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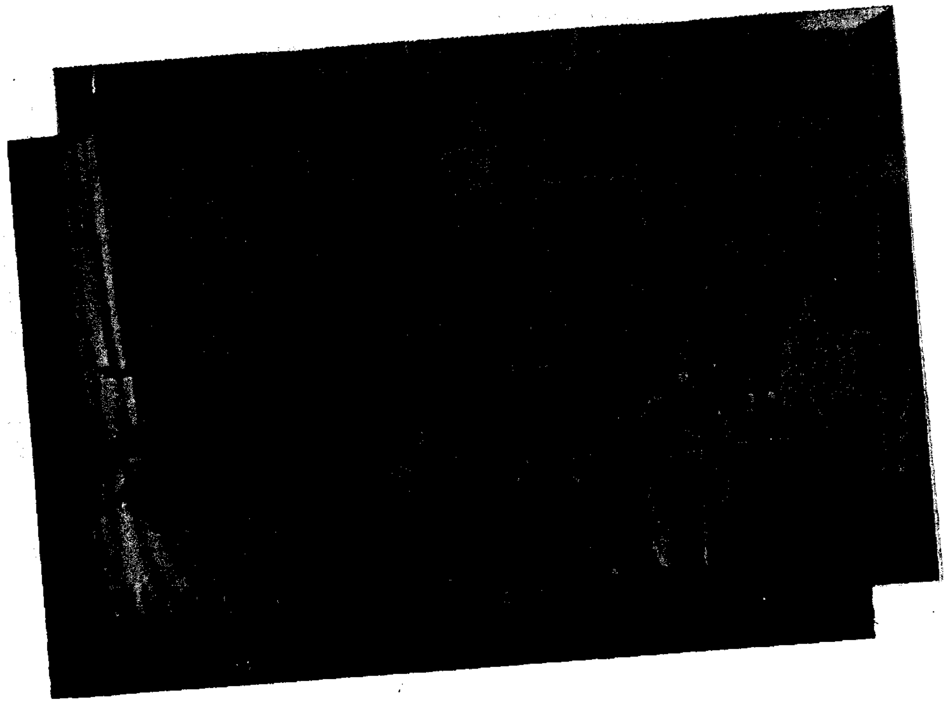
Food Technology Research



PROTEIN CONTENT OF CHICKPEA CROSSES

Twenty-three crosses of chickpeas obtained from Pulses Programme, NARC, were analysed for protein (Figure 1). The protein (dm basis) of these crosses varied from 19.7 to 24.9%. Among these crosses 'CM-72' x 'ILC-3279' had the lowest protein content while 'PK-51832' had the highest protein content.

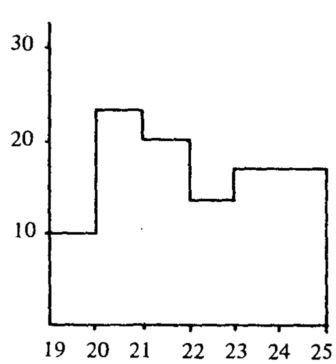


Figure 1. Distribution of protein in chickpea crosses

PROTEIN CONTENT OF WHEAT VARIETIES/ADVANCE LINES GROWN AT FAISALABAD

Forty seven wheat varieties/ advance lines received from AARI, Faisalabad were analyzed for their protein content (Figure 2). The protein content (Nx5.7) of the advance lines varied from 10.5% for the line 'V-85165' to 15.2% for line 'V-85116'. The protein content of the commercial varieties varied from 10.7% ('Jow-83', 'Jow-87', 'Sutlej-86') to 14.2% ('Barani-83'). As wheat is a staple diet of Pakistan, there is need to improve its production and to evolve new varieties/ breeding lines having higher content of lysine, which is deficient in wheat.

EFFECT OF SOWING DATES ON THE QUALITY CHARACTERISTICS OF WHEAT VARIETIES

Five varieties ('Lyp-73', 'Barani-83', 'Blue Silver', 'Pak-81', 'Faisalabad-83') corresponding to six sowing dates from October 1987 – December 1987 with regular intervals for each variety were collected from wheat programme, NARC (Table 1). The

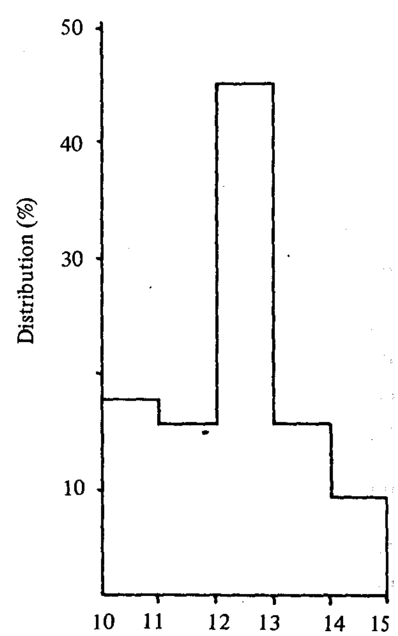


Figure 2. Distribution of protein in wheat advance lines/varieties

1000 kernel weight and test weight showed inconsistent changes with sowing dates, for all varieties.

Flour yield in 'Lyp-73' and 'Blue silver' was maximum for the sowing dates of October 22 and November 5, for 'Barani83' and 'Faisalabad-83', it was maximum for October 8 while for 'Pak-81', it was maximum for December 6. Amylase activity was minimum in the samples for the crop sown in November and December.

