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NUTRITIONAL EVALUATION OF LEAVES OF CHICKPEA VARIETIES AT DIFFERENT GROWTH STAGES

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SUMMARY

The present study was carried out with the objective to determine the nutrient composition and antioxidant properties of chickpea leaves of *desi* and *kabuli* varieties (HC-1, C-235, HK-1 and HK-2) at different stages of maturity (30, 45 and 60 DAS). Moisture, crude fat and carbohydrate were found maximum in the chickpea leaves at 30 DAS, while crude protein, crude fibre and ash content were found to be maximum in the leaves taken at 60 DAS. Dietary fibres (total insoluble and soluble) were found to be the highest in the leaves taken at 45 and 60 DAS. β-carotene in fresh leaves and dry leaves was highest (30 DAS) and vitamin C in fresh leaves (60 DAS). Both the anti-nutrients were lowest in chickpea leaves (30 DAS).

Key words : Chickpea, β-carotene content, vitamin C content, phytic acid content, oxalic acid content

Many varieties of chickpea have been developed for irrigated, rainfed, early and late sowing conditions and disease resistance. The varieties under the present study are medium tall (C-235) and dwarf (HC-1 and HK-1) and branched (HK-1). The *desi* chickpea variety C-235 is recommended for the irrigated condition, which is medium in height and maturity, tolerant to blight disease prone to wilt with yield potential of 8.00 q per acre. The *kabuli* chickpea variety HK-1 is recommended for whole Haryana except rainfed areas. It has higher number of branches with more leaves. It is medium in maturity. Wilt is less in this variety as compared to all other *kabuli* chickpea varieties. The yield potential is 8 to 10 q per acre. The *kabuli* chickpea variety HK-2 is also recommended for the whole Haryana except for the rainfed areas. The leaves are light green in colour. This variety is resistant to all the main diseases of chickpea. The yield potential of the variety is 7 to 8 q per acre. All the four varieties were taken for the present study for their leaves for nutritional evaluation and their products with their storability. The study will impact the farmers of Haryana, where these varieties are grown on large scale and they can be benefitted with the information generated for the use of leaves with the objective to determine the nutrient composition and antioxidant activity of chickpea leaves of *desi* and *kabuli* varieties at different stages of maturity.

MATERIALS AND METHODS

The present investigation was carried out in the Department of Foods and Nutrition, College of Home Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Two *desi* (C-235, HC-I) and two *kabuli* (HK-I, HK-2) chickpea varieties newly released by the Pulses Section, Department of Genetics and Plant Breeding of CCSHAU, Hisar were selected for the present study. The young fully expanded leaves (Fourth through seventh nodes from the apex, up in triplicate) at three stages of growth of chickpea i.e. 30, 45 and 60 days after sowing were collected. After collection, the leaves were washed in distilled water and dried at 65-70ºC for a minimum of 48 h or till the dried weight was constant. Chickpea crop growth stages were divided into three stages, namely, vegetative (30 DAS), reproductive (45 DAS) and maturity (60 DAS). Leaf samples of chickpea varieties *desi* and *kabuli* were taken accordingly on these stages i.e. 30, 45 and 60 days after sowing. These stages were selected for the nutritional composition of leaves for the comparative analysis and knowing the proper stage of picking of chickpea leaves for maximum nutrient composition (Table 1). Moisture in the samples was calculated by employing the standard methods of analysis. Crude protein was estimated by standard method of analysis using KEL PLUS Automatic Nitrogen Estimation

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System. Crude fat was estimated by employing the standard method of analysis using the Automatic SOCS plus Solvent Extraction System. Crude fibre was estimated by standard method of analysis using crude fibre apparatus. Ash in the sample was estimated by employing the standard method of analysis (A. O. A. C., 2000).

The total carbohydrate was calculated by difference method. Total carbohydrate (%) = 100 – [Moisture (%) + crude protein (%) + crude fat (%) + crude fibre (%) + total ash (%)]. Total, soluble and insoluble dietary fibre constituents were determined by the enzymatic method given by Furda (1981). The sum of insoluble dietary fibre and soluble dietary fibre contents were calculated for determining total dietary fibre content. Total dietary fibre = Insoluble dietary fibre+Soluble dietary fibre. Both vitamins (β - carotene and Vitamin C) were analyzed in the fresh leaves as well dried leaves powder. β-carotene content in sample was separated by column chromatography and estimated colorimetrically (A. O. A. C., 2000). Vitamin C was estimated by employing the method of (A. O. A. C., 2000).

