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Study the Nutritional Performance of Original and S_1 Progeny of Local Maize Germplasm of North East India

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ABSTRACT

Local maize landraces are generally less yielders. Farmers have been cultivating and consuming local maize available in their areas due to specific color and taste of the grains. Only a few attempts were made by the researchers to study the nutritional status in north eastern maize, there was a lot of scope to study the local maize germplasm of the north eastern region for various nutritional compositions further. Considering the above, the following research study was undertaken. The six germplasm and their corresponding S_1 progenies along with check were analyzed for estimation of the nutritional traits viz., crude protein, crude fat, carbohydrate, crude fiber, ash, iron and zinc. The mean value for a replicate for each entry in respect of a trait was used for analysis of data in Completely Randomized Design (CRD) with two replications. Analysis of variance reveals that the estimates of mean square due to germplasm were significant to highly significant for the traits viz., iron (mg /100 g), zinc (mg /100 g), moisture content (%), crude protein (%), crude fat (%), carbohydrate plus crude fiber (%) and ash (%) indicating sufficient variation among the thirteen entries tested. The result showed ARY2 exhibited high carbohydrate content, crude protein and zinc content.

Keywords Maize, Local germplasm, Nutitional analysis, North east.

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INTRODUCTION

Maize is one of the most important cereal crops after wheat and rice. It belongs to Monocot family. It provides highest food energy than any other crop worldwide. It is also a rich source of vitamins, minerals, carbohydrate, fat, oils and protein. A maize grain on an average contains around 67–72% starch, 8–12% protein, 2–4% fat, 3% fiber, 15% moisture and around 1.5% minerals. North east India is a hotspot of local maize germplasms. Farmers have been cultivating

and consuming this germplasms due to specific color, flavor and taste known to them. The kernel structural features and nutritional composition give special value to specific variety or germplasm of maize. In the present investigation, few maize landraces of NE were estimated for some important biochemical parameters. Germplasm with higher nutritional composition for specific parameters may be treated as specialty germplasm or as donor in future maize breeding program. Plant breeder can significantly improve the diet of the rural poor people though crop improvement. Therefore, it is important to know about the genetic variation of micronutrients in available varieties or germplasm of maize to use potential germplasm as parents or donors for development of nutritionally enriched varieties. Several researchers studied maize germplasm for nutritional properties such as carbohydrate, crude fat, ash, amino acid and crude protein in several studies but maize germplasm from North East India appeared only in few of those studies. Although a few attempts were made by the researchers to study the biochemical status in north eastern maize, there was a lot of scope to study the local maize germplasm of the north eastern region for various nutritional compositions further. Considering the above, the following research was undertaken in the present investigation.

MATERIALS AND METHODS

The present evaluation of maize germplasm was performed at Assam Agricultural University, Jorhat. Sufficient number of plants was randomly selected from each germplasm and they were hand pollinated in the breeding nursery during *rabi* 2018-19. All S_1 progeny cobs (Fig. 1) were harvested and dried properly. The six germplasm and their corresponding S_1 progenies along with check (Table 1) were analyzed for estimation of the nutritional traits viz., Moisture content, crude protein, crude fat, total carbohydrates including crude fiber, ash, iron and zinc. Random sample of kernels from each of the entries was drawn for biochemical analysis using standard procedures described by AOAC (1970). The mean value for a replicate for each entry in respect of a trait was used for analysis of data in Completely Randomized Design (CRD) with two replications.

Table 1. List of original germplasm included in the present study.

Sl. No.	Genotype	Color
1	ARW1	White
2	ASKAW1	White
3	ARY2	Yellow
4	ARR1	Red
5	MNB2	Black
6	ARY5	Yellow
7	VMH 53	VPKAS (ICAR), Almora, UK

Fig. 1. Selfed seed of different germplasm of local maize.

