A	A	A	CW	A	A	CW	R	A	CW	A	A	CW	A	A	CW	CW	A
Grain size	++	+	+++	+++	+++	+	+	++	++	++	++	++	++	+++	+++	++	+	++	+
Plumpness	VB	B	VB	B	VB	B	B	B	VB	B	B	B	B	B	B	B	B	B	B
Wheat quality (overall)	MH	MH	S	MH	MH	S	MH	MH	MH	MH	H	H	S	MH	S	H	MH	S	S
Moisture (%)	9.0	9.3	9.0	8.7	9.2	9.1	8.8	8.8	9.2	9.7	9.1	9.1	8.6	9.1	9.2	9.2	9.2	9.1	9.4
Protein (%) d.b.	15.7	14.4	13.1	14.6	14.3	13.4	15.4	15.0	15.3	14.4	16.8	15.6	13.5	15.1	13.5	16.3	14.7	12.4	15.2
Flour yield (%)	74.6	74.7	76.9	78.0	74.7	79.0	74.0	76.3	76.4	76.6	75.6	75.8	76.1	76.3	75.8	75.5	76.7	77.7	75.2
Ash (%)	0.6	1.0	0.8	0.7	0.7	1.0	0.9	0.7	0.8	0.7	1.0	0.9	0.9	0.8	0.7	1.0	0.8	0.9	1.0
Wet gluten (%) d.b.	51.7	47.8	45.0	45.6	45.7	42.9	48.9	50.0	51.2	43.6	41.3	44.7	43.4	52.1	40.9	49.8	44.7	26.6	25.2
Gluten quality	XX	XX	X	XX	XX	X	XX	XX	XX	XX	XXX	XXX	X	XX	X	XX	XX	X	X

R = Red, A = Amber, CW = Creamy white, VB = Very bold, B = Bold
 + = Small, ++ = Medium, +++ = Large
 S = Soft, MH = Medium Hard, H = Hard
 X = Weak, XX = Medium Strong, XXX = Strong

Average PSI value of samples was around 41 ± 3 percent with the exception of 'Sonalika'. Pelshanke value, determined as wheatmeal fermentation time (WMFT) indicated the gluten quality during leavening by yeast. Eight wheat varieties, i.e., 'Lyp-73', 'Pak-81', 'Sind-81', 'Sarhad-82', 'Barani-83', 'Yecora', 'Zargoon' and 'Indus-79' had fermentation time exceeding 2½ hours. The farinograph test value indicated water absorption between 59 and 64.5 percent and dough development time between 2.5 and 9.0 minutes. There were flours with dough development time of 3.00 minutes or less, thus showing their weak gluten characteristic. Values over 3 minutes in general represented medium strong flours while in some cases, development time of over 5 minutes revealed very strong glutes. Stability of dough during mixing (on 500 Brabender Units) presented similar trend and R value at 15 minutes showed the mixing tolerance of doughs. In general, values exceeding 60 Brabender Units indicate low tolerance to mixing except in

medium strong flours. Thus Pakistani wheat varieties can be classified among medium hard to hard wheats. Hard wheat varieties, in general, produce strong flour and they are suitable for the production of leavened pan breads and rolls. Medium hard varieties in general produce moderately strong flours, more suitable for *chapaties* and other flat breads. Since most of the tested varieties showed medium to strong flour characteristics with reasonably good kernel colour and plumpness, they could be utilised for the production of good quality breads. However, very strong flours would need the addition (blending) of a certain percentage of weak flours, to reduce the strong gluten properties. Strong gluten flours produce leathery and tough *chapaties* with poor shelf-life. Weak flours may be used for *chapati* production, provided they are blended with strong or medium strong flours to improve their mixing and handling characteristics. Weak flours as such are very suitable for the production of cakes and other sweet bakery goods.

