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Determination of Protein and Carbohydrate Content and Its Correlation with Grain Yield in Foxtail Millet Germplasm

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A B S T R A C T

The present study was conducted for evaluation of 40 foxtail millet germplasm accessions for nutritional traits protein and carbohydrate content and its correlation with grain yield. The experiment was laid out in a randomized complete block design with three replications at National Bureau of Plant Genetic Resources, Regional Station, Rajendranagar, Hyderabad during *Kharif*, 2015. Average protein content recorded was 10.68 % with a range of 7.66 for accession IS-663 t 13.49 % for KP/SC-1484, while mean values ranged from 56.20% to 79. 90 % with a general mean of 67.54%, KP/SC-1505 accession has recorded highest carbohydrate content while ISE-1511 recorded the lowest. Both the traits negatively correlated with the grain yield.

Introduction

Foxtail millet one of the minor millet with ample amount of nutritional reserves can become one of the alternative for cereal based consumption with good amount of protein and B-Carotene (Murugan and Nirmalakumari, 2006).

Nutritional composition of foxtail millet per 100g edible portion according to (Gopalan *et al.*, 2007) is proteins (12.3 g), carbohydrates (60.9 g), fat (4.3 g). The grains have long shelf-life, a preferable attribute (Ravi *et al.*, 2010). It has been suggested to use foxtail millet protein as a food component to fight type 2 diabetes and cardiovascular diseases (Choi *et al.*, 2005).

Lack of knowledge about use of small millets in the daily diet are the important constraints in promoting their production and consumption, the correlation with grain yield is an important attribute to a breeder for selection of characters and genotypes accordingly so that simultaneously two characters can be improved.

Materials and Methods

The present study was carried out on 40 genotypes of foxtail millet having indigenous and exotic collections.

The experiment was laid out in a randomized complete block design with three replications at National Bureau of Plant Genetic Resources, Regional Station, Rajendranagar, Hyderabad during *Kharif*, 2015. Protein content was estimated by Micro-Kjeldhal method by AOAC procedure which includes

Reagents

40% NaOH, 2% Boric acid, Mixed indicator: 0.2% bromocresol green and 0.2% methyl red, Standard 0.5N HCL, Digestion mixture: 98g of potassium sulphate and 2g of copper sulphate were ground together.

Procedure

Digestion

500mg of sample, 1g of digestion mixture and 10ml of concentrated H_2SO_4 were carefully added and the samples were digested in a digestion block for 1 hour at 375^0C. The tubes were removed and cooled distilled water (50ml) was added carefully from sides

Distillation

In a 100ml conical flask, 40ml of boric acid was added with a few drops of mixed indicator. Distillation was done in the Gerhardt instrument with the following settings.

Step 1 (NaoH): 50ml

Step 2 (steam digestion time): 10 seconds

Step 3 (distillation time): 180 minutes

Titration

The contents of conical flask turned green during distillation. Titration was done with standard HCL till the content of the flask turned to original colour (pink). A blank was all run simultaneously.

Calculations

$$\text{Protein (\%)} = \frac{\text{Titre value (X)} \times 14.007 \times 0.5(\text{N of HCl}) \times 6.25}{\text{Weight of sample (mg)}} \times 100$$

Carbohydrate analysis

Estimation of carbohydrates by phenol-sulphuric acid method (Biochemical Methods Textbook by Sadasivam, 1991).

Principle

In hot acidic medium glucose is dehydrated to hydroxmethyl furfural. This forms a green coloured product with phenol and has maximum absorption at 490 nm.

Materials

Phenol 5% redistilled (reagent grade), Sulphuric acid (96% reagent grade),

Standard Glucose: Stock - 100 mg in 100 ml of water

Working standard - 10 ml of stock diluted to 100 ml with distilled water

Procedure

Weigh 100 mg of the sample in a boiling tube, Hydrolyse by keeping it in boiling water bath for 3 hrs with 5 ml of 2.5 N HCL and cool to room temperature, neutralize it with solid sodium carbonate until the effervescence

ceases, make up the volume to 100 ml and centrifuge. Pipette out 0.2, 0.4, 0.6, 0.8 and 1 ml of working standard into a series of test tubes, pipette out 0.1 and 0.2 ml of sample solution in two separate test tubes and make up the volume in each tube to 1 ml with water. Set a blank with 1 ml of water, Add 1ml of phenol solution to each tube, Add 5 ml of sulphuric acid to each tube and shake well, after 10 minutes shake the contents in the tubes and place in water bath at 25-30ºC for 20 min. Read the colour at 490 nm. Calculate the amount of total carbohydrate present in sample solution using the standard graph.

Calculation: Absorbance corresponds to 0.1 ml of test = x mg of glucose100 ml of sample solution contains

Calculations

$$\frac{X}{0.1} \times 100$$

Results and Discussion

The analysis of variance for nutritional quality parameters was carried out in 40 germplasm collections. The results are presented in Table 1. The genotypes exhibited highly significant differences for the nutritional parameters viz., protein, carbohydrate and seed yield/plant.

