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Antioxidant properties and mineral composition of different genotypes of Niger

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Abstract
The present investigation "Antioxidant Properties and Mineral Composition of Different Genotype of Niger" was carried out at the Department of Soil Science and Agril. Chemistry, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India. Twelve genotypes and three check varieties of Niger were studied for nutrient content along with antioxidant activity. The above mentioned study revealed that Genotype NMS-1702 is an excellent in antioxidant activity, P, B, Zn and Cu while genotype NMS-1709 serves good source of Mg, B, and Na. Variety GNNIG-3 showed good results in S, Zn, Mn, Fe. In addition to that NMS-1711 and NMS-1703 also provide rich source of minerals. These genotypes showed to be relatively superior in respect of high mineral content and could therefore be encouraged for.

Keywords: Antioxidant activity, phenol, mineral, Niger

Introduction
Niger (*Guizotia abyssinica* Cass.) is a cost-effective important minor oilseed crop used for human consumption. It belongs to the Compositae family as sunflower and safflower (Bhatnagar and Gopalakrishna, 2015) [2]. Niger is mainly originated from African countries like Ethiopian highlands and is largely cultivated in that place. Besides Ethiopia it is extensively cultivated in India, Sudan, Uganda, Zaire, Tanzania, Malawi, Zimbabwe, the West Indies, Nepal, Bangladesh, and Bhutan. Ethiopia and India is the major Niger seed producing countries which constitutes about 50% and 2% production respectively (Ramadan and Morsel, 2002) [10].

In India, it is cultivated in Andra Pradesh, Madhya Pradesh, Orissa, Maharashtra, Bihar, Karnataka, West Bengal and in some extent to Gujarat. *Guizotia abyssinica* is prevalent in South Gujarat region where tribal population uses this Niger seed oil as cooking purpose. Oilseeds are mainly used for the extraction of edible oils. In addition to its oil, Niger seed served as rich source of protein, carbohydrate, crude fibre and fat soluble Vitamin A. It also contribute to the daily intake of several nutrients (Deosthale YG, 1981) [5]. The dietary requirement of minerals is relatively small which is in the range of 1–2500 mg per day depending on the type of mineral (Soetan *et al.* 2010) [12]. They have a crucial role in blood and bone formation, transmitting impulses from nervous system to extremities and vice versa and generally maintaining optimal healthiness. Niger seed offers good source of minerals like Na (159–736), K (5594–8203), Ca (340–680), Mg (2404–4656), Mn (13.4–34.3), Fe (31.6–370), Cu (9.5–61.2), Zn (23.4–46.2), Cr (4.0–16.8), Co (4.9–27.3), Ni (13.0–32.4), Pb (15.5–19.3) (µg/g). Moreover, due to presence of sterols and tocopherols it proved to be a significant source of antioxidant activity.

The present investigation was conducted to evaluate the antioxidant activity and mineral analysis of Niger (*Guizotia abyssinica* Cass.) seeds.

Material and Methods
Sample Collection
For determining the seed quality, the seeds of different 12 genotypes along with 3 check varieties were collected from Niger Research Station, Vanarasi, Navsari Agricultural University, Navsari.

Phenol Content
Phenol content measured by the Folin-Ciocalteau reagent using catechol as standard (Malick & Singh, 1980) [8].

Sample (0.5g) weigh in 10 time volume of 80% ethanol, centrifuged at 10000 rpm for 20 minutes and supernatant collected. Re extract the residue in 5 time volume of 80% ethanol, centrifuge and pull the supernatant. The supernatant was evaporated to dryness. The residue was dissolved in 20 ml with distilled water. For the estimation of phenol, aliquot 0.2 ml was diluted to 3 ml of distilled water and 0.5 ml Folin-Ciocalteau reagent was added. After 3 minutes, 2 ml of 20% sodium carbonate was added. The tubes were then kept in boiling water bath for 1 minute. The solution was cooled and the absorbance was read at 650 nm.