red chemically and biologically in N-balance experiments with growing rats. The protein content was the highest in 'Barani-83' (16.0 percent) and the range in the rest of varieties was from 13.2 to 15.7 percent (Table 3). The fat contents appeared to lie between 2.6 and 3.0 percent while available carbohydrates were highest in 'Punjab-83' (74.4 percent) and lowest in 'Barani-83' (67.3 percent). The fibre content ranged from 2.2 to 2.9 percent while the ash content was almost uniform in all varieties. The calcium content varied from 11.0 – 40.0 mg per 100 g and Phosphorus from 284 to 336 mg per 100 g. The concentration of iron was the highest (4.8 mg/100 g) in 'Sonalika' and the lowest (2.9 mg/100 g) in 'Faisalabad-83'. The Zn content varied from 2.8 to 4.1 mg/100 g with highest content in 'Sarhad-82'. Lysine per 16 g N ranged from 2.46 g in 'Barani-83' to 2.75 g in 'Punjab-83'. The highest contents (3.88 g/16 g N) of methionine and cystine in variety 'Sonalika' and lowest (3.45 g per 16 g N) in 'Sarhad-82' were found. The protein concentration of the varie-

Table 2. Technological values of some commercial wheat varieties

Variety	1000-kernel weight (g)	Hardness (PSI%)	WMFT (Min)	Farinograph				Remarks
				Abs. (%)	Dv.T (min)	St.T (min)	Δ R (Bran-bender Unit)	
'Sonalika'	45.0	48	71	62	2.5	2.7	125	Medium hard wheat weak flour
'Lyp-73'	35.6	43	205	59	5.0	7.0	45	Hard wheat, medium, strong flour
'Pak-81'	37.0	43	181	62.3	4.8	4.0	130	Hard wheat, weak flour
'Sind-81'	37.3	40	209	63	4.5	9.7	35	Hard wheat, medium strong flour
'Sarhad-82'	36.0	41	171	63	4.5	4.2	135	Hard wheat, medium strong flour
'Faisalabad-83'	38.5	41	60	65	2.8	3.1	110	Hard wheat, weak flour
'Punjab-83'	29.0	41	71	60	3.6	6.4	60	Hard wheat, medium strong flour
'Barani-83'	40.9	40	252	62.5	9.0	12.5	25	Hard wheat, strong flour
'Zamindar'	41.6	43	116	64.2	4.6	6.2	55	Hard wheat, medium strong flour
'Arz'	34.0	40	86	64.5	4.8	8.6	40	Hard wheat, medium strong flour
'Sandal'	37.3	44	140	59	5.2	12.8	20	Hard wheat, strong flour
'Bwp-79'	33.7	42	66	63.5	3.0	3.6	90	Hard wheat, weak flour
'Punjab-81'	41.1	38	68	64.5	2.6	3.4	80	Hard wheat, weak flour
'Yecora'	37.4	43	227	60	7.8	13.2	20	Hard wheat, strong flour
'Zarghoon'	38.4	43	198	64	4.9	5.8	60	Hard wheat, medium strong flour
'Pavon'	34.1	38	79	62.5	2.9	4.2	65	Hard wheat, weak flour
'Indus-79'	38.8	39	177	63	3.4	5.0	70	Hard wheat, medium strong flour

PSI = Particle size index, WMFT = Wheat meal fermentation time, Abs = Water absorption, Dv.T = Development Time; St.T = Stability time; Δ R = Mixing tolerance at 15 minutes.

The lysine content in wheat varieties was negatively correlated ($r = -0.67$) with protein concentration. Results obtained on true protein digestibility (TD), biological value (BV), net protein utilization (NPU) and utilizable protein (UP) are summarized in Table 3. A negative correlation ($r = -0.76$) between BV and protein concentration was found (Figure 2). The present results indicated that wheat varieties had adequate amounts of Fe and Zn to meet the daily human requirement of these nutrients. Available carbohydrates, lysine and biological value were lowered in varieties with a higher content of protein. The negative correlation between lysine and protein concentration was probably due to the fact that environmentally-induced increases in nitrogen were stored mainly in the prolamine fraction which was poor in lysine. As lysine is the first limiting amino acid in wheat protein, a decrease in this amino acid must result in a reduction in BV, which shows a linear decrease with increase in protein concentrations due

to lower lysine content in those wheats which are high in protein. The most desirable objective, especially in the developing countries

where wheat is a staple food, should be to increase the protein content and essential amino acids, especially lysine and possibly threonine.