RESULTS AND DISCUSSION

Maize has a great worldwide significance as human food, animal feed and a source of a many industrial products. To improve the maize germplasm through breeding, the knowledge about their nutritional composition is important for getting nutrient rich genetic forms such as a variety, inbred lines or germplasm. Local maize landraces are usually poor yielders. Farmers have been cultivating and consuming local germplasms available in their areas due to specific color and taste of the grains. The chemical composition of the maize kernel and their nutritional value give it a good position among the group of cereals in the "agrifood" category (Demeke 2018). Deficiency of important micronutrients, i.e. zinc (Zn) and iron (Fe), affects more than two billion people worldwide. This deficiency affects mostly women and children below the age of five who suffer from severe acute

Table 2. Analysis of variance for the nutritional traits. *, **Significant at 5% and 1% level, respectively.

Source of variation	DF	Mean squares						
		Moisture content	Crude protein	Carbohydrates including crude fiber	Crude fat	Ash	Iron	Zinc
Treatment	12	11.39**	9.77*	20.25*	1.40 **	0.05*	12.08**	0.17**
Error	13	1.28	2.71	7.33	0.22	0.01	1.02	0.02
CV (%)		11	16	4	14	10	14	6

malnutrition.

Analysis of variance for nutritional traits

The estimates of mean square due to germplasm were significant to highly significant for the traits viz., crude protein (%), crude fat (%), total carbohydrates including crude fiber (%), ash (%), iron (mg /100 g) and zinc (mg /100 g) indicating sufficient variation among the thirteen entries tested (Table 2).

The mean data for different S_0 and S_1 entries for various traits were presented (Table 3).

Moisture content (%)

Among the S_0 population, ARR1 showed the lowest moisture content of 5.5% and it was statistically at par with ASKAW1 (6.9%). Among the S_1 progenies, ARY2 exhibited the lowest moisture content 6.5%. Ndukwe *et al.* (2015) performed ten maize varieties grown in Eastern part of Nigeria and they reported the highest value of moisture content was found 11.35% and the lowest was found 9.85%. Aisha and El-Tinay (2004) found the moisture value in twelve corn genotypes in the range of 4.3-6.7%. Ullah *et al.* (2010) reported the value of moisture content in ten varieties of corn seeds in the range of (10.91-9.20%) which is in close agreement with result of this present study.

Crude protein (%)

Among the S_0 populations tested, ASKAW1 recorded the highest crude protein content (16.6%) and it was at par with ARR1 (13%). Out of the S_1 progenies tested, ARR1 (11%) had the highest crude protein content and it was at par with all other S_1 progenies. Out of all the entries tested, the S_0 populations namely,

Table 3. Mean performance of maize germplasm and their corresponding S_1 progenies for the nutritional traits.

S_0 (germplasm)	Moisture (%) fresh basis	Crude protein (%) dry basis	Crude fat (%) dry basis	Ash (%) dry basis	Carbohydrates including crude fiber (%) dry basis	Iron (mg/100 g) dry basis	Zinc (mg/100 g) dry basis
ARW1	10.5	9.4	3.8	1.30	75.1	8.3	3.1
MNB2	10.1	10.3	3.6	1.41	74.7	11.4	2.4
ASKAW1	6.9	16.6	4.9	1.07	70.2	7.6	2.6
ARY5	13.7	8.6	3.1	1.12	73.6	11.0	2.4
ARR1	5.5	13.0	3.7	1.56	76.3	7.6	3.4
ARY2	9.2	10.5	4.9	1.19	74.3	4.6	2.7
S_1 (progenies)							
ARW1	12.4	8.7	3.3	1.07	69.5	7.9	2.5
MNB2	10.3	9.1	3.1	1.22	70.0	10.2	2.8
ASKAW1	10.7	9.2	4.0	1.04	66.8	5.7	2.9
ARY5	11.7	9.6	2.6	1.07	68.0	6.7	2.8
ARR1	9.4	11.0	2.0	1.28	74.0	3.5	2.4
ARY2	6.5	9.5	2.6	1.08	71.0	4.6	3.1
VMH53	11.5	9.8	3.9	1.09	73.9	8.4	2.8
CD (5%)	**2.4**	**3.6**	**1.0**	**0.26**	**5.8**	**2.1**	**0.3**