DPPH Free Radical Scavanging Assay

Radical Scavenging Activity toward DPPH Radical was carried out by Braca *et al.* (2001) [3]. A toluenic solution of DPPH radicals was freshly prepared at a concentration of 10^{-4} M. For evaluation, 10 mg of crude seed powder or their fractions (in 100 µl of toluene) was mixed with 390 µl of toluenic solution of DPPH radicals and the mixture was vortexed for 20s at ambient temperature. Against a blank of pure toluene without DPPH, the decrease in absorption at 515 nm was measured after 1, 30, and 60 min of mixing, using a UV visible spectrophotometer. RSA toward DPPH radicals was estimated from the differences in absorbance of toluenic DPPH solution with or without sample (control) and the inhibition percent was calculated according to Braca *et al.* (2001) [3].

$$\% \text{ Inhibition} = \frac{(\text{absorbance of control} - \text{absorbance of test sample})}{\text{absorbance of control}} \times 100$$

Mineral Content

Mineral analysis had been carried out by Jackson 1967 [7] method Dried seed powder (0.5g) was taken in 15 ml of di-acid (HNO_3: $HClO_4$=10:4) mixture which was allowed to stand for overnight. The mixture was heated until a clear solution was obtained. Heating was continued till the volume reduced to approximately 3 to 5 ml. After that the clear solution was cooled and the volume was made up to 100 ml. This solution was stored and used for mineral analysis. Ca, Mg, B, Fe, Mn, Cu, Zn from Niger sample was analyzed by Atomic Emission Spectrometer (MP-AES, Agilent, 4200); K and Na determined by flame photometer and P and S determined by spectrophotometer.

Result and Discussion

Phenol Content and Antioxidant Activity

Phenol content and antioxidant activity of the 12 genotypes and 3 check varieties of Niger were presented in Fig.1 and Fig. 2.

The range of phenol content recorded, was 5.613mg/g to 1.452 mg/g. NMS-1701 showed highest amount of phenol at par with NMS-1704, NMS-1705, IGPN-2004-1, GN-2, NMS-1710, NMS-1708, NMS-1702 and NMS-1709. The lowest phenol content was observed in NMS-1711 which was at par with GNNIG-3 and NMS-1703. Compared to other genotypes, phenol content was similar in check varieties. The result of present study was less comparable with the findings of Sreeramulu and Raghunath (2011) [13] who reported the phenol content of Niger seed was 143mg/100g.

