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CARBOHYDRATES AND MINERALS STATUS OF FIFTEEN GENOTYPES OF HUSKED BARLEYS

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Introduction

Barley (*Hordeum vulgare* L.) is one of the major cereal crops ranking fourth in world acreage and production after wheat, rice and maize. About ten percentage of the world's barley production is utilized in malting and brewing industries and the rest for feeding to humans and animals. The health and medicinal benefits of barley foods have been stressed in ancient Egyptian, Greek and Romans[1] .Barley husk has been utilized for the production of furfural and active carbon[2]. Due to the liberalized economic policy of government of India and the increase in the malt production in India the future and scope of exporting good quality barley malt at competitive prices in south-east Asian and far-east countries, is likely to be widened. In European Union countries barley is the most nutritious food supplying minerals, amino acids, fiber and enzymes and barley has been used in the treatments of arthritis, digestive diseases, diabetes, skin abnormalities, weight loss, detoxification mechanisms and cancer[3].

Huskless barley varieties are ideally suitable for the alcohol industry in comparison to hulled ones[4]. Husked barleys are superior to dehusked for malting on the basis of higher thousand kernel weight, starch content and true extract and low crude fibre and fat content[5]. The national core groups of "Malt barley development" have laid down certain specifications for grain and malt quality characteristics that the two row and six row barleys must have in order to provide good raw materials for malt production [6]. Understanding the overall nutrients build up, their action, interaction and overall utilization by the human system may help in greater acceptability and usage and identifying barley cultivars with better storage quality, industrial application and development of value added products. The present investigation deals with structural and non structural carbohydrates, macro and micro minerals present in fifteen varieties of husked barleys grown in Rajasthan state.

Materials and Methods

Barley husked genotypes of fifteen varieties namely RD-2052, RD-2503, RD-2624, RD-2035, RD-2683, RD-2660, RD-2670, RD-

2715, RD-2706, RD-2696, RD-2685, RD-2552, RD-2592, RD-2508 and RD-2668 were procured from senior barley breeder Rajasthan Agriculture Station, Durgapura, Jaipur. The recommended doses of fertilizers and other agronomical practices were adopted to raise the crop under Rajasthan conditions during Rabi season of 2008-09. Grains were cleaned, air dried and stored in tight plastic containers for analysis. One tablet of Parad (Zandu pharmaceuticals) was added to each container to avoid infestation during storage. Grain samples of each variety were ground through Cyclotec sample mill. Structural carbohydrates were fractionated into Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), cellulose, hemicellulose and lignin by the method using standard methods[7]. Carbohydrates were partitioned into total soluble sugars, reducing sugars, total fructose and non reducing sugars by employing the methods as detailed by Kalim[8].The mineral extract for sodium, phosphorus and potassium assays was prepared in digestion mixture containing nine volumes of sulphuric acid and one volume of perchloric acid. Flame Photometer Systronics FPM 121 was employed for analysis of sodium, calcium and potassium. Total sulphur was estimated by turbidimetric method as mentioned by Chesnin and Yein[9] and phosphorus by the method of Dickman and Bray [10]. For manganese, zinc, iron and magnesium estimations Perkin Elmer Model 2380, Atomic Absorption Spectrophotometer were employed[11].

Results and Discussion

Structural carbohydrates

Table I shows partitioning of structural carbohydrates of husked barley genotypes. Data indicates that NDF varied from 42.9 (RD-2660) to 23.9 per cent (RD-2552) with mean of 31.349 per cent. The ADF was highest (27.1%) in RD 2660 and the lowest in RD-2035 (15.0%) whereas the mean was 19.49 per cent. The hemicelluloses and cellulose contents ranged from 2.6 (RD-2508) to 15.8 per cent (RD-2660) and from 6.9 (RD-2683) to 12.7 per cent (RD-2592 and RD-2668).The mean hemicelluloses and cellulose was 10.89 and 9.41 per cent. The acid detergent lignin is virtually indigestible and makes complexes with cellulose and lignified cellulose. The lignin content varied from 6.10 (RD-2685) to 10.6 per cent (RD-2660) and averaged to 7.47 per cent.The negative relationship between lignin and digestibility of plant cell wall components is well understand. The observed differences in structural carbohydrates in the present study appear to be mainly genetic. Partitioning structural carbohydrates has been reported[12].