RESULTS AND DISCUSSION

Protein Content

The crude protein contents were found to be maximum in the leaves of both *desi* and *kabuli* varieties at 60 days after sowing (Tables 2 & 3 and Fig. 1). The highest protein content was observed in the leaves of *kabuli* chickpea variety HK-1 (26.27%) and *desi* chickpea variety C-235 (25.77%) at 60 days after sowing (Tables 2 & 3). The results have been found comparable with Singh and Grover (2014) The highest per cent increase in crude protein was recorded in the leaves of HC-1 (12.58); HK-1 (12.41), HK-2 (12.37) and C-235 (10.46) from 30 days after sowing to 60 days after sowing (Tables 2 & 3). The crude protein content of leaves increased as the age of the crop advanced. It increased 12.58 per cent in the leaves of *desi* chickpea variety HC-1 from 30 days after sowing to 60 days after sowing. In case of leaves of C-235, it increased by 10.46 per cent from 30 days after sowing to 60 days after sowing. It increased by 12.41 per cent in *kabuli* chickpea variety HK-1 from 30 days after sowing to 60 days after sowing. It increased by 12.37 per cent in leaves of *kabuli* chickpea variety HK-2 from 30 days after sowing to 60 days after sowing on the contrary. Ncube *et al.* (2015) found out that crude protein in early harvested leaves were higher than in the mid and late growth stage ($P<0.05$).

Fat Content

The crude fat content at 30 days after sowing were almost similar in HC-1 (5.60%) and C-235 (5.50%) varieties and they had the highest crude fat content when compared to their leaves collected a 45 days and 60 days. Similar trend was noticed in *kabuli* chickpea leaves also. HK-1 (5.7%) and HK-2 (5.7%) leaves at 30 days after sowing had the similar and the highest crude fat content when compared to those collected at 45 and 60 days after sowing. The lowest fat content was estimated in the leaves of *kabuli* chickpea variety HK-1 (5.07%) at 60 days after sowing and highest in both the *kabuli* chickpea varieties HK-1 and HK-2 (5.70% each) at 30 days after sowing. This fat content was almost comparable with the fat content of leaves of *Myrianthus arboreius* and *Spargonophorus sporgonophora* as 6.01 and 6.45 per cent, respectively, as estimated by Oyeyemi *et al.* (2014). It was higher than the crude fat content of leaves of seven varieties of sweet potato (0.38 to 1.91%) and *Moringa olefera* (2.23%) as reported by Oduro *et al.* (2008). Crude fat, though serves as principal sources of energy should be consumed with caution so as to avoid obesity and other related diseases (Oko, 2012). Also dietary fats function to increase food palatability by absorbing and retaining flavours.

The highest fat reduction was estimated in HK-1 (12.43%) followed by HC-1 (9.80%), HK-2 (9.62%) and the lowest reduction in fat content was found in the leaves of *desi* chickpea variety C-235 i.e. 7.84 per cent from 30 days after sowing to 60 days after sowing. However, the fat content in leaves of C-235 variety was estimated as 5.50 per cent at 30 days after sowing (Table 2 & 3). Singh and Grover (2014) also reported the fat content of the dehydrated chickpea leaves as 3.25 g /100 g.

Crude Fibre

The crude fibre contents were found to be maximum in the leaves of both *desi* and *kabuli* varieties at 60 days after sowing (Tables 2 and 3). Dietary fibre helps to prevent constipation, gastrointestinal disorder, pile, diabetes and breast cancer (Ishida *et al*., 2000). The highest crude fibre contents in leaves were found in *kabuli* chickpea variety HK-1 (12.4%) and *desi* chickpea variety C-235 (12%) at 60 days after sowing

TABLE 1
Growth stages of chickpea and collection of leaf sample

Year	Type	Varieties	Date of sowing	Growth stages		
				Vegetative	Reproductive	Maturity
				1 to 30 days	31-45 days	45 to 60 days
				Dates of collection of sample		
2012	*Desi*	HC-1, C-235	17.11.12	17.12.12	01.01.13	16.01.13
2012	*Kabuli*	HK-1, HK-2	26.11.12	26.12.12	10.01.13	25.01.13
2013	*Desi*	HC-1, C-235	18.11.13	18.12.13	02.01.14	17.01.14
2013	*Kabuli*	HK-1, HK-2	25.11.13	25.12.13	09.01.14	24.01.14