'Faisalabad-82', 'Blue silver' and 'Pak-81' had maximum gluten content for the crop sown in December. 'Lyp-73' had highest gluten contents for the sowing dates in November and December, while 'Barani-83' did not show any consistent pattern. Water absorption showed inconsistant and slight variations. Dough development time showed wider ranges for different sowing dates only in case of 'Faisalabad-83' (2.0-4.0), 'Pak-81' (3.0-5.0) and 'Barani-83' (3.0-6.8). Stability was maximum in the samples sown on December 17 in all varieties except in case of 'Blue silver' where it was maximum for samples sown on December 6. Mixing tolerance also showed wide variations for different sowing dates for each variety.

EFFECT OF LOCATION ON QUALITY CHARACTERISTICS OF WHEAT VARIETIES

Three varieties of different strength (based on previous results) were collected from three different locations (NARC, Islamabad, CCRI, Pirsabak and AARI, Faisalabad) and the effect of location on their quality characteristics was investigated (Table 2). The 1000 kernel weight varied between 36.7 and 41.1 g for 'Pak-81', 40.5 and 46.0 g for 'Lyp-73' and 37.8 and 43.7 g for 'Barani-83' at the three locations. However, slight variation was observed in test weight for each variety at different locations. Flour yield range was 64.8-69.4% for 'Pak-81' and 67.7-73.9 for 'Lyp-73' while in case of 'Barani-83' it varied slightly (70.0-71.5%) for the three locations. Different locations also affected protein, gluten and ash content. There was a greater difference in alpha-amylase activity within each variety at the three locations. Farinographic characteristics for each variety except in case of dough development time for 'Barani-83' were different. It is concluded that each variety was not only affected by the genetic variability but also by environmental factors.

Chappati quality was satisfactory for all varieties from all the three locations.

EFFECT OF PARTIAL REPLACEMENT OF COMMON SALT ON QUALITY OF WHEAT CHAPPATI

Three commercial wheat varieties ('Pak-81', 'Barani-73' and 'Lyp-73') were procured from the Wheat Programme, NARC and the effect of partial replacement of the common salt by other salts (Na_2SO_4, KCl,

Table 1. Effect of sowing dates of the quality of wheat varieties

Variety	Sowing Date	1000 kernel weight (g)	Test Weight (kg/hl)	Flour yield%	PSI%	Falling No. (sec)	Dry Gluten (%db)	Farinograph			
								Wat. Abs.	DDvt (min)	Stability (min)	MTI (Bu)
'Lyp-73'	8–10–1987	38.8	73.4	59.9	32.0	402	11.8	64.1	3.0	3.7	40
	22–10–1987	39.7	73.2	69.9	36.5	490	11.7	65.8	3.0	2.7	50
	5–11–1987	41.5	74.9	68.9	28.0	591	14.5	67.2	3.2	9.5	20
	6–12–1987	41.6	74.9	65.6	29.0	677	15.1	68.2	3.0	3.2	60
	17–12–1987	35.5	75.5	64.9	32.0	627	15.1	68.8	3.7	12.0	20
	29–12–1987	36.2	74.3	66.3	24.0	607	13.1	65.3	3.5	8.0	30
'Barani-83'	8–10–1987	42.6	73.9	71.9	25.5	372	11.3	70.0	4.7	2.7	35
	22–10–1987	42.1	74.1	65.6	23.0	408	11.4	66.6	3.0	3.0	80
	5–11–1987	40.1	74.5	67.5	27.5	567	12.0	70.8	6.0	13.5	5
	6–12–1987	36.7	72.1	64.0	30.0	579	10.2	70.1	6.5	13.0	5
	17–12–1987	31.7	71.8	64.1	30.5	534	12.7	70.2	6.8	19.0	5
	29–12–19787	36.4	72.4	64.9	33.0	434	12.8	67.8	4.8	6.3	40
'Blue Silver'	8–10–1987	42.4	71.9	63.9	35.0	288	12.5	70.2	2.5	1.5	90
	22–10–1987	42.4	74.4	65.1	37.5	523	12.5	68.8	2.3	1.5	90
	5–11–1987	40.6	73.8	64.3	33.0	554	13.2	70.1	3.0	3.0	70
	25–11–1987	41.7	–	62.4	43.0	566	13.7	67.0	2.5	1.2	90
'Pak-81'	8–10–1987	43.1	75.3	65.9	34.0	156	10.3	67.1	3.0	2.0	70
	22–10–1987	40.8	76.8	66.1	32.0	260	9.1	69.6	3.0	1.8	50
	5–11–1987	39.3	73.5	64.6	28.0	386	10.0	70.0	5.0	3.7	25
	6–12–1987	35.4	73.5	67.5	29.0	399	11.5	70.6	5.0	4.0	30
	17–12–1987	30.1	71.0	64.4	29.0	361	11.5	70.6	5.0	6.0	25
	29–12–1987	31.9	70.1	64.8	32.0	370	12.2	69.8	4.7	5.5	30
'Faisalabad-83'	8–10–1987	42.0	73.3	67.4	30.5	319	11.7	70.4	2.2	1.5	120
	22–10–1987	40.0	72.9	64.3	33.0	380	12.3	69.0	2.5	1.5	100
	6–12–1987	40.0	74.3	66.5	32.0	513	13.4	69.2	2.5	2.3	65
	17–12–1987	31.0	71.9	65.8	34.0	544	13.4	69.0	4.0	9.0	20
	29–12–1987	39.2	73.6	64.8	33.0	452	13.9	[illegible]	[illegible]	[illegible]	[illegible]

$MgCl_2$, $MgSO_4$, $CaCl_2$), on the quality characteristics of their Chappati was evaluated (Tables 3-6). The water absorption decreased slightly in 'Pak-81', while it showed significant increase in 'Barani-83' for all the salts including NaCl when compared to control. For 'Lyp-73', water absorption changes were small and inconsistent in relation to the control. The dough development time increased for all the three varieties with addition of every salt except $CaCl_2$, which gave slightly different results for 'Lyp-73' and 'Barani-83'. Stability increased generally with the addition of each salt for each variety. Mixing tolerance index (MTI) increased with the addition of different salts in 'Pak-81'. It also showed an increase in 'Barani-83' and 'Lyp-73' with the addition of most of the salts.