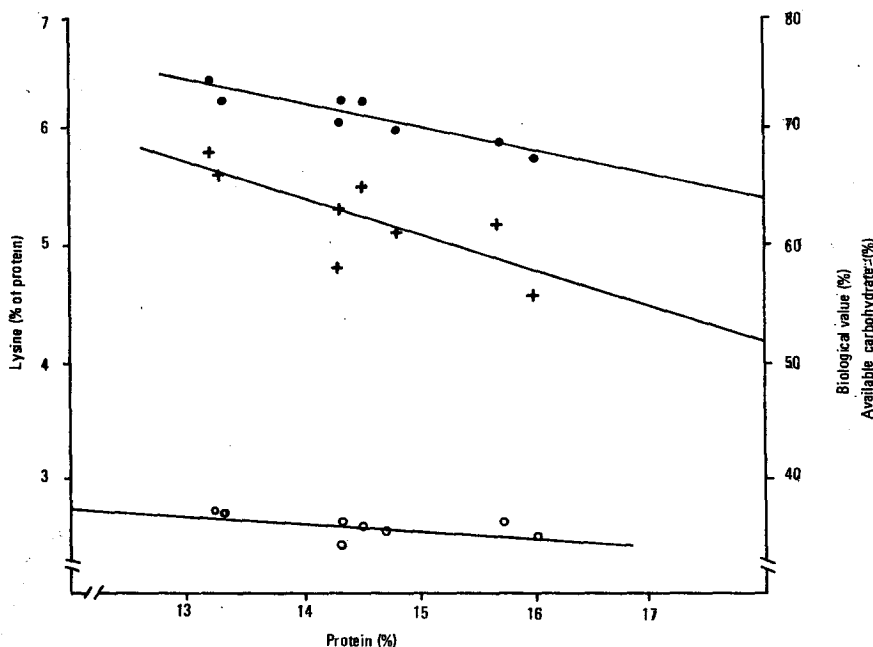


Fig 2. Lysine content (o), biological values (+) and available carbohydrate (●) in relation to protein content in commercial wheat varieties

Table
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Ash %
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Lysin
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Table 3. Chemical composition (on dry basis) and Biological data of some commercial wheat varieties

Wheat variety	'Sonalika'	'Lyp-73'	'Pak-81'	'Sind-81'	'Sarhad-82'	'Faisal- abad-83'	'Punjab-83'	'Barani-83'
Protein (N x 5.7)%	15.7	14.8	14.3	13.3	14.5	14.3	13.2	16.0
Fat%	2.7	2.7	2.9	2.7	2.7	2.6	2.7	3.0
Available CHO %	68.6	70.0	72.5	72.9	72.7	70.8	74.4	67.3
Crude Fibre %	2.2	2.5	2.5	2.2	2.7	2.6	2.8	2.9
Ash %	1.6	1.7	1.6	1.5	1.5	1.6	1.6	1.7
Calcium mg/100g	37.0	11.0	18.0	25.0	20.0	30.0	40.0	19.0
Phosphorus mg/100g	336.0	315.0	287.0	310.0	284.0	319.0	325.0	309.0
Iron mg/100g	4.8	3.9	4.1	4.5	3.8	2.9	4.2	3.3
Zinc mg/100g	3.3	2.8	3.0	3.5	4.1	2.9	3.7	2.5
Lysine g/16g N	2.62	2.54	2.63	2.71	2.60	2.48	2.75	2.46
Methionine + Cystine g/16g N	3.88	3.77	3.62	3.83	3.45	3.56	3.70	3.48
True Protein	92.0	93.0	93.0	95.0	92.0	94.0	95.0	94.0
Digestibility %								
Biological Value %	62.0	61.0	63.0	66.0	65.0	58.0	68.0	56.0
Net Protein Utilization %	57.0	57.0	59.0	63.0	60.0	55.0	65.0	53.0
Utilizable Protein %	10.2	9.2	9.1	9.2	9.5	8.5	8.9	10.0

Quality Characteristics of Ration Flour (Atta) Consumed in Islamabad and Rawalpindi Districts

As many as 56 samples of ration *atta* collected at random from all tehsils of Rawalpindi and Islamabad were evaluated for their quality characteristics. A popular brand of fine *atta* consumed in these districts was also purchased and a wholemeal *atta* was milled from a grist of local wheats. The ration samples collected from each tehsil were blended to obtain a representative sample. The ratio of white flour (*maida*) and bran content were determined by sifting through 36 GG sieve in sifter of Quaidarabad Sugar Mills.