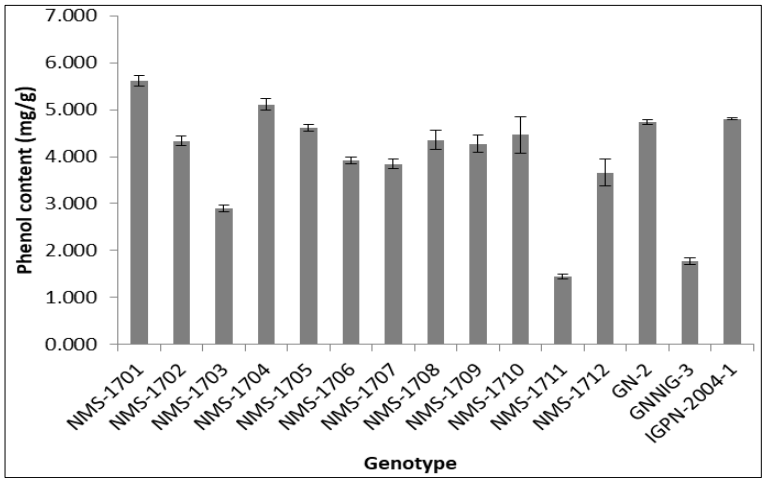

Fig 1: Phenol content of 12 Genotypes and 3 check varieties of Niger

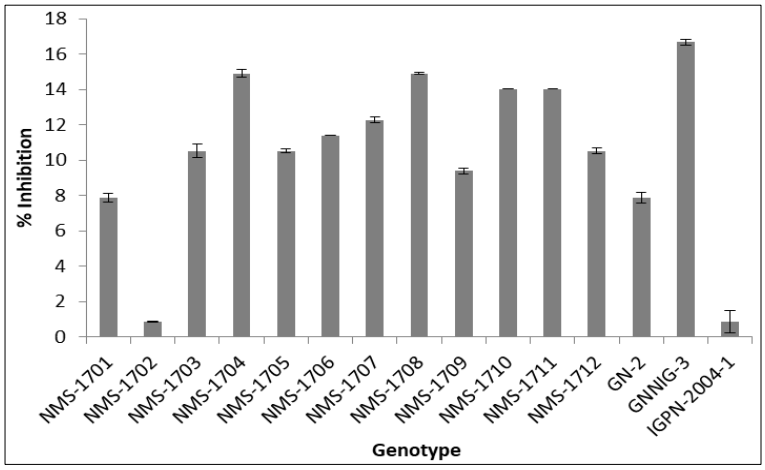

Fig 2: Antioxidant activity of 12 Genotypes and 3 check varieties of Niger

Total antioxidant activity had been expressed as IC_{50} value of DPPH radical which means as the higher amount of extract is needed to quench 50% of the DPPH radical has lower antioxidant activity and the lower amount is needed to quench 50% of the DPPH radical has higher antioxidant activity.

The total antioxidant activity of 12 genotypes and 3 check varieties of Niger had been carried out by DPPH method and the data reported was significantly varied from (0.877 to 16.66%). GNNIG-3 genotypes had a lowest antioxidant activity and the highest antioxidant activity was found in IGPN-2004-1 and NMS-1702. The findings of Ramadan *et al.* (2003) [9] were well comparable with present findings who reported that Niger seed oil was able to quench 14% of DPPH radicals.

Mineral Content

The data on macro mineral composition of Niger presented in Table 1 showed a variability for the content of sulphur (0.221-0.123%), phosphorus (0.888-0.611%), calcium (6536.67-4746 ppm), magnesium (5102-3198ppm), Potassium (1.30-0.96%), respectively. The highest sulphur content was found in NMS-1704(0.221%) at par with NMS-1703 (0.220%), NMS-1710 (0.206%), IGPN-2004-1 (0.202%) and GNNIG-3 (0.201%).

Table 1: Macro elements content of 12 genotypes and 3 check varieties of Niger

Genotypes	S (%)	P (%)	Ca (ppm)	Mg (ppm)	K (%)
NMS-1701	0.17	0.82	4950.00	4220.00	1.12
NMS-1702	0.12	0.89	4935.33	3198.00	0.96
NMS-1703	0.22	0.67	5006.00	4340.67	1.30
NMS-1704	0.22	0.87	5965.33	4772.67	1.29
NMS-1705	0.19	0.78	4888.00	4290.67	1.13
NMS-1706	0.16	0.66	5648.00	4064.00	1.08
NMS-1707	0.15	0.73	4922.67	3741.33	1.10
NMS-1708	0.15	0.78	6427.33	4473.33	1.17
NMS-1709	0.16	0.74	5802.67	5102.00	1.13
NMS-1710	0.21	0.79	4746.00	4474.67	1.17
NMS-1711	0.17	0.61	5816.00	4294.00	1.22
NMS-1712	0.19	0.86	6536.67	4740.00	1.20
GN-2 (c)	0.19	0.81	5235.33	4058.67	1.10
GNNIG-3 (c)	0.20	0.73	6376.67	4545.33	1.19
IGPN-2004-1(c)	0.20	0.86	5970.00	4897.33	1.20
SEm±	0.01	0.07	4.92	5.05	0.04
CD at 5%	0.02	NS	14.21	16.26	0.11
CV%	7.85	16.14	0.15	0.22	5.54

There was no significant difference in mean values of phosphorus content of 12 genotypes and 3 check varieties of Niger. The maximum value of phosphorus content was obtained in NMS-1702 (0.888%) while minimum value of phosphorus content was obtained in NMS-1711 (0.611%). The highest calcium content (Ca) was recorded in genotype NMS-1712 (6536.67ppm), while the lowest Calcium content was found in NMS-1710 (4746 ppm) among Niger genotypes. It can be observed from above results that compared to check varieties other genotypes had higher Ca content. The highest magnesium (Mg) content was observed 5102 ppm in NMS-1709 and the lowest magnesium content was observed 3198ppm in NMS-1702. The data from present findings revealed that genotypes other than check varieties had higher Mg content.