Protein content (%)

The protein content of millets when compared to rice it is twice higher in the small millets. The recommended dietary allowance for man and women are 60 and 50 grams of protein per day. It is fulfilled by consuming 600 grams of millets instead of 1000 grams of rice. Foxtail millet protein characterization showed that its protein concentrate is a potential functional food ingredient and the essential amino acid pattern suggests possible use as a supplementary protein source to most cereals because it is rich in lysine (Mohamed, T.K 2009). Large amount of variation was observed among the genotypes for protein content ranging from 7.66 to 13.49 % with a mean value of 10.68 per cent (Table 2).

Among the 40 genotypes KP/SC-1484 had highest protein content of 13.49 per cent followed by Sri Lakshmi (12.24 %) and Ise-237 (12.19%). ISE-663 had recorded lowest (7.66 %), Krishnadevaraya (8.16%) followed by IC-436885(8.54%).

Extremely varying genotypes for protein content were belonging to different geographical origins like Telangana, Andhra Pradesh, Karnataka, Tamil Nadu, Nagaland, Switzerland, Turkey. Hence the present results indicate that vast geographical difference is needed to have diversity for nutrition composition in foxtail millet genotypes (Kamatar *et al.*, 2015).

Out of 40 genotypes, 23 genotypes has more protein content than average value. Among the 23 genotypes most of them possesses high protein content than the multiple checks used. These genotypes can be selected for further breeding programme.

Carbohydrate content (%)

Irrespective of high protein foxtail millet also possesses high carbohydrates. Among the 40 genotypes range varies from 56.20 % to 79.90 % with general mean of 67.54 %. Genotype KP/SC-1505 recorded highest carbohydrate content while IS-1511 recorded the lowest followed by IC-426581(59.05%). Several accessions were leading in the carbohydrate content when compared to the multiple checks. Lower carbohydrates and high protein content in food is desirable for maintenance of good health especially for diabetics and cardiovascular patients.

Table.1 The mean sum of squares for nutritional characters in 40 foxtail millet germplasm accessions

S. No	Characters	Replication df: 2	Treatments df: 39	Error df: 78
1	Seed yield/plant (gm)	72.138	700.604	24.232
2	Protein content %	0.060	5.224	0.024
3	Carbohydrate content (%)	1.773	94.905	0.758

Table.2 Mean values of the nutritional traits in 40 foxtail millet germplasm accessions

S. NO	GENOTYPE	Seed yield/plant (gm)	PC%	CC%
1	**AR-13**	22.59	10.46	77.38
2	**ISE-200**	23.80	10.70	64.08
3	**ISE-237**	60.56	12.19	62.06
4	**ISE-663**	29.63	7.66	65.13
5	**ISE-1286**	36.95	11.46	69.29
6	**ISE-1511**	29.99	11.00	56.20
7	**LC-1-K.Devaraya**	56.50	8.16	61.80
8	**ISE-1629**	29.23	11.15	64.04
9	**SK-13933**	40.25	10.33	57.70
10	**SK-13963**	37.92	11.17	69.63
11	**LC-2-LEPAKSHI**	34.61	10.30	60.41
12	**IC-283910**	30.27	11.31	56.95
13	**LC-3-N.charya**	31.06	9.84	58.26
14	**IC-283911**	27.65	9.56	66.96
15	**IC-308861**	22.81	12.33	73.21
16	**IC-308939**	31.28	9.95	67.15
17	**LC-4-PRASAD**	31.63	10.91	68.97
18	**LC-5-PS4**	29.71	11.47	68.00
19	**LC-6 -SIA-2829**	28.55	11.20	67.36
20	**IC-308981**	36.27	12.69	72.08
21	**LC-7-SIA-2871**	29.79	8.77	71.17
22	**IC-413272**	46.58	10.92	69.23
23	**IC-413275**	32.31	9.67	59.05
24	**IC-426581**	34.89	10.31	70.26
25	**LC-8-Sri Lakshmi**	27.10	12.24	72.53
26	**IC-436885**	35.60	8.54	61.08
27	**IC-598145**	42.33	10.24	73.52
28	**IC-610532**	41.57	9.28	72.13
29	**IC-308966**	24.27	11.94	69.00
30	**KP/SC-1452**	12.03	11.92	63.09
31	**KP/SC-1482**	13.53	8.71	73.52
32	**KP/SC-1483**	10.35	10.61	71.79
33	**KP/SC-1484**	16.57	13.49	70.69
34	**KP/SC-1505**	48.86	11.39	79.90
35	**KP/SC-1532**	5.90	12.21	67.97
36	**KP/SC-1579**	12.90	11.43	70.08
37	**KP/SC-1580**	9.90	8.90	71.30
38	**BS-9293**	36.71	11.63	71.40
39	**RJR-608**	75.64	11.60	71.07
40	**RJR-643**	71.21	9.81	66.46
	MEAN	**32.48**	**10.68**	**67.54**

High protein and low carbohydrate content, high yield combinations were observed like ISE-237 (12.19% P, 62.06% C, 60.56gm/plant), ISE-1511 (11.00% P, 56.20 %C), SE-1629 (11.15 % P, 64.04 % C), IC-283910 (11.31 % P, 56.95 % C) and high yielding genotypes like RJR-608, RJR-643 which are more reliable. But when combined with grain yield both the traits has shown negative association with grain yield which indicates that simultaneous selection for yield and quality traits is not possible.

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