All samples of ration flour were found to contain 57 to 62 percent white *maida* as compared to over 80 percent found in laboratory or commercial *atta* samples (Table 4). Ration *atta* samples had low gluten contents and the gluten was sticky and heavily contaminated with fine bran particles. Other two samples had over 20 percent gluten contents. These observations indicated that either white portion of kernel (endosperm) or white *maida* contents was removed from the flour stream during milling or the bran content was mixed with low

make up the deficiency of removed "white content", obtained during sifting of break and reduction flour streams. Moderate quality of laboratory - milled *atta* was due to freshly milled un-aged flour with little or no oxidation. The chemical composition indicated higher moisture contents in ration *atta* from Islamabad, Kahuta and Gujar Khan. Such moisture level (exceeding 15 percent) could result in deterioration of *atta* quality during storage in bags. The laboratory milled *atta* had the highest protein content i.e., 15.2 percent as compared to other samples showing 11.8 - 12.6 percent protein. Due to higher bran content (38-43 percent), higher ash values (over 1.5 percent) were observed in ration *atta* samples. All samples of ration flour had reasonably good water absorption, but weak dough properties as presented by stability time. Low stability time of laboratory-milled *atta* was due to fresh unmaturing or under oxidised flour. *Chapaties* prepared from ration *atta* samples produced brown colour product with tough texture and high chewability. Their quality was unsatisfactory and the after-taste was slightly bitter due to higher percentage of bran in flour. Commercial and laboratory-milled

good quality *chapaties*. Thus, the wheat flour available at the ration shops was poor in quality than the one available commercially.

Evaluation of Physiochemical and Nutritional Quality of Kabuli and Desi Chickpea (Cicer arietinum) Varieties/Advanced Lines

Seeds of four Kabuli viz; 'ILC-182', 'ILC-195', 'ILC-200' and 'ILC-3279' and seven *desi* viz; 'CM-1', 'CM-68', 'CM-72', 'CM-141', 'HG-202-6-1', 'NCG-1' and 'NEC-1382' cultivars/advanced lines grown by Pulses Programme, NARC, during *Rabi* 1984-85, and received from our Food Legume Programme were evaluated for physico-chemical and nutritional quality.

There was no significant difference between the mean seed size of Kabuli (22.6 g) and *desi* (20.9 g), indicating an improvement in the seed size of some *desi* chickpea types (Table 5). The largest seed size of 26.2 and 25.6 g/100 seed were found in 'ILC-3279' (Kabuli) and 'CM-141' (*desi*), respectively. Seed size is critical for the selection of genetic material and in general the larger seed is considered of better quality. The larger seeds are also preferred for consump-

Table 4. Quality characteristics of ration and commercial flour (*atta*) consumed in Islamabad and Rawalpindi districts

Location/ Source	Physical composition (%)		Gluten		Chemical composition (%)					Farinograph			Chapti Quality		
	White flour	Bran	Wet gluten %	Quality	Moisture	Protein	Fat	Crude fibre	Ash	Abs* (%)	Do** (min)	Stability (min)	Colour	Texture	Overall acceptability
Islamabad ration shops	61	39	17	Low	15.5	12.1	2.0	2.3	1.7	59.8	16.5	5.0	Brown	Coarse but pliable	U
Murree ration shops	58	42	19	Low	13.5	12.6	2.2	2.9	1.7	62.7	12.0	7.5	Brown	Tough	U
Rawalpindi ration shops	60	40	17	Low	14.5	12.5	1.9	2.9	1.7	61.6	14.5	4.5	Brown	Tough	U
Kahuta ration shops	62	38	13	Low	15.9	12.2	1.9	3.0	1.7	57.5	15.5	2.0	Brown	Tough	U
Gujar ration shops	57	43	15	Low	15.5	11.8	2.0	2.9	1.8	57.5	15.5	2.5	Brown	Tough	U
Ibd/Rwp commercial	81	19	21	Moderate	14.1	12.2	1.6	1.5	0.9	57.0	9.0	12.0	Creamy white	Soft and pliable	S
fine flour NARC/Lab. milled flour	88	12	28	Moderate	12.1	15.2	1.9	2.5	0.9	71.0	5.0	2.7	Creamy	Slightly rough but pliable	S