For 'Pak-81', addition of high doses of $CaCl_2$ and $MgCl_2$ resulted in slack dough. The dough strength values at a rest period of 135 min suggest an improvement with all salts in the dough machinability as compared to the control. Addition of some salts gave energy values <50 cm which is an indication of poor machinability and baking quality. In 'Lyp-73', most of the salts increased the dough energy but in case of Na_2SO_4 and $CaCl_2$ (low doses) very high ratio figure values showed a short dough nature. In 'Barani-83', low dose of $MgCl_2$ resulted in slack dough while addition of other salts increased the dough energy and thus showed an improvement in the baking quality. In case of $MgSO_4$, the very high values indicated a short dough. For 'Pak-81', both KCl and $MgCl_2$ gave satisfactory Chappati quality. The rate of moisture loss decreased significantly with the addition of each salt. 'Lyp-73' gave Chapatti of unsatisfactory quality with Na_2SO_4 and $CaCl_2$ (at high doses). The rate of moisture loss was higher during the Ist hour, but after the 2nd hour it became lower in most of the cases. 'Barani-83' gave a mixed trend for baking quality with the use of different salts.

The data indicated that KCl can satisfactorily be used for partial replacement of NaCl in all the three varieties studied, while $MgCl_2$ (at both low and high doses) can give satisfactory Chappati quality for 'Pak-81' and 'Barani-83'. In 'Lyp-73', low dose of $CaCl_2$ and both low and high levels of $MgSO_4$ can also be used for this purpose. For 'Barani-83', $CaCl_2$ can also be used for partial replacement of NaCl in preparation of good quality Chappati.

Table 2. Effect of location on the quality characteristics of three wheat varieties

Characteristics	NARC, Islamabad			Pirsabak (NWFP)			AARI, Faisalabad		
	'Pak-81'	'Lyp-73'	'Barani-83'	'Pak-81'	'Lyp-73'	'Barani-83'	'Pak-81'	'Lyp-73'	'Barani-83'
1000 kernel weight (g)	41.1	43.0	43.7	36.7	40.5	40.0	39.2	46.0	37.8
Test weight (kg/hl)	76.8	77.0	76.6	76.6	77.0	76.2	75.2	78.8	74.7
Flour yield (14.0 mb%)	66.8	67.7	70.0	64.8	73.9	71.5	69.4	71.4	70.8
PSI (%)	43.0	41.0	41.0	42.0	40.0	40.0	43.0	41.0	43.0
Moisture White flour	9.8	10.2	10.1	10.0	10.7	10.1	10.2	10.3	10.1
Whole flour	9.9	9.9	9.6	9.7	9.3	9.5	8.8	11.3	8.4
Protein (%, db)									
White flour	11.10	11.90	12.10	11.50	12.20	11.00	13.00	11.10	13.20
Whole flour	12.70	14.40	13.40	12.00	13.70	11.10	13.30	11.00	13.40
Ash (%, db) White flour	0.55	0.54	0.56	0.71	0.69	0.76	0.68	0.64	0.80
Whole flour	1.79	1.69	1.63	1.72	1.73	1.74	1.50	1.57	1.37
Falling number (sec.)	297.00	457.00	448.00	512.00	503.00	379.00	477.00	461.00	647.00
Dry gluten (%, db) White flour	9.90	11.60	9.80	8.30	11.70	8.90	11.10	9.40	11.00
Farinograph (14%, mb)									
Water absorp. %	68.3	65.0	66.0	64.9	64.8	66.2	71.2	60.1	69.4
Dough development time (min)	3.7	2.5	5.0	4.5	3.2	5.0	4.3	3.6	5.5
Stability (min)	1.5	2.5	4.0	4.5	4.5	5.7	3.2	3.8	13.5
Time to breakdown (min)	5.5	8.0	12.3	11.0	10.0	12.0	6.5	7.3	18.5
Chapatti quality	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory

Table 3. Effect of partial replacement of NaCl on the quality of dough and *Chapati* 'Pak-81'

No.	Salts Combination	Farinograph				Extensograph				*Chapati* quality
		Water absorption (%)	Dough dev. time (min)	Stability (min)	MTI (Bu)	Energy (cm2)	Resist. to extension (Eu)	Extensibility (min)	Ratio figure	
1.	Control (0)	68.3	3.5	1.5	130	–	–	–	–	O
2.	NaCl (2%)	67.8	4.5	3.0	70	53.7	310	123	2.5	O
3.	Na_2SO_4+NaCl*	66.7	4.2	2.5	80	51.2	275	127	2.2	US
4.	Na_2SO_4+NaCl**	66.2	4.5	3.0	70	68.8	355	120	3.0	US
5.	KCl + NaCl*	67.2	4.0	2.5	80	46.0	280	108	2.6	S
6.	KCl + NaCl**	67.2	4.0	3.0	80	41.8	260	104	2.5	S
7.	$CaCl_2$ + NaCl*	67.9	4.7	2.0	100	29.5	240	90	2.7	US
8.	$CaCl_2$ + NaCl**	68.0	4.0	1.7	120	–	–	–	–	US
9.	$MgSO_4$ + NaCl*	66.4	3.7	25	90	51.2	320	111	2.9	US
10.	$MgSO_4$ + NaCl**	66.3	3.7	2.7	80	41.0	275	103	2.7	US
11.	$MgCl_2$ + NaCl*	67.0	4.5	2.0	80	49.3	320	104	3.1	S
12.	$MgCl_2$ + NaCl**	67.5	4.8	2.3	100	–	–	–	–	S