TABLE 2
Proximate composition and dietary fibre constituents of leaves of *desi* chickpea varieties (per cent on dry matter basis)

Parameters	HC-1			C-235		
	Days after sowing					
	30	45	60	30	45	60
Proximate composition						
Moisture	$6.70^{b}\pm0.06$	$6.30^{c}\pm0.06$	$6.00^{d}\pm0.06$	$7.00^{a}\pm0.06$	$6.67^{b}\pm0.09$	$6.23^{c}\pm0.03$
Crude protein	$22.50^{e}\pm0.06$	$24.77^{c}\pm0.09$	$25.33^{b}\pm0.09$	$23.33^{d}\pm0.12$	$25.43^{b}\pm0.09$	$25.77^{a}\pm0.09$
Crude fat	$5.60^{a}\pm0.06$	$5.30^{bc}\pm0.06$	$5.10^{c}\pm0.06$	$5.50^{ab}\pm0.10$	$5.37^{b}\pm0.09$	$5.10^{c}\pm0.06$
Crude fibre	$10.60^{c}\pm0.12$	$11.33^{b}\pm0.09$	$11.93^{a}\pm0.09$	$10.63^{c}\pm0.09$	$11.53^{b}\pm0.09$	$12.00^{a}\pm0.06$
Ash	$5.40^{d}\pm0.06$	$5.77^{c}\pm0.09$	$6.00^{b}\pm0.06$	$5.63^{c}\pm0.03$	$6.00^{b}\pm0.06$	$6.37^{a}\pm0.09$
Carbohydrates	$49.20^{a}\pm0.06$	$46.53^{c}\pm0.32$	$45.63^{d}\pm0.09$	$47.93^{b}\pm0.26$	$45.00^{de}\pm0.36$	$44.55^{e}\pm0.20$
Dietary fibre constituents (g/100 g)						
Total dietary fibre	$27.03^{b}\pm0.12$	$28.43^{a}\pm0.15$	$28.97^{a}\pm0.12$	$26.90^{b}\pm0.17$	$28.53^{a}\pm0.23$	$28.90^{a}\pm0.21$
Insoluble dietary fibre	$24.13^{b}\pm0.12$	$25.23^{a}\pm0.01$	$25.37^{a}\pm0.12$	$23.90^{b}\pm0.25$	$25.43^{a}\pm0.09$	$25.10^{a}\pm0.12$
Soluble dietary fibre	$2.9^{b}\pm0.00$	$3.2^{b}\pm0.10$	$3.6^{a}\pm0.00$	$3.00^{b}\pm0.12$	$3.10^{b}\pm0.15$	$3.8^{a}\pm0.10$

Values are mean±SE of three independent determinations.
The mean values in same row with different superscripts differ significantly (P≤0.05).

which were significantly higher over the fibre contents at 30 and 45 days after sowing. The lowest crude fibre was found in the leaves of *desi* chickpea variety HC-1 (10.6%) and *kabuli* chickpea variety HK-2 (10.37%) at 30 days after sowing. The results were confirmed by Madhu and Kochhar (2014) who reported the crude fibre content of broccoli as 11.0 g/100 g. Singh *et al.* (2012) recorded the crude fibre content in bael leaves as 14.8 g /100 g.

Carbohydrate Content

The highest carbohydrate content was estimated in the leaves of *desi* chickpea variety HC-1 (49.20%) at 30 days after sowing and the lowest was in the leaves of *kabuli* chickpea variety HK-1 (44.13%) at 60 days after sowing (Tables 2 and 3). The carbohydrate content of the chickpea leaves was found higher than carbohydrate contents of leaves of Bengal gram (12.57 g /100 g) reported by Islam *et al.* (2004) but similar with the carbohydrate content of chickpea leaves (49.6 g) as reported by Singh and Grover (2014).