* = Water absorption, U = Unsatisfactory
 ** = Dough development time (500 B.U.), S = Satisfactory

heritable characteristic but it can be affected up to 25 percent by growing location, season and disease such as *Ascochyta* blight.

In the current study, the seed coats of *desi* chickpeas were significantly ($P < 0.01$) harder than seed coats of Kabuli type. The results also indicated that 'ILC-182', 'ILC-195', 'ILC-200', 'CM-68' and CM-1', had normal

seed coats. The hardness in seed coat i.e., the permeability of the seed coat, was influenced by growing environment, the state of maturity of the seeds at harvest and the temperature during the maturation. Hard coated seeds do not germinate as quickly or cook as quickly as normal seeds. The hydration capacity is the degree to which the cotyledons and cell contents

become fully saturated with water. The mean values for hydration capacity of Kabuli and *desi* chickpeas were 0.22 and 0.16 g, respectively, and the difference was statistically significant ($P < 0.01$). Cooking time is an important component of cooking quality. The mean cooking time of dry Kabuli and *desi* chickpeas were 103 and 121 minutes, respectively, and the dif-

Table 5. Physical and physico-chemical data of Kabuli and *desi* chickpeas

Variety	Seed weight (g/100 seeds)	Seed volume (ml/100 seeds)	Seed density (g/ml)	Hard seed coatedness (%)	Hydration capacity/seed (g)	Hydration Index	Cooking time (min)		
							Dry	Soaked	Soaked with 0.5% NaHCO ₃
KABULI									
Range	19.1–26.2	15.0–22.0	1.19–1.27	0–2.0	0.18–0.27	0.99–1.08	93–116	32–46	16–23
Mean	22.6	18.0	1.26	0.5	0.22	1.03	103	36	23
S.d.	3.33	3.04	0.03	0.87	0.04	0.01	10.40	5.54	2.91
C.V.	14.73	16.90	2.24	—	17.42	0.97	10.10	15.40	12.68
DESI									
Range	12.8–25.0	12.0–21	1.06–1.35	0–7.0	0.10–0.23	0.56–0.97	115–129	32–57	22–34
Mean	20.9	17.0	1.22	3.1	0.16	0.82	121	41	27
S.d.	3.74	2.72	0.09	2.36	0.04	0.13	4.62	7.93	3.70
C.V.	17.92	16.03	7.13	—	22.71	16.50	3.82	19.33	13.72

S.d. = Standard deviation, C.V. = Coefficient of variance

ference was statistically significant ($P < 0.01$). On average it took 36 and 41 minutes to cook soaked Kabuli and *desi* chickpeas, respectively, and the differences between cooking times was significant ($P < 0.01$). Overnight soaking of seeds with or without NaHCO_3 (baking soda) reduced the cooking time drastically in both types. On the average, it took 36 and 41 minutes to cook soaked Kabuli and *desi* chickpeas, respectively, and the difference between cooking times was significant ($P < 0.01$). The cooking time was further reduced to 23 and 27 minutes for Kabuli and *desi* types, respectively, when soaked with 0.5 percent NaHCO_3 and difference was significant ($P < 0.01$). The cooking time is considered to be a function of permeability of the seed coat, followed by the rate at which the hot water causes the gelatinization of starch and denaturation of cell wall material in the cotyledons. The hard seed coatedness and poor hydration capacity resulted in longer cooking time in *desi* chickpeas. However, seed size and hydration capacity of Kabuli chickpeas showed positive correlation ($r = 0.99$) with cooking time.