O = Objectionable S = Satisfactory US = Unsatisfactory

** and ** 20% and 40% of the sodium ions, respectively (equivalents) were replaced with respective ions/salts.*

NUTRITIONAL QUALITY OF MASH (ADVANCE LINES)

Ten advance lines of mash grown at NARC were evaluated for physical characters, cookability and nutritional quality (Table 7). The 100 seed weight ranged from 4.0 to 5.2 g. The hydration coefficient varied from 108 to 152%. The average mean cooking time of dry seed was 56 min which reduced to 34.6 minutes when the seeds were soaked overnight in water. Cooking time may be expected to be affected by the starch itself, the permeability of the seed coat, and by the internal structure of the seed endosperm material, all of which

Table 4. Effect of partial replacement of NaCl by other salts on the quality of dough and *chapati* of 'Lyp-73'

No.	Salts Combination	Farinograph				Extensograph				*Chapati* quality
		Water absorption(%)	Dough dev. time (min)	Stability (min)	MTI (Bu)	Energy (cm2)	Resist. to extension (Eu)	Extensibility (min)	Ratio figure	
1.	Control (0)	58.8	3.5	2.8	90	38.6	390	72	3.8	S
2.	NaCl (2%)	59.2	4.5	4.0	100	55.1	410	94	4.4	S
3.	Na_2SO_4 + NaCl*	59.4	4.8	4.8	90	72.4	540	94	5.8	US
4.	Na_2SO_4 + NaCl**	59.6	5.0	4.8	110	85.2	630	100	6.3	US
5.	Kcl + NaCl*	58.9	4.0	2.8	120	56.8	430	88	4.9	S
6.	KCl + NaCl**	59.0	4.0	3.5	120	49.1	360	95	3.8	S
7.	$CaCl_2$ + NaCl*	58.8	4.0	3.0	130	52.6	445	81	5.5	S
8.	$CaCl_2$ + NaCl**	57.6	3.0	3.0	140	33.5	355	78	3.9	US
9.	$MgSO_4$ + NaCl*	57.0	4.0	3.5	130	53.9	430	88	4.9	S
10.	$MgSO_4$ + NaCl**	57.6	4.5	4.0	120	46.9	305	105	2.9	S
11.	$MgCl_2$ + NaCl*	57.8	4.0	3.3	120	39.9	315	86	3.7	O
12.	$MgCl_2$ + NaCl**	57.6	4.0	3.8	90	40.5	315	90	3.5	O

O = Objectionable S = Satisfactory US = Unsatisfactory
** and ** 10% and 40% of the sodium ions, respectively (equivalents) were replaced with respective ions/salts.*

Table 5. Effect of partial replacement of NaCl by other salts on the quality of dough and *chapati* of 'Barani-83'

No.	Salts Combination	Farinograph				Extensograph				*Chapati* quality
		Water absorption(%)	Dough dev. time (min)	Stability (min)	MTI (Bu)	Energy (cm2)	Resist. to extension (Eu)	Extensibility (min)	Ratio figure	
1.	Control (0)	66.0	5.0	4.0	30	43.8	260	114	2.3	S
2.	NaCl (2%)	66.5	5.5	10.5	35	60.6	260	147	1.8	S
3.	Na_2SO_4 + NaCl*	66.2	7.5	8.0	45	111.7	500	136	3.7	US
4.	Na_2SO_4 + NaCl**	66.4	9.0	>14.5	20	151.3	635	136.5	4.7	US
5.	KCl + NaCl*	66.6	5.5	6.0	40	67.7	285	141.5	2.0	S
6.	KCl + NaCl**	67.0	5.5	>17.5	30	81.1	335	146	2.3	S
7.	$CaCl_2$ + NaCl*	68.8	5.0	6.5	40	59.4	380	105	3.6	S
8.	$CaCl_2$ + NaCl**	69.8	5.0	4.0	45	45.5	280	115	2.5	US
9	$MgSO_4$ + NaCl*	66.4	6.0	6.5	40	120.8	770	98	7.9	O
10.	$MgSO_4$ + NaCl**	66.2	6.0	6.0	40	127.0	>1000	90	11.1	US
11.	$MgCl_2$ + NaCl*	70.6	6.0	9.0	40	–	Slack dough			S
12.	$MgCl_2$ + NaCl**	70.8	5.5	3.0	30	57.6	300	127	2.4	O

O = Objectionable S = Satisfactory US = Unsatisfactory
** and ** 10% and 40% of the sodium ions, respectively (equivalents) were replaced with respective ions/salts.*

Table 6. Percent loss of moisture contents of *chapati* made by partial replacement of NaCl in three wheat varieties