ASKAW1 (16.6%), ARR1 (13%), ARY2 (10.5%) and MNB2 (10.3%) as well as the S_1 progeny of ARR1 (11%) outshined the check VMH 53 (9.8%) in respect of crude protein content. The percent superiority of these entries over the check was found in range of 5.10–69.39%. This work was in good agreement with the results of Ullah *et al.* (2015) with the value of crude protein in the range 7.71–14.60%. Crude protein content in maize germplasm were reported by Purificacion *et al.* (2018) to be in the range of 6.12 -17.87%. A food with high protein content is used to make protein-based processed food products, such as the manufacture of bread, biscuits, cookies and others.

Crude fat (%)

Among the S_0 populations, ASKAW1 and ARY2 had the highest crude fat content (4.9%). Out of the S_1 progenies tested, ASKAW1 (4.0%), ARW1 (3.3%) and MNB2 (3.1%) recorded the highest crude fat content as they were statistically at par. Out of all the entries, only two germplasms viz., ASKAW1 (4.9%) and ARY2 (4.9%) and one S_1 progeny i.e., ASKAW1-S_1 (4%) surpassed the check VMH53 (3.9%) in respect of crude fat content. The percent superiority of these entries over the check was found in range of 2.56–25.64%. Ilyas *et al.* (2014) also obtained crude fat content values in the range of 4.16 to 5.76% for the genotypes tested by them. Kabir *et al.* (2019) evaluated maize varieties to know the effect of genotype on proximate composition in Bangladesh Agricultural Research Institute (BARI). They found the highest fat content with the range in 4.027% to 5.44%.

Total carbohydrates including crude fiber (%)

Maize is well known for its high carbohydrate which provides energy, aids in utilization of body fats due to metabolic process and helps in the process of functioning of the intestinal tract (Adeniyi and Ariwoola 2019). Among the S_0 populations tested, ARR1 was noted to have the highest carbohydrate content of 76.3% and it was at par with all the germplasm except ASKAW1 which had relatively a lower proportion of 70.2%. Out of the S_1 progenies tested, ARR1 had the highest carbohydrate content (74%) and it was at par with ARY2 (71%), MNB2 (70%) and ARW1 (69.5%). Out of all the entries, including the S_0 and S_1 populations along with the check, ARR1 (76.3%), MNB2 (74.7%), ARY2 (74.3%), ARW1 (75.1%) and S_1 progeny ARR1 (74%) out yielded the check (73.9%) in respect of carbohydrate content. The percent superiority of these entries over the check was found to be in range of 0.14%–3.24%. Result reported by Ilyas *et al.* (2014) revealed the carbohydrate content in the range of 63.03 to 69.36% in the genotypes tested. Adeniyi and Ariwoola (2019) evaluated six maize varieties in South-Western Nigeria. They found comparative results in respect of carbohydrate content with the range 67.76% to 74.40%. Similar finding was reported by Demeke (2018) with the value ranged from 62.13 (BHQMY 545) to 69.99% (CML 165) for carbohydrate content in seven maize varieties. Kabir *et al.* (2019) reported the range from the highest 82.40% to the lowest 77.67% for carbohydrate content for the varieties under test.

Ash content

Out of the S_0 populations tested, ARR1 exhibited the highest ash content of 1.56% and it was at par with MNB2 (1.41%). Out of the S_1 progenies tested, ARR1 recorded the highest ash content of 1.28% and it was at par with all the other S_1 progenies. Out of all the entries, including the maize populations and corresponding S_1 progenies, all the six populations except ASKAW1 (1.07%) and the S_1 progenies namely, ARR1 (1.28%) and MNB2 (1.22%), outshined the check (1.09%) in respect of ash content. The percent superiority of these entries over the check was found in range of 2.75–43.11%. The ash content gives an idea of the total mineral amount present in the grain. In the present study, ash content in maize genotypes was found to be lower than the range of values reported by Enyisi *et al.* 2014 (1.4–3.3%) and Purificacion *et al.* 2018 (1.23%–3.13%).