Non structural carbohydrates

Table II reveals that total soluble sugars in barley grains varied from 1.17 (RD-2503) to 2.42 (RD-2592) percentage and averaged to 1.93 per cent. Reducing sugars varied from 0.25 (RD-2508) to 0.48 per cent (RD-2035) the mean observed was 0.368. Non reducing sugars ranged from 0.75 (RD-2503) to 2.13 per cent (RD-2592) with a mean of 1.57 per cent. The highest total fructose was

TABLE I

Structural Carbohydrates of Husked Barleys

Varieties	NDF %	ADF %	Hemi cellulose %	Cellulose %	Lignin %
RD-2052	24.4	15.8	8.60	7.30	6.80
RD-2503	29.2	16.2	13.0	7.30	6.80
RD-2624	28.0	18.9	9.10	8.60	7.20
RD-2035	24.1	15.0	9.10	7.30	6.80
RD-2683	29.2	16.0	13.2	6.90	6.80
RD-2660	42.9	27.1	15.8	11.9	10.6
RD-2670	35.7	22.6	13.1	11.9	9.10
RD-2715	34.5	20.6	13.9	10.2	7.50
RD-2706	28.8	16.1	12.7	8.10	6.20
RD-2696	32.8	20.5	12.3	10.6	6.90
RD-2685	26.6	16.0	10.6	8.60	6.10
RD-2552	23.9	15.2	8.70	7.10	6.90
RD-2592	40.6	26.3	14.3	12.7	8.20
RD-2508	32.1	19.5	2.60	9.20	7.70
RD-2668	33.3	23.5	9.80	12.7	6.80
Max	42.9	27.1	15.8	12.7	10.6
Min	23.9	15.0	2.60	6.90	6.10
Mean	31.3	19.49	10.89	9.41	7.47
S.D.	6.17	4.26	3.78	2.18	1.35
C.V.	19.7	21.89	34.77	23.23	18.11

exhibited by RD-2685 (1.39%) whereas RD-2508 showed the lowest (0.64%). Maltose varied from 0.059 (RD-2706) to 0.091 (RD-2683) mg/100g and mean observed was 0.071mg/100g .Total phenols varied from 57.57 to 98.63 mg/100g with a mean of 74.79mg/100g .The lowest total phenols was noticed in RD-2508 and highest in RD-2668. Non structural carbohydrates has been reported by Hall *et. al* [3].

Mineral composition

Data on macro and micro minerals of husked barley grains of fifteen genotypes are given in Tables III and IV. The information depicts that in barley genotypes minerals are accumulated in amounts suggesting that they are implicated in various physiological and biochemical processes from time to time during the growth of barley genotypes. A perusal of data in Table III evinced that the

TABLE II

Non Structural Carbohydrates and Total Phenol of Husked Barleys

Varieties	Total soluble sugar (%)	Reducing sugar (%)	Total fructose (%)	Maltose (mg/100g)	Total phenol (mg/100g)	Non reducing sugar (%)
RD-2052	2.19	0.26	1.32	0.068	63.64	1.93
RD-2503	1.17	0.42	0.88	0.074	69.70	0.75
RD-2624	1.90	0.32	1.07	0.082	72.73	1.58
RD-2035	1.98	0.48	1.05	0.065	63.64	1.50
RD-2683	2.08	0.42	1.11	0.091	84.85	1.66
RD-2660	2.04	0.42	1.01	0.068	62.13	1.62
RD-2670	1.84	0.31	0.92	0.074	69.71	1.53
RD-2715	2.17	0.34	1.25	0.076	57.58	1.83
RD-2706	1.85	0.48	0.93	0.059	93.94	1.37
RD-2696	2.14	0.35	1.10	0.065	74.25	1.79
RD-2685	2.38	0.35	1.39	0.068	92.43	2.03
RD-2552	1.94	0.48	1.04	0.076	78.79	1.46
RD-2592	2.42	0.29	1.33	0.065	75.76	2.13
RD-2508	1.49	0.25	0.64	0.059	57.57	1.24
RD-2668	1.78	0.36	1.01	0.076	98.63	1.42
Max	2.42	0.48	1.39	0.091	98.63	2.13
Min	1.17	0.25	0.64	0.059	57.57	0.75
Mean	1.93	0.36	1.06	0.071	74.79	1.57
S.D.	0.36	0.08	0.22	0.009	13.90	0.39
C.V.	18.86	21.94	20.72	13.46	18.59	0.47

mean values for macro minerals namely sulphur, sodium, potassium, calcium and phosphorus are 13.05, 13.88, 191.97, 11.24, 947.29 mg/100g.Whereas the respective ranges were 8.88 to 17.76, 12.9 to 15.2, 160.4 to 215.5, 9.12 to 12.64 and 736 to 1088 mg/100g. Ranges for micro minerals namely zinc, iron, manganese, and magnesium were from 3.05 to 3.80, 5.63 to 9.52, 0.07 to 0.60, 96 to 150 mg/100g, respectively. It is well established that the mineral concentration in plants varies significantly from one part of the plant to another and various factors such as plant