No.	Salt Combinations	'Pak-81' (% Moisture loss)			'Lyp-73' (% Moisture loss)			'Barani-83' (% Moisture loss)		
		Ist hour	2nd hour	3rd hour	Ist hour	2nd hour	3rd hour	Ist hour	2nd hour	3rd hour
1.	Control (0)	16.5	33.1	44.3	10.7	30.2	59.2	8.0	15.2	–
2.	NaCl (2%)	8.0	14.0	18.3	6.6	31.4	47.6	8.0	19.9	26.3
3.	Na_2SO_4 + NaCl*	3.1	6.1	8.8	25.4	36.6	62.9	11.3	20.6	34.6
4.	Na_2SO_4 + NaCl**	1.8	3.9	19.4	27.0	40.1	61.2	7.9	14.5	15.0
5.	KCl + NaCl*	6.8	8.7	23.9	26.4	38.6	65.6	9.4	30.4	51.4
6.	KCl + NaCl**	2.5	10.1	11.7	36.1	40.4	43.6	4.6	7.1	10.0
7.	$CaCl_2$ + NaCl*	1.2	3.6	8.5	9.5	13.2	16.5	3.6	6.3	11.9
8.	$CaCl_2$ + NaCl**	5.6	12.0	16.0	17.6	34.9	39.4	4.2	11.2	15.2
9.	$MgSO_4$ + NaCl*	4.9	10.2	18.8	29.8	40.8	62.8	8.0	8.9	11.0
10.	$MgSO_4$ + NaCl**	13.2	17.7	20.6	7.4	20.4	27.5	11.7	15.8	24.8
11.	$MgCl_2$ + NaCl*	12.6	30.3	31.4	14.3	15.6	21.0	23.2	34.8	50.0
12.	$MgCl_2$ + NaCl**	3.4	9.0	19.0	2.6	6.9	14.6	6.5	14.3	24.9

would be affected by soaking in water. The protein content (Nx 5.7) ranged from 15.2% in cultivar 'Mash-133' to 17.5% in cultivar 'Pasroor', the overall mean being 16.5%. The fat content was almost uniform in all these lines (0.6 to 0.7%) and the ash content varied slightly from 3.1 to 3.6%.

New varieties//breeding lines of mash should also be tested for their amino acid content, antinutritional factors and flatulence effect.

PHYSICOCHEMICAL AND NUTRITIONAL QUALITIES OF COWPEA (ADVANCE LINES)

Ten advance lines of cowpea received from Food Legume Programme, NARC, were evaluated for physicochemical characteristics and nutritional quality (Table 8). The 100 seed weight of these lines ranged from 12.4 to 21.8 g with a mean value of 16.7 g. Seed size is critical for selection of genetic material and in general the large seed size is considered to be of better quality. The larger seeds are also preferred for consumption. Although seed size is a highly variable characteristic, it can be effected upto 25% by the production environment.

Hydration capacity is the degree to which these seeds absorb water to become fully saturated. The hydration index of these lines was almost uniform (9.92 to 1.15). Swelling index is the increase in volume of dry seeds after soaking. In the present study it varied from 0.82 to 1.15 with a mean value of 0.91. Mean cooking time of these lines was 43 min which reduced to 29.7 min after soaking in water overnight. The cooking time is considered to be a function of permeability of the seed coat, followed by the rate at which 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. The mean value of protein content was

Table 7. Physicochemical and nutritional quality of mash (advance lines)

No.	Advance Lines	100-seed wt (g)	Hydration coefficient (%)	Cooking dry (min)	Time soaked	Protein (% dry basis)	Fat (% dry basis)	Ash (% dry basis)
1.	'Pasroor',	5.2	108	39	30	17.5	0.7	3.3
2.	'NC-5'	4.0	122	38	28	16.5	0.7	3.2
3.	'MM-5-60'	4.4	146	52	37	16.7	0.7	3.6
4.	'Mash-133'	4.2	113	32	21	15.2	0.7	3.1
5.	'MS-5-1'	4.0	126	44	34	16.1	0.7	3.4
6.	'BRS-57'	4.0	127	45	35	16.9	0.6	3.2
7.	'NC-13'	4.1	129	44	36	16.7	0.7	3.3
8.	'MM-33-40'	4.8	152	55	43	16.1	0.6	3.3
9.	'Sialkot'	4.4	134	54	44	16.3	0.7	3.2
10.	'MM-6-68'	4.2	146	47	38	16.7	0.6	3.3
	Mean	4.3	130.3	46	34.6	16.5	0.7	3.3
	S.E.	0.12	4.56	2.33	2.18	0.19	0.02	0.04
	C.V.	9.11	11.07	16.39	19.94	3.77	8.4	4.16

cultivar 'IT 83S-874'. Ash content ranged from 3.0 to 3.8%. Fat content varied from 1.0 to 1.7% in all advance lines with a mean value of 1.2%.

NUTRITIONAL QUALITY OF MUNG ADVANCE LINES

Six advance lines of mung received from Pulses Programme, NARC, were analysed for quality parameters (Table 9). The 100 seed weight varied from 3.2 to 4.0 g with a mean of 3.5 g. The hydration coefficient ranged from 112% in cultivar 'NCM-231' to 139% in cultivar 'NCM-10'. Cooking time, one of the important parameters in evaluating the quality of legumes, was 26.8 min for dry seeds while after overnight soaking in water it reduced to 16.8 min. The protein content (Nx5.7) ranged from 22.6% for 'NCM-5' and 'NCM69' to 23.9% for 'NCM-231'. The average values for ash and fat content were 3.7 and 0.8, respectively.

Food legumes are regarded as a protein supplement in 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, commensurate with yield improvement. Greater attention needs to be given to their genetic diversity to improve amino acid profile particularly the sulphur containing amino acid, and to eliminate antinutritional factors. The cooking quality and consumer acceptance of the new varieties should also be taken into account.

PHYSICOCHEMICAL AND NUTRITIONAL QUALITIES OF COMMERCIAL MUNG VARIETIES

Six commercial varieties of mung grown at NARC were evaluated for physical characteristics, cookability and nutritional quality (Table 10). The 100 seed weight ranged from 3.2 to 4.0 g. The hydration coefficient varied from 127 to 161%. The mean cooking time of dry seeds was 27 min. The cooking time was reduc significantly when the seeds w soaked overnight in water. Prot content (Nx5.7) ranged from 20.7% variety 'M-28' to 26.3% in varie '6601', the overall mean being 22.5 Crude fibre content was almo uniform in all these varieties (5. 5.9%). The fat content varied fro 0.7 to 1.2% and the ash content w found to vary from 3.2 to 4.6%.

