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PHYTATE AND MINERAL CONTENTS OF CEREAL GRAINS

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High-yield varieties of wheat, barley, maize and sorghum were analysed for calcium, magnesium, sodium, potassium, phytate-phosphorus and inorganic-phosophorus. Wheat and barley contained Ca: 17.5-54.4 and 21.3-32.9mg/100g; Mg: 32.6-71.1 and 28.4-32.9mg/100g; Na: 11.1-30.1 and 12.6-24.2mg/100g; K: 143.7-338.1 and 195.5-300.2mg/100g; phytate-P:349-660 and 276-480mg/100g and inorganic-P: 235-467 and 96-402mg/100g. The various varieties of maize and sorghum contained Ca: 10.6-13.9 and 7.8-16.0mg/100g; Mg: 27.6-31.6 and 35.8-38.5mg/100g; Na: 12.2-24.6 and 6.4-11.1 mg/ 100g; K: 248-338 and 245-263mg/100g; phytate-P:302-432 and 284-500mg/100g and inorganic-P: 99-255 and 70-180mg/100g respectively.

Key words: Phytate. Minerals; Cereals.

INTRODUCTION

Phytate-phosphorus constitutes 50-80% of total phosphorus in cereals [9,6,7,18]. The anti-nutritional significance of phytate lies in its ability to chelate several essential minerals like calcium [13,5], magnesium [3], sinc [9,11,14] and iron [17,15] thereby reducing their biological availability. The poor utilization of these minerals due to excess of phytate in the main cereal diets of Iranian villagers has been shown to be the cause of deficiencies of these minerals, although the intake of these nutrients was adequate quantitatively [11,15,16]. About 70 % of the diet of the masses in Pakistan is also made up of cereals; so it was important to investigate the phytate contents of indigenous cereals. Excess presence of phytate could be a cause of deficiency diseases like anaemia which is prevalent in the lower income-group of people.

MATERIALS AND METHODS

Wheat samples were obtained from the Cereal Chemist, Ayub Agricultural Research Institute, Faisalabad and Cereal Botanist, Agricultural Research Station, Jamshoro, Hyderabad Sind). Maize and sorghum specimen were received from the Maize and Millet Research Institute, Yousufwala, Sahiwal, Punjab. Barley samples were obtained from the Cereal Technologist, Ayub Agricultural Research Institute, Faisalabad. Reagents used in the present study were of analar or spectroscopic grade. Deionised water was used in the preparation of all solutions and standards. Harlco (USA) standards were employed in the caliberation and standardization of assay procedures.

All samples were cleaned of straw etc., powdered in a Maulinex electric grinder to 100-mesh and stored in glass jars at room temperature. Estimation of moisture and ash was done by the A.O.A.C method [1]. Samples were prepared for assaying minerals by extracting the ash obtained from 10 g. material with 3-5ml conc. HCl on a boiling water-bath. The liquid extracts were diluted and made up to 100ml volume with deionised water, filtered and stored in plastic bottles for subsequent analysis. The Jerrel and Ash Atomic Absorption Spectrophotometer was used to assay calcium, magnesium, sodium and potassium. Phytate-phosphorus was estimated by the method of Lopez and Moreno [4], while total phosphorus was determined by the Fiske and Subbarow method [2]. A Pye-Unicam Spectrophotometer was used for colourimetric analysis.

RESULTS AND DISCUSSION

High-yield varieties of wheat, barley, maize and sorghum were analysed for the macro-nutrients of calcium, magnesium, sodium, potassium, total phosphorus and phytate-phosphorus. In the 23 varieties of wheat from the Punjab and Sind, the average values for calcium, magnesium, sodium and potassium were 29.85, 56.1, 19.8 and 223.5 mg/100g respectively. Average values for total-phosphorus, phytate-phosphorus and inorganic-phosphorus were 495.3, 331.0 and 164.3 mg/100g respectively. The data indicated that average phytate-phosphorus occurred to an extent of 67.0 % which is quite a signifi-

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Table 1. Macro-nutrients in different varieties of wheat; maize barley and sorghum from Punjab and Sind