It is, therefore, concluded that chickpeas should be soaked overnight with 0.5 percent NaHCO_3 before cooking to reduce the cooking time and therefore the consumption of fuel. Seed coat being a critical factor for cooking quality and germination of the seed, the breeders should keep this important character in mind during their crop improvement studies.

The average values for the chemical composition of Kabuli and *desi* chickpeas are presented in Table 6. The protein content in whole Kabuli chickpeas ranged from 21.4 to 27.5 percent, in *dhal* from 22.1 to 26.2 percent, in seed coat from 6.6 to 8.9 percent and in whole *desi* chickpeas from 20.5 to 26.7 percent, in *dhal* from 20.2 to 31.1 percent and in seed coat from 4.7 to 8.5 percent. The average fat contents in whole Kabuli and *desi* seed were 5.3 and 4.3 percent, respectively. The available carbohydrate content in Kabuli chickpeas variety from 52.3 to 56.9 percent

Table 6. Chemical composition (on dry basis) of Kabuli and *Desi* chickpea cultivars (mean values)

Component	Whole seed	
	Kabuli chickpea	<i>Desi</i> chickpea
Protein (N x 5.7) (%)	24.1	23.9
Fat (%)	5.3	4.3
Available CHO (%)	54.1	50.7
Fibre (%)	4.3	9.9
Ash (%)	2.8	2.7
Ca (mg/100 g)	382.5	260.0
P (mg/100 g)	354.3	294.4
Fe (mg/100 g)	10.2	9.5
Zn (mg/100 g)	4.3	4.0
Mn (mg/100 g)	4.7	5.9
Cu (mg/100 g)	1.5	1.4
Ni (mg/100 g)	0.3	0.3
Tannin (g/100 g)	0.37	0.82
Gross energy (Kcal/100 g)	361	320

11.4 percent) in *desi* chickpeas and ranged from 3.2 to 5.1 percent in Kabuli chickpeas. The ash contents were almost identical in whole seed and *dhal* of both types. The average content of Ca was higher in Kabuli than *desi* but that of Fe, Zn, Mn, Cu and Ni was almost the same. Tannin content was higher in *desi* (0.82 percent) than Kabuli type chickpeas (0.37 percent). It is known that tannin has a negative effect on protein digestibility. The gross energy values for Kabuli and *desi* chickpeas were 361 and 320 Kcal/100 g, respectively. Food legumes are

regarded as a protein supplement in the human diet and although the protein content is usually substantially higher than that of cereals, care must be taken to increase protein production per unit area, commensurating with yield improvement. Greater attention be paid to improve amino acid profile, particularly sulphur containing amino acids, to reduce seed coat hardness, fibre content and to eliminate anti-nutritional factors in *desi* chickpeas. The cooking quality and consumer's acceptance of the new varieties should also be taken into account.

Table 7. Physio-chemical properties of lentil cultivars/advanced lines

Cultivar/ advanced lines	Seed yield (kg/ha)	Seed weight (g/100 seeds)	Hydration coefficient (%)	Cooking time (min)	
				Dry	Soaked
'18-10'	550	1.9	184.6	26.4	6.3
'9-6'	750	1.9	178.3	24.5	7.5
'18-12'	550	2.0	189.7	24.5	8.0
'Vm-25'	550	2.0	175.0	23.0	7.0
S.E.	100	0.06	6.55	1.44	0.65
C.V.	16.67	3.08	3.60	5.85	8.97

Table 8. Chemical composition (dry basis) of some lentil cultivars/advanced lines

	Protein (N x 5.7) (%)	Fat (%)	Avail- able carbo- hydrates (%)	Crude fibre (%)	Ash (%)	Energy (Kcal) 100 g)	(mg/100g)							Tannin (%)
							Ca	P	Fe	Zn	Mn	Cu	Ni	
'18-10'	22.8	4.9	57.4	4.3	2.7	365	173.9	260.6	9.6	5.2	3.3	2.0	0.3	1.09
'9-10'	24.6	3.6	56.4	4.8	2.5	356	171.2	264.5	9.6	5.4	2.6	2.0	0.3	1.08
'Vm-25'	25.0	4.9	50.0	4.8	2.7	344	130.9	330.6	10.1	8.9	3.9	2.6	0.3	0.98
'S.C.	0.96	0.75	3.39	0.30	0.10	8.66	65.87	50.87	0.45	1.90	0.57	0.32	0.05	0.06
C.V.	3.99	17.65	6.14	6.35	3.77	2.44	34.49	18.85	4.70	31.28	16.89	14.06	18.18	5.78

S.E. = Standard error, C.V. = Coefficient of variability.