Iron content

For grain Fe content, MNB2 had recorded the highest estimate of 11.4 mg/100 g and it was at par with ARY5 (11.0 mg/100g). Out of the S_1 progenies tested, MNB2 had the highest amount of Fe content (10.2 mg/100 g). Out of all the entries including the maize germplasms and S_1 progenies, germplasms MNB2 (11.4 mg/100

g), ARY5 (11 mg/100 g) and one S_1 progeny MNB2 (10.2 mg/100 g) had surpassed the check for grain Fe content (8.4 mg/100 g) with 35.71%, 30.95% and 21.42% superiority over the check, respectively. Each of the six germplasms exhibited significantly higher estimate of kernel Fe content as compared to its corresponding S_1 progeny. Such reduction of iron content from an S_0 population to its corresponding S_1 progeny resulted from segregation and inbreeding depression for the trait. Few researchers revealed that Fe content is a heritable trait influenced mostly by environmental factors. Gene interaction and role of environment on gene expression in the segregating populations will have a bearing on reduced Fe content in kernels. Dixon *et al.* (2000) found significant genotypic variation for iron concentration in maize inbred lines with the range from 1.5 to 15.9 mg/100g for mid- altitude and from 1.4 to 13.4 mg/100 g for lowland maize inbred lines. Enhancement of micronutrients can be done through conventional plant breeding. Therefore, identification of germplasm with high iron content is a key step to improve nutritional quality of germplasm.

Zinc content

Among the S_0 populations, the germplasm ARR1 (3.4 mg/100 g) showed the highest zinc content and it was at par with ARW1 (3.1 mg/100 g). Out of the S_1 progenies tested, ARY2 (3.1 mg/100 g) recorded the highest zinc content and it was at par with ASKAW1 (2.9 mg/100 g), ARY5 (2.8 mg/100 g), and MNB2 (2.8 mg/100 g). Out of all the entries tested, ARR1 (3.4 mg/100 g), ARW1 (3.1 mg/100 g) and ARY2 (3.1 mg/100 g) surpassed the check (2.8) for ash content. The percent superiority of these entries over the check was found in range of 3.57–21.42%. The values observed in the present investigation were found to be lower than the range reported by Dixon *et al.* (2000) in maize inbred lines (1.2 mg/100 g to 9.6 mg/100 g). Comparative result was found by Kabir *et al.* (2019) for zinc content of germplasm in the range from 3.0 mg/100 g to 4.2 mg/100 g. Bajnziger and Long (2000) also reported a range of maize grain-Zn concentrations between 1.29 and 5.76 mg/100 g from a screening of > 1800 maize germplasm in Mexico and Zimbabwe. The promising genotypes, thus identified, could be utilized in the breeding program aimed at developing micronutrient-rich biofortified varieties.

The comparison of mean performances of the germplasm studied with respect to various nutritional traits revealed that ASKAW1 had the highest crude protein content as well as high crude fat content. The germplasm ARR1 had showed high carbohydrate content as well as high ash content including zinc content. MNB2 showed high iron content in both S_0 population and S_1 progenies. The germplasm with high zinc content will be a special importance for people suffering from reduced immunity. Zinc plays important role in cell division, cell growth, wound healing and the metabolism of carbohydrate. Iron is an essential element for blood production. About 70% of the iron present in human body is found in red blood corpuscles and muscle cells. Iron of the human body is present in both haemoglobin and myoglobin. Maize germplasm with high iron will provide healthy diet for the anaemic person suffering from reduced haemoglobin or loss of blood. Thus, maize germplasm rich in protein, fat, iron, zinc and other valuable nutrients will be important for derivation of speciality inbreds and development of composites, hybrids and other genetic forms.

CONCLUSION

The estimates of mean square due to germplasm were significant to highly significant for all the traits indicating sufficient variation among the thirteen entries tested. Among the maize germplasm studied, ARR1 exhibited higher amount of carbohydrate content, crude protein, ash content and zinc content. Both the germplasm MNB2 and its selfed progeny (S_1) exhibited higher iron content compared to check varieties/ other test germplasm.

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