The lowest carbohydrate content was observed in the leaves of *kabuli* chickpea variety HK-1 (44.13%) at 60 days after sowing, while the highest carbohydrate content was noticed in the leaves of *desi* chickpea variety HC-1 (49.20%) at 30 days after sowing. Variety HC-1 significantly had higher carbohydrate contents in the leaves at 30 days after sowing; likewise carbohydrate content in leaves at 30 days after sowing of variety HK-2 (49.17%) was significantly higher over the carbohydrate contents of leaves at 45 and 60 days after sowing in *kabuli* varieties 38.90 to 42.11 per cent of carbohydrates were reported in amaranthus leaves on dry weight basis. Madhu and Kochar (2014) reported that broccoli leaves contained 53.62 g carbohydrates per /100 g.

Nutritional Evaluation

The total dietary fibre, insoluble dietary fibre and soluble dietary fibre contents in the leaves of *desi* and *kabuli* chickpea varieties varied from 26.9 to 29.27; 23.9 to 25.43 and 2.9 to 3.83 g per 100 g, respectively.

Highest total dietary fibre content was found in the leaves of chickpea variety HK-2 (29.07 g), HC-1 (28.97 g), and C-235 (28.9 g) at 60 days after sowing. The lowest total dietary fibre was found in the leaves of *desi* chickpea variety C-235 (26.9), followed by HC-1 (27.03), HK-2 (27.33) and HK-1 (27.5) at 30 days after sowing (Tables 2 & 3 and Fig. 2). This range was higher than the total fibre content in chickpea leaves (13.89 g) given by Singh and Grover (2014).

Insoluble Dietary Fibre

The highest insoluble dietary fibre was found in the leaves of *kabuli* chickpea variety HK-1 (25.43 g / 100 g) at 60 days after sowing followed by *desi* chickpea variety C-235 (25.43 g /100 g) at 45 days after sowing (Tables 2 & 3, Fig. 2). The lowest insoluble dietary fibre content in leaves was observed in the variety C-235 (23.9 g /100 g) followed by HK-2 (24.00 g /100 g) at 30 days after sowing. The insoluble dietary fibre content in the leaves of different chickpea varieties in the present study was higher than the content in jute leaves (11.09 g) by Islam *et al.* (2004). Among the *desi* chickpea varieties, C-235 resulted in highest insoluble dietary fibre in leaves (25.43 g/100g) which is at par with HC-1 (25.37 g / 100 g) at 60 days after sowing, HC-1 (25.23 g /100 g) at 45 days after sowing, C-235 (25.10 g / 100 g) at 60 days after sowing, but significantly higher over C-235 (23.9 g /100g) and HC-1 (24.13 g /100 g) at 30 days after sowing. Among the *kabuli* chick pea varieties, highest insoluble dietary fibre contents in leaves were found in the leaves of HK-1 (25.43 g /100g) at 60 days after sowing, HK-1 (25.27 g/100 g) at 45 days after sowing, HK-2 (25.23 g /100 g) at 60 days after sowing and HK-2 (25.17 g/100 g) at 45 days after sowing but significantly higher over the insoluble dietary fibre content in the leaves of HK-2 (24.00 g/ 100 g) and HK-1 (24.50 g /100 g) at 30 days after sowing. From the above, pattern, it can be said that the insoluble dietary fibre content in leaves increased as the chickpea crop reached to maturity.

Soluble Dietary Fibre Content

Higher soluble dietary fibre content (g /100g) was found in the leaves of chickpea varieties HK-2 and HK-1 (3.83), C-235 (3.80) and HC-1 (3.60) at 60 days after sowing and the lowest was observed in the leaves of chickpea variety HC-1 (2.90), C-235 (3.00) and kabuli chickpea variety HK-1 (3.00) at 30 days after sowing (Tables 2 & 3, Figure 2). The soluble dietary fibres content of the present study are lower in green leafy vegetables had around 25.0 per cent of the total dietary fibre. Soluble dietary fibre content in the chickpea leaves was found maximum at maturity.