Sereal	Variety	Province	Moisture	Ash	mg/100g. on dry weight basis							
				g%	Ca	Mg	Na	K	Total-P	Phytate-P	Inorg.-P	P.P/T.P %
Wheat	Pari	Punjab	9.0	1.8	24.1	69.7	19.8	338.1	508	360	148	70.9
	SA-75	"	9.8	1.7	24.0	68.0	11.1	250.2	465	320	145	68.8
	Lyallpur-73	"	9.5	1.9	39.8	60.2	30.1	217.8	516	340	176	65.8
	Blue Silver	"	9.7	1.6	31.7	69.0	28.1	236.1	508	350	158	68.7
	Indus-79	"	9.6	1.7	24.9	55.7	18.2	214.7	450	322	128	71.5
	Chenab-79	"	9.6	1.8	28.1	58.2	17.5	189.9	596	370	226	62.1
	Sandal	"	9.5	1.9	24.9	63.3	15.7	181.1	439	305	134	69.5
	AVERAGE		9.5	1.7	28.2	63.5	20.0	232.5	497.4	338.1	159.3	68.2
	Coefficient of Variability %				20.6	8.83	33.73	22.53	10.7	6.96	20.95	4.77
	Tosapaco	Sind	10.2	1.6	33.0	60.3	16.7	143.7	490	301	189	61.4
	Arz	"	8.8	1.5	43.0	62.8	28.3	172.5	390	276	114	70.8
	Mehran	"	8.4	1.5	41.6	60.2	19.5	223.8	378	235	143	62.2
	Sanine	"	9.2	1.7	53.9	71.0	26.1	192.5	660	467	193	70.7
	Pavon	"	9.7	1.6	29.7	50.3	13.5	211.6	627	340	287	54.2
	L-711	"	8.0	1.7	25.5	68.6	23.3	217.8	479	300	179	62.6
	Pima	"	8.5	2.0	54.5	59.2	27.3	247.8	501	368	133	73.5
	D-2009	"	8.2	1.8	28.8	37.2	25.7	149.5	596	395	201	66.3
	Nacozari	"	8.3	1.8	21.3	58.1	12.1	226.5	584	410	174	70.2
	T-38	"	8.2	1.8	31.4	40.3	25.9	223.8	465	325	140	69.9
	Sind-76	"	8.9	1.9	20.8	38.2	14.6	239.2	494	366	128	74.1
	Pa-77	"	8.5	1.7	17.5	32.6	16.7	195.5	450	305	145	67.8
	Harman	"	8.8	1.8	24.1	36.4	16.9	223.7	436	300	136	68.8
	J-75	"	9.6	1.9	25.3	35.0	17.2	242.2	349	255	94	73.1
	Torin	"	8.8	1.7	23.1	34.0	12.0	263.6	488	241	247	49.4
	Pak-70	"	8.6	2.0	30.6	35.2	15.4	261.0	507	300	207	59.2
	AVERAGE		8.79	1.75	31.5	48.7	19.5	214.6	493.3	324	169.3	65.9
	Coefficient of Variability %				35.6	28.39	29.41	16.8	17.8	19.74	29.87	10.87
	OVERALL AVERAGE		9.15	1.66	29.85	56.1	19.78	223.5	495.3	331	164.3	67.0
	" C.V %				33.11	24.38	29.87	18.44	15.68	16.51	27.69	9.32
Maize	Composite-15	Punjab	10.1	1.4	13.9	31.6	12.6	338.1	596	432	164	72.5
	Faisal	"	9.9	1.6	13.4	28.3	12.2	324.3	401	302	99	75.3
	E.V. 1081	"	10.1	1.4	11.6	30.2	24.2	260.1	523	335	188	64.1
	E.V. 5081	"	9.8	1.8	10.6	29.3	17.6	307.2	572	400	172	69.9
	E.V. 6081	"	10.0	1.9	11.3	27.6	24.6	248.4	645	390	255	60.5
	AVERAGE		10.0	1.68	12.16	29.4	18.24	295.6	547.4	380.8	175.6	68.5
	Coefficient of Variability %				11.67	5.37	32.97	13.37	16.97	13.86	31.80	8.87
Barley	CR-368/4-1	Punjab	8.4	1.6	26.7	31.1	12.6	233.1	396	300	96	75.7
	M-6969	"	8.3	1.9	32.2	32.9	22.2	300.2	468	276	192	58.9
	POR-U-SASK	"	8.8	2.0	25.9	29,3	24.2	223.7	857	455	402	53.1
	Menute Minek	"	8.2	2.1	15.5	33.1	17.6	201.3	810	480	330	59.2
	KY-63-1294	"	9.0	2.3	21.3	27.9	14.5	195.5	477	380	97	79.7
	Giza	"	8.9	1.9	26.6	28.4	12.6	230.0	799	472	327	59.1
	Arivate	"	8.8	2.0	32.9	30.6	13.2	211.6	407	309	98	75.9
	AVERAGE		8.6	1.97	27.3	30.5	16.69	227.9	602	381.7	220.2	65.9
	Coefficient of Variability %				14.76	6.76	28.72	15.3	34.65	23.02	59.43	16.27
Sorghum	JC-1039	Punjab	10.2	1.7	7.8	35.8	6.9	245.4	680	500	180	73.5
	Pak-SS-111	"	10.1	1.8	9.4	38.5	6.4	251.5	365	295	70	80.8
	99-1082		9.9	1.5	16.0	37.0	11.1	263.8	450	284	166	63.1
	AVERAGE		10.1	1.66	11.1	37.1	8.1	253.6	498	359	138	72.4
	Coefficient of Variability %				39.28	3.65	31.74	3.69	32.7	33.82	43.18	12.27