Mung is commonly used in o diet, but very little research has be undertaken on its quality aspec New varieties/ breeding lines shou be tested for their antinutrition factors, flatulence effect, amino ac contents and cookability.

SCREENING OF OILSEEDS FO OIL CONTENT

As many as 1972 samples o sunflower germplasm/early lines, 21 samples of safflower germplasm advance lines, 2043 advance lines o rapeseed and mustard, and 6 varieti of groundnut received from BAR project and Oilseed Research Pro gramme, NARC and University o Agriculture, Faisalabad, were screene for their oil content (Table 11). Th highest oil contents were distribute in 51, 57 and 71% samples of su flower, safflower and rapeseed/musta rd, respectively.

FATTY ACID PROFILE OF RAPESEED AND MUSTARD ADVANCE LINES

As many as 264 advance lines o

Table 8. Physicochemical and nutritional quality of cowpea (advance lines)

S. No.	Advance Lines	100-seed wt (g)	Seed volume (ml/seed)	Hydration Capacity	Hyd. index	Swelling capacity	Swelling Index	Cooking Dry	Time (min) Soaked	Protein (% dry basis)	Ash	Fat
1.	'IT-84D-449'	17.2	0.17	0.17	1.01	0.14	0.82	45	25	21.3	3.5	1.2
2.	'IT-82E-16'	15.0	0.14	0.16	0.93	0.15	1.07	52	39	24.1	3.6	1.4
3.	'TV-1948-01F'	12.4	0.12	0.13	0.92	0.12	1.00	44	24	24.4	3.7	1.1
4.	'IT-84S-2231-15'	21.8	0.21	0.22	0.99	0.21	1.00	43	39	20.9	3.0	1.7
5.	'1184E-124'	19.2	0.18	0.20	0.97	0.18	1.00	42	38	23.4	3.4	1.4
6.	'IT83S-874'	16.8	0.16	0.17	0.97	0.14	0.87	64	32	27.3	3.8	1.0
7.	'TVX4272-013D'	14.2	0.12	0.15	0.93	0.16	0.82	39	30	22.4	3.2	1.2
8.	'IT83S-875'	19.0	0.16	0.16	1.15	0.17	1.06	42	29	21.0	3.1	1.1
9.	'IT82D-716'	16.2	0.13	0.15	0.92	0.17	1.30	29	22	21.7	3.8	1.3
10.	'IT84D-513'	14.8	0.13	0.14	1.07	0.15	1.15	30	19	22.0	3.5	1.1
	Mean	16.7	0.15	0.17	0.98	0.16	0.91	43	29.7	22.8	3.5	1.2
	S.E.	0.87	0.01	0.01	0.02	0.01	0.11	3.17	2.3	0.63	0.09	0.04
	C.V.	16.65	19.31	15.99	7.61	15.81	36.66	23.38	24.48	8.78	8.19	11.11

Table 9. Physicochemical and nutritional quality of mung (advance lines)

S. No.	Advance lines	Seed size (100-seed wt) (g)	Hydration coefficient (%)	Cooking Dry	Time Soaked	Protein	Ash	Fat
						(% dry basis)		
1.	'V5458'	3.6	119	25	17	23.6	3.7	0.9
2.	'NCM-7'	3.2	126	27	15	23.1	3.4	0.8
3.	'NCM-69'	3.6	137	31	19	22.6	3.9	0.8
4.	'NCM-231'	3.4	112	28	18	23.9	4.3	0.8
5.	'NCM-5'	3.2	130	27	17	22.6	3.4	0.8
6.	'NCM-10'	4.0	139	23	15	23.2	3.3	0.8
	Mean	3.5	127.2	26.8	16.8	23.2	3.7	0.8
	S.E.	0.12	4.25	1.11	0.65	0.21	0.16	0.02
	C.V.	8.66	8.19	10.11	9.51	2.26	10.44	5.56

Table 10. Physicochemical and nutritional quality of mung (Commercial Varieties)

S. No.	Variety	Seed size 100-seed wt	Hydration Coefficient (%)	Cooking Dry	Time (min) Soaked	Protein	Ash	Fat	Crude Fibre
						% dry basis			
1.	'6601'	3.2	161	26	18	26.3	3.0	1.2	5.6
2.	'NM-13-1'	4.0	155	28	17	23.2	4.1	0.9	5.8
3.	'M-121-25'	3.2	142	27	18	21.9	3.9	0.8	5.9
4.	'M-19-19'	3.4	127	25	17	21.9	4.6	0.7	5.9
5.	'M-20-21'	3.8	133	29	19	21.1	3.2	1.1	5.8
6.	'M-28'	3.6	143	31	19	20.7	3.2	1.0	5.4
	Mean	3.53	143.5	27.7	18	22.5	3.8	0.9	5.7
	S.E	0.13	5.23	0.88	0.36	0.83	0.22	0.07	0.08
	C.V.	9.24	8.94	7.80	4.96	9.06	14.25	19.7	3.42

Table 11. Oil content in different oilseeds

Oilseed	No. of samples	Range (%)	Mean (%)	S.E	C.V
Sunflower (early lines/ germplasm)	1972	20.4–52.7	39.4	0.13	14.55
Safflower (early lines/ germplasm)	210	17.5–30.0	25.3	0.16	8.94
Rapeseed and mustard (Advance lines)	2043	20.1–50.1	41.6	0.08	8.32
Groundnut (varieties)	6	46.8–53.0	49.2	1.06	5.29