β-carotene Content

Highest β-carotene content (mg/100 g) was observed in the fresh leaves of chickpea variety HK-1 (3.03) at 30 days after sowing and the lowest in the *desi* chickpea variety C-235 (2.03) at 60 days after sowing. β-carotene content was found to be more in

TABLE 3
Proximate composition and dietary fibre constituents of *kabuli* chickpea varieties (per cent on dry matter basis)

Parameters	HK-1			HK-1		
	Days after sowing					
	30	45	60	30	45	60
Proximate composition						
Moisture	$7.03^{a}\pm0.03$	$6.77^{b}\pm0.09$	$6.3^{cd}\pm0.06$	$6.93^{ab}\pm0.09$	$6.43^{c}\pm0.09$	$6.17^{d}\pm0.07$
Crude protein	$23.37^{e}\pm0.15$	$25.77^{b}\pm0.09$	$26.27^{a}\pm0.09$	$22.63^{f}\pm0.12$	$24.73^{d}\pm0.09$	$25.43^{c}\pm0.09$
Crude fat	$5.7^{a}\pm0.06$	$5.3^{b}\pm0.06$	$5.07^{c}\pm0.09$	$5.7^{a}\pm0.06$	$5.53^{a}\pm0.03$	$5.2^{bc}\pm0.06$
Crude fibre	$10.87^{d}\pm0.09$	$11.9^{b}\pm0.06$	$12.4^{a}\pm0.06$	$10.37^{e}\pm0.12$	$11.30^{c}\pm0.12$	$11.73^{b}\pm0.09$
Ash	$5.27^{d}\pm0.07$	$5.63^{bc}\pm0.09$	$5.83^{ab}\pm0.12$	$5.2^{d}\pm0.12$	$5.5^{cd}\pm0.15$	$6.07^{a}\pm0.09$
Carbohydrates	$47.77^{b}\pm0.17$	$44.63^{de}\pm0.20$	$44.13^{e}\pm0.24$	$49.17^{a}\pm0.33$	$46.5^{c}\pm0.35$	$45.4^{d}\pm0.15$
Dietary fibre constituents (g/100 g)						
Total dietary fibre	$27.50^{c}\pm0.18$	$28.70^{ab}\pm0.15$	$29.27^{a}\pm0.26$	$27.33^{c}\pm0.18$	$28.57^{b}\pm0.20$	$29.07^{ab}\pm0.09$
Insoluble dietary fibre	$24.50^{b}\pm0.06$	$25.27^{a}\pm0.09$	$25.43^{a}\pm0.09$	$24.00^{c}\pm0.12$	$25.17^{a}\pm0.15$	$25.23^{a}\pm0.09$
Soluble dietary fibre	$3.00^{c}\pm0.12$	$3.43^{b}\pm0.07$	$3.83^{a}\pm0.18$	$3.33^{b}\pm0.07$	$3.40^{b}\pm0.06$	$3.83^{a}\pm0.09$

Values are mean±SE of three independent determinations.
The mean values in same row with different superscripts differ significantly (P≤0.05).

the fresh leaves of chickpea at the initial stage of the growth and decreased towards maturity (Tables 2 & 3, Fig. 1). The highest β-carotene content (8.83 mg/ 100 g) in the dried leaves of chickpea was observed in *kabuli* chickpea variety HK-1 at 30 days after sowing and the lowest was in *desi* chickpea variety HC-1 (8.78 mg/100 g). The stage of crop growth affected the β-carotene content in fresh as well as dry leaves. The results are in confirmation with those of Yadav and Sehgal (1999) and were in the range of β-carotene content in the leaves of *cholai* (0.68 to 9.62 mg/100 g) but lower than the β-carotene content in fresh amaranth vegetables (25.2 to 37.3 mg/100 g) as reported by Vijay (2002) in *Amaranthus spinosus* (4829 µg β-carotene/100g), respectively. is non-oxygenated carotene and is the most important and widely distributed carotenoid in plants and is converted into vitamin A more efficiently than the other carotenoids (Abbo *et al.*, 2005).

Vitamin C

Vitamin C content in fresh leaves of chickpea (Table 4) was found to be highest in variety HK-1 (8.73 mg/100), while the content increased in the dried leaves. The dried leaves of *kabuli* chickpea variety HK-1 had the highest vitamin C content (24.57 mg/100 g) at 30 days after sowing decreased to 23.17 mg /100 g) at 60 days after sowing. The reduction per cent was 5.70. This specified the nature of vitamin C and depicted that the fresh leaves up to 60 days after sowing contained the highest vitamin C content and it was the highest in dried leaves of 30 days chickpea crop. This may be due to the reason that the sowing time of chickpea was mid November, after which the temperature starts to fall down. Vitamin C is sensitive to temperature and its movement falls down will decrease in temperate. The leaves picked at 30 days after sowing having maximum accumulation of vitamin C, when dried, the concentration increased per unit quantity. The results of the present study are in confirmation with the results reported by Karmakar *et al.* (2013).