Physico-chemical and Nutritional Quality of Some Lentil Cultivars/Advanced Lines

Four cultivars/breeding lines of lentils grown at NARC were evaluated for physical characteristics, cookability and nutritional quality (Table 7). The cultivars yielded from a minimum of 550 kg/ha to a maximum of 750 kg/ha. The seed size ranged from 1.9 to 2.0 g/100 seed. The overall mean of seed yield and 100-seed weight of lentil varieties grown in the Middle East, have been reported to be 1223 kg/ha and 3.69 g/100-seed, respectively. The hydration co-efficient in the present study varied from 175.0 to 189.7 percent. Cooking time is one of the important parameters in evaluating the quality of legumes. The cooking process makes hard seed soft by improving the plasticity of the cell wall and gelatinization of the starch. The mean time for cooking of dry seeds was 24.6 min. However, the cooking time was reduced significantly, when seed were soaked overnight in water. A range of 6.5-8.0 minutes in cooking time amongst the various cultivars was observed.

The protein content (N x 5.7) ranged from 22.8 percent in cultivar ('18-10') to 25.0 percent in 'Vm-25'. The overall mean was 24.1 percent giving a protein yield of 141 kg/ha. The fat content varied from 3.6 to 4.9 percent (Table 8). The available carbohydrates were highest (57.4 percent) in cultivar '18-10' and lowest (50.0 percent) in 'Vm-25'. The fibre content ranged from 4.3-5.0 percent. The ash content was uniform in all cultivars. Calcium content was highest (284.4 mg/100 g) in cultivar '18-10' whereas phosphorus was highest (330.6 mg/

Table 9. Chemical composition of some commercial potato products

Samples	Moisture %	Protein Fat Ash		
		% dry basis		
Golden Chips	3.4	4.8	43.0	3.1
Nimko	4.8	4.4	45.6	2.3
S.B. Chips	3.3	4.9	43.4	1.5
Pak. Potato Chips	3.2	5.3	42.0	2.3
Pak. Potato Spicy	3.6	5.3	47.0	2.4
Bingo	3.0	7.0	18.6	4.6

100 g) in 'Vm-25'. The concentration of iron ranged from 9.0-10.1 mg/100 g. Highest content (8.9 mg/100 g) of zinc was found in 'Vm-25'. The concentration (mg/100 g) of manganese, copper and zinc ranged from 2.6-3.9 mg percent, 2.0-2.6 mg percent, and 4.8-8.9 mg percent, respectively. The tannin content varied between 0.98 and 1.09 percent. The gross g in cultivar '18-10'.

Although lentils are commonly used foodgrains in our diet, very little research has been undertaken on their quality aspects. New varieties/breeding lines should be tested for their amino acid contents, anti-nutritional factors, flatulence and cookability. As the decortication loss is related to seed size, the breeder should introduce varieties having larger seed size.

Nutritive Value of Some Commercial Potato Products

Six samples of commercial potato products viz; Golden Chips (Standard Foods), Nimko (Unneed Foods) and S.B. Chips (Shahid Brothers), Pak Potato Chips (Pak Foods), Pak Potato Spicy (Pak Foods) and Bingo (Harvey's) received from Potato Programme, NARC, were analysed. The results are presented in Table 9.

The moisture content ranged

from 3.0 to 4.8 percent. The protein content was the highest (7.0 percent) in Bingo and was the lowest (4.4 percent) in Nimko. The fat content varied between 18.6 and 47.0 percent. The ash content was the highest (4.6 percent) in Bingo and lowest (1.5 percent) in S.B. Chips. The nutritive value of all products was satisfactory when compared with similar products consumed in European countries. However, Bingo contained highest protein but in fat content they were found to contain the lowest amount.

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