Table 12. Fatty acid pattern of rape and mustard advance lines

Fatty acid	Range (%)	Mean (%)	S.E.	C.V
Palmitic acid	1.9–7.6	3.3	0.05	25.1
Stearic acid	0.04–2.1	0.7	0.02	49.45
Oleic acid	6.1–73.0	29.8	1.39	76.26
Linoleic acid	8.9–34.3	18.2	0.23	20.71
Linolenic acid	3.4–16.4	10.0	0.17	28.33
Gadoleic acid	1.1–17.0	7.9	0.43	89.20
Eicosedienoic acid	0.2–1.9	0.6	0.02	54.43
Behenic acid	0.01–3.5	0.4	0.02	92.01
Erucic acid	0.1–51.0	28.5	1.11	63.83

rape and mustard were analyzed for fatty acid profile. The data revealed that the linoleic and linolenic acid ranged from 8.9 to 34.3 and 3.4 to 16.4%, respectively. Erucic acid ranged from 0.1 to 51% with an average of 28.5% (Table 12). The lines having low erucic acid contained high level of oleic acids and vice versa. Large amount of rapeseed oil (50% or more of total energy) may cause fatty changes in the heart muscles of experimental animals due to large amount of erucic acid. Efforts should therefore, be made to modify the fatty acid composition of rape and mustard lines, so as to achieve low levels of erucic acid. Varieties high in linoleic and linolenic acids are desirable.

TOTAL GLUCOSINOLATES OF RAPE AND MUSTARD SEEDS

About 3941 samples of whole seeds of rapeseed and mustard were analyzed for total glucosinolates spectrophotometrically by the glucose release method. Thirty three percent of the samples had total glucosinolate content ranging from 90 to 120 um/g whole seed (Figure 3).

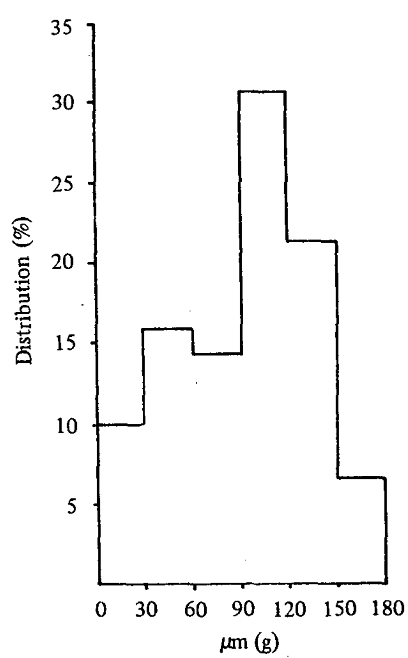


Figure 3. Distribution of total glucosinolates in rape and mustard seeds

Table 13. Fatty acid composition of sunflower advance lines

Fatty acid	Range (%)	Mean (%)	S.E.	C.V.
Palmitic acid	3.9–13.1	5.6	0.04	16.49
Stearic acid	0.01–4.0	1.7	0.06	15.00
Oleic acid	17.0–76.4	54.3	0.39	15.37
Linoleic acid	19.3–45.3	37.5	0.33	18.78
Linolenic acid	0.04–0.5	0.25	0.01	11.28
Arachidic acid	0.02–0.45	0.23	0.08	19.43

Table 14. Fatty acids profile of commercial groundnut varieties

Fatty acid	Range (%)	Mean (%)	S.E.	C.V.
Palmitic acid	9.5–11.5	10.9	0.20	5.59
Stearic acid	2.3–2.6	2.5	0.03	3.76
Oleic acid	58.9–64.0	59.9	0.54	2.72
Linoleic acid	21.1–25.2	24.5	0.45	5.49
Linolenic acid	0.05–0.11	0.09	0.01	19.31
Arachidic acid	0.9–1.1	1.0	0.02	7.01
Lignoceric acid	0.8–1.0	0.9	0.02	6.05

Table 15. Fatty acid composition of soybean varieties

Fatty acid	Range (%)	Mean (%)	S.E.	C.V.
Palmitic acid	9.2–11.2	10.1	0.23	6.55
Stearic acid	2.3–3.5	2.8	0.14	14.33
Oleic acid	20.6–28.1	23.5	1.01	12.19
Linoleic acid	52.3–60.1	56.5	0.97	4.86
Linolenic acid	4.9–6.3	5.5	0.22	11.10
Gadoleic acid	0.3–0.4	0.3	0.01	11.43
Behenic acid	0.2–0.5	0.3	0.05	50.58

Table 16. Proximate composition of soybean varieties

(%)

Variety	Moisture	Carbo-hydrate	Protein (db)	Ash (db)	Fat (db)
'Hobbit'	6.9	27.2	38.1	5.2	22.6
'BM-2'	6.7	29.6	38.6	5.4	19.5
'Douglas'	7.0	26.4	41.7	5.3	19.6
'EPPS'	6.8	26.9	41.1	5.1	20.1
'Century'	6.9	26.3	40.6	5.4	20.8
'Davis'	6.8	28.5	38.4	5.3	21.0
'Weber'	6.7	32.2	35.8	5.3	20.0
'Egyptian'	6.8	27.5	39.2	5.4	21.1

FATTY ACID PROFILE OF SUNFLOWER ADVANCE LINES

As many as 460 samples of sunflower advance lines received from Oilseeds Research Programme, NARC and University of Agriculture, Faisalabad were subjected to fatty acid analysis. The data indicated that oleic acid and linoleic acid ranged from 17.0 to 76.4 and 19.3 to 45.3 percent, respectively (Table 13)

FATTY ACID PROFILE OF COMMERCIAL GROUNDNUT VARIETIES

Nine groundnut varieties received from BARD project were analysed for fatty acid profile. The data revealed that oleic acid and linoleic acid ranged from 58.9 to 64.0 and 21.1 to 25.2 percent, respectively (Table 14). Linolenic acid content were low in all varieties as high linolenic acid contents are not desirable in groundnut. It has been shown that the stability of groundnut oil is greatest when the percentage of linoleic acid is the lowest. Breeding efforts should, therefore, be aimed to modify the fatty acid composition.