CONCLUSION

From the above studies, it can be concluded that leaves of *kabuli* chickpea variety HK-1 resulted

TABLE 4
Mean values of vitamins* and antinutrients** (mg/100 g) in fresh leaves of *desi* and *Kabuli* chickpea varieties

Parameters		HC-1			C-235		
		Days after sowing					
		30	45	60	30	45	60
β-carotene	Fresh leaves	$2.95^{a}\pm0.001$	$2.38^{e}\pm0.001$	$2.10^{e}\pm0.004$	$2.89^{b}\pm0.001$	$2.30^{d}\pm0.002$	$2.03^{f}\pm0.007$
	Dried leaves	$8.78^{a}\pm0.011$	$8.70^{b}\pm0.006$	$8.61^{c}\pm0.004$	$8.64^{c}\pm0.012$	$8.59^{d}\pm0.007$	$8.51^{e}\pm0.007$
Vitamin-C	Fresh leaves	$5.43^{d}\pm0.09$	$6.63^{b}\pm0.12$	$8.25^{a}\pm0.91$	$5.13^{e}\pm0.09$	$6.30^{c}\pm0.12$	$8.00^{a}\pm0.06$
	Dried leaves	$23.57^{a}\pm0.09$	$22.60^{c}\pm0.15$	$22.03^{d}\pm0.12$	$23.20^{b}\pm0.06$	$22.43^{c}\pm0.12$	$21.87^{d}\pm0.09$
Oxalic acid		$3.40^{e}\pm0.06$	$4.10^{c}\pm0.06$	$4.53^{a}\pm0.03$	$3.13^{f}\pm0.03$	$3.90^{d}\pm0.06$	$4.33^{b}\pm0.03$
Phytic acid		$95.67^{f}\pm1.45$	$125.33^{d}\pm0.88$	$148.67^{b}\pm1.45$	$101.33^{e}\pm1.45$	$135.33^{c}\pm1.20$	$157.67^{a}\pm2.03$
Parameters		HK-1			HK-2		
		Days after sowing					
		30	45	60	30	45	60
Vitamin content							
β-carotene	Fresh leaves	$3.03^{a}\pm0.01$	$2.47^{c}\pm0.01$	$2.98^{e}\pm0.004$	$2.98^{b}\pm0.01$	$2.35^{d}\pm0.004$	$2.05^{f}\pm0.009$
	Dried leaves	$8.83^{a}\pm0.009$	$8.77^{b}\pm0.005$	$8.64^{d}\pm0.006$	$8.76^{b}\pm0.008$	$8.69^{c}\pm0.008$	$8.59^{e}\pm0.009$
Vitamin C	Fresh leaves	$5.70^{d}\pm0.06$	$6.97^{c}\pm0.09$	$8.73^{a}\pm0.12$	$5.53^{d}\pm0.09$	$6.77^{c}\pm0.09$	$8.33^{b}\pm0.09$
	Dried leaves	$24.57^{a}\pm0.12$	$23.90^{b}\pm0.12$	$23.17^{c}\pm0.12$	$24.07^{b}\pm0.09$	$23.13^{c}\pm0.18$	$22.33^{d}\pm0.12$
Anti-nutrient content							
Oxalic acid		$3.43^{c}\pm0.03$	$4.13^{b}\pm0.09$	$4.30^{b}\pm0.06$	$3.6^{c}\pm0.06$	$4.23^{b}\pm0.09$	$4.60^{a}\pm0.06$
Phytic acid		$92.67^{e}\pm1.45$	$118.33^{d}\pm1.45$	$141.33^{b}\pm1.45$	$96.67^{e}\pm0.88$	$127.67^{c}\pm0.88$	$149.0^{a}\pm1.53$

Values are mean ± SE of three independent determinations. *On fresh as well as dry matter basis. **On dry weight basis. The mean values in same row with different superscripts differ significantly ($P\leq0.05$).

into maximum nutrients like crude protein, crude fibre, total dietary fibre, soluble dietary fibre, vitamins, total minerals as well as HCl extractable and available minerals and highest antioxidant activity at 45 days after sowing.

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