NMS-1703 (1.30%) had highest value of potassium content which was at par with NMS-1704, NMS-1711, NMS-1712 and IGPN-2004-1 while the lowest potassium content was present in genotype NMS-1702 (0.96%). The results showed the highest boron content in NMS-1707 (9.33 ppm) which was at par with NMS-1704, NMS-1706, NMS-1701, NMS-1705, NMS-1711, NMS-1703, NMS-1709 and NMS-1702. The lowest boron content was found 3.33 ppm in NMS-1712 which was at par with NMS-1708, NMS-1710, GN-2, GNNIG-3, IGPN-2004 -1, NMS-1702 and NMS-1703. It can be observed from above results that compared to check varieties other genotypes had higher B content.

Deme *et al.* in 2017 [4], found that Phosphorous (P) comprises the highest amount among the minerals ranging from 660.61 mg/100g to 867.02 mg/100g which was in line with present investigation. In that study it was also observed that the calcium and magnesium content of different varieties of Niger ranged from 371.94 – 467.58 mg/100g and 264.93-352.95 mg/100g, respectively which is comparable to present investigation. Moreover, it was reported that niger varieties contained sulphur and boron content ranged between 236.56mg/100g to 276.67mg/100g and 1.87-2.23mg/100g, respectively which was higher than the present study. In opposite to that they reported potassium in different Niger varieties with values in the range of 610.15 mg/100g to 808.65 mg/100g which was lesser than present investigation.

The finding of present study was less comparable with Fatima *et al.*, (2015) [6] who reported 1.0% phosphorus content in Niger seeds grown in USA. The amount of calcium recorded in the present investigation was comparable with the findings of Rao (1994) [11] who reported Ca content in the range of 290-587mg/100g. Syume and Chandravanshiin (2015) [14], also reported that Niger contained calcium and potassium in range between 340-680 (µg/g) and 5594–8203(µg/g), respectively which was very lower than the present findings. It was also reported that Niger comprises 2404-4656 (µg/g) of magnesium content which was in line with present study.

The data on micro mineral composition of niger presented in Table 2 showed a variability for the content of boron (9.33-3.33ppm), zinc (45.33-24ppm), manganese (32.67-18.67ppm), copper (50-22.67ppm), iron (480-247.33ppm) and sodium (0.079-0.045%), respectively. The maximum value of Zinc content recorded in NMS-1708 (45.33 ppm) which was at par with NMS-1705, NMS-1706, NMS-1702, NMS-1707, NMS-1703 and GNNIG-3. The minimum value of Zinc content recorded in NMS-1712 (24.00 ppm) which was at par with NMS1701, NMS-1711, NMS-1709, NMS1710 and NMS1704. GNNIG-3 had similar Zn content as in other genotypes. However, check varieties other than GNNIG-3 showed lower Zn content compared to other genotypes.