FATTY ACID PROFILE OF SOYBEAN VARIETIES

Eight varieties of soybean received from Oilseeds Research Programme, NARC were analysed for fatty acid composition (Table 15). The linoleic acid contents were highest and ranged from 52.3 to 60.1% whereas the linolenic acid content varied from 4.9 to 6.3 percent.

NUTRITIVE VALUE OF SOME COMMERCIAL SOYBEAN VARIETIES, SOYMILK AND INSOLUBLE RESIDUE

Eight soybean varieties ('Hobbit', 'BM-2', 'Douglas', 'EPPS', 'Century', 'Davis', 'Weber' and 'Egyptian') obtained from Oilseeds Research Programme, NARC, were analysed for proximate analysis (Table 16). The protein contents (dry basis) ranged

Table 17. Proximate composition of soymilk from various commercial soybean varieties

Variety	% Moisture	Total solid	Protein (%)	Fat (%)	Ash (%)	Carbohydrate by difference
'EPPS'	92.8	7.2	4.1	2.0	0.4	0.7
'Hobbit'	92.3	7.7	4.1	2.6	0.5	0.5
'Century'	93.8	6.2	3.0	2.0	0.4	0.8
'Davis'	93.6	6.4	3.3	2.0	0.4	0.7
'Weber'	92.7	7.3	3.2	2.5	0.2	1.4
'Douglas'	91.9	8.1	4.2	1.8	0.2	1.9
'Egyptian'	93.2	6.8	3.4	1.8	0.1	1.5
'BM-2'	92.3	7.7	3.7	2.0	0.2	1.8

Table 18. Organoleptic evaluation of soymilk prepared from different varieties, mixed with 15% cow's or buffalo's milk

Variety	Mean organoleptic scores for			
	Colour	Flavour	Mouthfeel	Taste
'EPPS'	6	4	4	4
'Hobbit'	5	6	4	6
'Century'	5	6	4	6
'Davis'	6	6	5	7
'Webber'	8	8	8	7
'Douglas'	6	8	8	8
'Egyptian'	5	7	5	5
'BM-2'	7	8	8	7
'EPPS' + 15% cow's milk	7	4	4	4
'Hobbit' + 15% cow's milk	6	6	4	6
'Century' + 15% cow's milk	6	6	4	6
'Davis' + 15% cow's milk	7	7	6	7
'Webber' + 15% cow's milk	8	8	8	8
'Douglas' + 15% cow's milk	6	8	8	8
'Egyptian' + 15% cow's milk	6	6	7	5
'BM-2' + 15% cow's milk	8	8	8	8
'EPPS' + 15% buffalo's milk	7	4	4	5
'Hobbit' + 15% buffalo's milk	6	6	4	7
'Century' + 15% buffalo's milk	6	6	4	7
'Davis' + 15% buffalo's milk	7	7	6	8
'Webber' + 15% buffalo's milk	7	8	8	8
'Douglas' + 15% buffalo's milk	7	8	8	8
'Egyptian' + 15% buffalo's milk	6	6	7	5
'BM-2' + 15% buffalo's milk	8	8	8	8

Table 19. Proximate composition of soybean insolubles

(%)

Variety	Moisture	Total solid	Protein (db)	Ash (db)
'Hobbit'	6.1	93.9	19.1	4.4
'BM-2'	5.0	95.0	25.4	4.5
'Douglas'	5.6	94.4	21.4	4.6
'EPPS'	5.2	94.8	29.9	4.5
'Century'	5.7	94.3	23.5	4.9
'Davis'	4.8	95.2	26.2	4.5
'Weber'	5.3	94.7	17.4	4.3
'Egyptian'	5.7	94.3	21.7	4.3

from 35.8% for variety 'Weber' to 41.7% for 'Douglas'. Fat contents (dry basis) were lowest in 'BM-2' (19.5%) and highest in 'Hobbit' (22.6%). The ash contents varied between 5.1% and 5.4%. Soymilk was prepared from all these varieties and was evaluated for proximate principles (Table 17). The protein content of soymilk ranged from 3.1 percent for the milk prepared from century to 4.2% for that prepared from the 'Douglas' variety. Fat contents were lowest for the milk prepared from 'Douglas' and 'Egyptian' (1.8%) and highest for that prepared from 'Hobbit' (2.6%). The ash contents for the milk prepared from the 'Egyptian variety were exceptionally low (0.1%) and were highest for that prepared from 'Hobbit' (0.5%). Sensory evaluation trials indicated that the milk prepared from 'Weber' has the highest scores. The soymilk was mixed with 15% buffalo milk and also with 15% cow's milk and evaluated for organoleptic qualities (Table 18). The soymilk from varieties 'BM-2' and 'Weber' prepared by mixing with 15% buffalo or cow's milk, attained highest scores for organoleptic quality. The insoluble residue from the filteration of soymilk was also analysed for protein and ash content (Table 19). The protein (dry basis) in insoluble residue ranged from 19.1% for variety 'Hobbit' to 29.9% for variety 'EPPS'. The ash contents varied from 4.3% to 4.9%.

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