cant fraction of the total phosphorus and could be a serious limiting factor in the bioavailability of minerals. The coefficient of variability for calcium, magnesium, sodium potassium, total-phosphorus, phytate-phosphorus and inorganic-phosphorus were 33.11, 24.38, 29.87, 18.44, 15.68, 16.51 and 27.69% respectively, indicating a large variation in the occurrence of various nutrients in the different varieties of wheat.

In comparing the wheat grown in the Punjab and Sind, the wheat from Punjab contained comparatively more magnesium but other macro-nutrients such as calcium, sodium, potassium and phosphorus were present in similar amounts. This could be due to the fact that the Punjab and Sind soils are largely of the same type. However, there was a large difference in the coefficient of variability for different nutrients in each province for various wheat varieties. It may also be inferred from the data that a person consuming 300mg of wheat in the form of bread, will obtain about 100mg calcium, 200mg magnesium, 60mg sodium, 700mg potassium, 1500mg total phosphorus along with 1000mg phytate phosphorus, the last one putting a serious constraint on the utilization of the other nutrients. The data also indicated that amongst the various varieties of the Punjab wheat, Blue Silver and Lyallpur-73 contained larger amounts of nearly all the macro-nutrients. In the Sind wheat, Sanine and Pima were prominent in containing larger concentrations of the nutrients.

Barley was a good source of calcium (27.3mg/100g), magnesium (30.5mg/100g), sodium (16.7mg/100g), potassium (227.9 mg/100g) and 602 mg/100g of total phosphorus. It compared favourably with wheat as a source of these nutrients. Barley, however, contained more phytate-phosphorus (381 mg/100g) than wheat. The coefficient of variability for various mineral constituents in barley fluctuated very widely (6-60%) Maize and sorghum also contained considerable amounts of various nutrients; calcium: 12.16 and 11.1 mg/100g; magnesium: 29.4 and 37.1 mg/100g; sodium: 18.24 and 8.1 mg/100g; potassium: 295.6 and 253.6 mg/100g; total phosphorus 547 and 498 mg/100g and phytate-phosphorus 380 and 359 mg/100g. respectively. Thus maize and sorghum are not inferior to barley or wheat in the contents of various mineral nutrients. Barley, maize and sorghum were consumed by the lower-income group of people, particularly in the barani areas but even there these grains are being replaced by wheat, placing a serious strain on wheat production. People may be persuaded to use more of these grains by publicizing the relevant facts and introducing various acceptable recipes. Since the bulk of the diet in the poor section of population is made up of cereals, phytate could be a limiting factor in the bioavailability of minerals like iron, zinc, calcium, magnesium etc., and a possible cause of deficiency diseases the masses.

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