Table 2: Micro elements content of 12 genotypes and 3 check varieties of Niger

Genotypes	B (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)	Fe (ppm)	Na (%)
NMS-1701	7.33	28.67	32.67	40.67	247.33	0.049
NMS-1702	6.00	42.00	25.33	46.67	258.67	0.045
NMS-1703	6.67	42.00	20.67	46.00	308.00	0.079
NMS-1704	8.67	26.67	18.67	45.33	381.33	0.063
NMS-1705	7.33	42.67	23.33	50.00	374.67	0.065
NMS-1706	8.00	42.67	20.67	44.67	294.67	0.073
NMS-1707	9.33	42.00	22.67	35.33	314.67	0.049

NMS-1708	4.00	45.33	21.33	32.67	278.00	0.053
NMS-1709	6.67	26.00	20.67	23.33	360.00	0.078
NMS-1710	4.00	26.67	20.00	32.00	360.00	0.058
NMS-1711	7.33	28.67	30.00	32.00	313.33	0.079
NMS-1712	3.33	24.00	28.00	33.33	471.33	0.068
GN-2 (c)	4.00	39.33	23.33	27.33	480.00	0.062
GNNIG-3 (c)	4.00	40.00	31.33	26.67	458.67	0.054
IGPN-2004-1(c)	4.00	30.67	25.33	22.67	460.67	0.071
SEm±	1.32	1.98	1.23	1.62	10.93	0.010
CD at 5%	3.81	5.71	3.55	4.69	31.55	0.010
CV%	37.88	9.74	8.77	7.83	5.29	13.74

NMS-1701 (32.67 ppm) showed highest Manganese content (Mn) which was at par with GNNIG-3 and NMS-1711 while the lowest Mn content was found in NMS-1704 (18.67 ppm) which was at par with NMS-1710, NMS-1703, NMS-1706, NMS-1709 and NMS-1708. It can be observed from the result that Mn content of GNNIG-3 was similar to other genotypes. In addition to that rest two check varieties had moderate amount of Mn content. The highest Copper (Cu) content had been found in NMS-1705 (50.00 ppm) at par with NMS-1702 and NMS-1703, while the lowest value was observed in genotype IGPN-2004-1 (22.67 ppm) which was at par with NMS-1709 (23.33 ppm), GNNIG-3 (26.67 ppm) and GN-2 (27.33 ppm). It can be observed from above results that compared to check varieties other genotypes had higher Cu content.

The highest iron (Fe) content was observed in GN-2 (480.00 ppm). The iron content was recorded significantly higher in all three check varieties namely GN-2, IGPN-2004-1 and GNNIG-3 as compared to rest genotypes. The lowest Fe content was observed in genotype NMS-1701 (247.33 ppm) which was at par with NMS-1702 (258.67 ppm) and NMS-1708 (278.00 ppm). Highest sodium content was found in NMS-1703 and NMS-1711 (0.079%) which was at par with NMS-1709, NMS-1706, IGPN-2004-1, NMS-1712 and NMS-1705. The lowest sodium content was observed in NMS-1702 (0.045%) which was at par with NMS-1707, NMS-1701, NMS-1708, GNNIG-3 and NMS-1710. Sodium content found in IGPN-2004-1 was at par with highest sodium containing genotypes

Deme *et al*. in 2017 [4], determined the zinc and manganese content in Niger varieties that was 3.57-3.96mg/100g and 1.05-7.36mg/100g, respectively which was in range with present investigation. It was found that the Niger varieties contained 0.93-1.12mg/100g copper and 1.64-4.97 mg/100g sodium. The iron content reported in that study was ranged from 5.65-13.65 mg/100g in different varieties of Niger which in disagreement with present findings. Syume and Chandravanshi (2015) [14], collected seeds of Niger from different parts of Ethiopia and Eretria and found that it contained copper and iron in the range of 9.5-61.2 (µg/g) 31.6-370 µg/g which was comparable with present findings. The zinc (23.4-46.2 µg/g) content reported in that study was in line with present investigation. It was also reported that the content of sodium and manganese ranged between 159-736 (µg/g) and 13.4-34.3 (µg/g), respectively. Baranwal and Bhatnagar (2013) [1], also reported the iron content of *Guizotia abyssinica* was 42.43 mg/100g of dry matter which was similar to present study

Conclusion

The genotypes/varieties included in present study are rich in macro and micro minerals and can play a great role in combating malnutrition. Significant variation was observed among the genotypes/varieties in their mineral content.

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