TABLE III

Macro Minerals Analysis of Husked Barley Genotypes (mg/100g dry weight)

Genotype	Sodium	Potassium	Calcium	Sulphur	Phosphorus
RD-2052	13.0	160.4	9.50	11.10	736
RD-2503	12.9	185.3	11.05	17.76	984
RD-2624	14.7	174.8	10.70	11.10	880
RD-2035	14.5	203.0	11.80	8.88	1008
RD-2683	13.5	193.0	11.62	11.10	816
RD-2660	13.6	187.5	11.27	15.54	992
RD-2670	13.2	200.6	11.74	13.32	880
RD-2715	14.0	170.3	9.95	13.32	960
RD-2706	14.0	202.0	11.90	11.10	1056
RD-2696	13.4	191.8	9.12	15.54	960
RD-2685	15.2	207.0	12.45	11.10	1088
RD-2552	14.4	206.2	12.24	13.32	736
RD-2592	14.7	195.7	11.76	13.32	1088
RD-2508	13.6	215.5	12.64	11.10	1008
RD-2668	13.2	194.5	11.60	17.76	1088
Max	15.2	215.5	12.64	17.76	1088
Min	12.9	160.4	9.12	8.88	736
Mean	13.88	191.97	11.24	13.05	947.29
S.D.	0.75	16.58	1.13	2.83	124.21
C.V.	5.43	8.63	10.10	21.72	13.11

type, variety, growing conditions and fertilization also influence their contents. It is also inferred that among the minerals analyzed phosphorus was found to be maximally concentrated followed by potassium and sodium. Natson and Ranganathan[14] hinted that the genetic variation, changing weather conditions and plant maturity are responsible for fluctuations in nutrients in plant system. Since all the genotypes were raised under identical agro climatic conditions, the possible reasons for their differences in barley grains may be due to differences in their absorption pattern from roots and translocation to grains for their differential metabolic activities. Many factors affect the chemical composition of plants eg. soil type, fertilization, irrigation, weather and stage of maturity which are linked to specific geographical areas.

TABLE IV

Micro Minerals Analysis of Barley Husked Genotypes (mg/100g dry wet basis)

Genotype	Zinc	Iron	Magnesium	Manganese
RD-2052	3.26	5.93	120	0.46
RD-2503	3.26	6.94	135	0.56
RD-2624	3.05	7.51	126	0.40
RD-2035	3.35	6.20	129	0.36
RD-2683	3.16	6.65	129	0.20
RD-2660	3.35	7.54	150	0.34
RD-2670	3.38	6.08	144	0.47
RD-2715	3.64	9.52	123	0.60
RD-2706	3.45	5.63	147	0.44
RD-2696	3.35	6.00	132	0.43
RD-2685	3.40	6.39	138	0.29
RD-2552	3.80	6.12	120	0.45
RD-2592	3.46	6.94	123	0.17
RD-2508	3.56	5.98	96	0.17
RD-2668	3.53	6.21	135	0.07
Max	3.80	9.52	150	0.60
Min	3.05	5.63	96	0.07
Mean	3.402	6.75	129	0.357
S.D.	0.213	1.15	15.36	0.166
C.V.	6.277	17.05	11.91	46.46

Summary and Conclusion

Partitioning of structural carbohydrates of 15 husked barley genotypes into NDF, ADF, cellulose, hemicellulose and lignin revealed that they varied from 23.9 to 42.9per cent, 15 to 27.19per cent, 2.6 to 15.69per cent, 6.9 to 12.79per cent and 6.1 to 10.69per cent respectively. Total soluble sugars, reducing sugars and total fructose ranged from 1.17 to 2.42%, 0.25 to 0.489per cent and 0.64 to 1.399per cent respectively. Total phenols and maltose ranged from 57.57 to 98.63mg/100g and 0.059 to 0.091mg/100g, respectively. Macro minerals namely sulphur, sodium, potassium, calcium, phosphorus ranged from 8.88 to 17.76, 12.9 to 15.2, 160.4 to 215.5, 9.12 to 12.64 and 672 to 1072 mg/100g.The micro minerals namely zinc, iron, magnesium, manganese varied from 3.05 to 3.80, 5.63 to 9.52 ,96 to 150 and 0.07 to 0.60 mg/100g, respectively.

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