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Supplementation of food products by dehydrated leaves of *desi* and *kabuli* varieties of chickpea: A recent way to ameliorate the nutritional deficiency in India

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ABSTRACT

A study was conducted at Food and Nutrition Department of CCS HAU Hisar during 2012-13 and 2013-14 with the objective to provide a product (sev) to be supplemented by dehydrated leaves of chickpea desi and kabuli varieties. It was found that sev had the highest protein content (21.22 to 21.88 g / 100 g) as well as crude fat content (22.00 to 22.50 g /100 g), total dietary fibre (17.60 to 18.45 g/100 g), insoluble dietary fibre (12.70 to 13.43 g / 100 g) and soluble dietary fibre (4.90 to 5.02 g /100 g) due to the addition of Bengal gram. Sev containing dried leaves powder (20%) at 45 DAS of kabuli chickpea variety HK-2 (1.75 mg GAE/100 g) and HK-1 (1.78 mg GAE/100 g) had significantly ($p \leq 0.05$) the lowest contents of phenolic compounds and both the sev containing 20 per cent leaves powder of HK-1 and HK-2 were at par with each other.

Keywords: Anti-oxidant content, Chickpea leaves, Fiber content, Minerals, and Protein content

I. INTRODUCTION

Chickpea (*Cicer arietinum* L.) commonly known as *chana* and *Garbanzo* beans, is the third most important food legume of the world is which is currently grown in about 10 million hectare of land worldwide, with 95 per cent in the developing countries alone. It contributes about 40 per cent to the total pulses grown in the country (Deshpande *et al.*, 2011) with average global productivity is 881 kg per hectare (Business Line, 2011).

Estimated chickpea area in India was 81.17 lakhs hectare with a production of 7060 thousand tonnes during 2015-16 (Anonymous, 2017) and productivity was 727 kg per hectare. Major chickpea producing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Andhra Pradesh, Telangana, Gujarat, Tamil Nadu, Jharkhand and Bihar. During the year 2014-15, area under chickpea in Haryana was 179.5 million hectare, production was 1440 million tonnes and yield was 802 kg per hectare (DES, 2016).

Although chickpea seed is consumed by making *dal* and *besan* but its leaves are very rich source of iron (23.8 mg). It is, therefore, highly beneficial in the treatment of iron deficiency, anaemia. Chickpea leaves contain high amount of oxalic acid and phytic acid etc. These anti-nutritional contents hinder the absorption of many nutrients. So different processing techniques are required to decrease the anti-nutritional contents of these leaves so as to increase the availability of minerals, especially. Modern science research is proving that various parts of

Cicer arietinum L. are one of the richest sources of such nutrients (Sankhla *et al.*, 2005). Like other green leafy vegetables, such as spinach, mustard leaves, mint, coriander leaves, *chulai* etc., chickpea leaves also contain good amount of some of the micronutrient minerals (Ibrikei *et al.*, 2003) which are required to combat hidden hunger affecting 1/3rd population of our country.

In fact the consumption of green leafy vegetables in Indian population is limited to 5-10 gram per day as against the recommendation of 100 gram per day. They can supplement the traditional food products. These leaves can be used fresh as well as processed and then utilized in value addition of traditional Indian recipes. The basic idea is to find novel methods by which consumption of greens can be increased. Green leafy vegetables are seasonal, highly perishable, having abundant supply during the peak season results but are spoilt in large quantities. By employing suitable preservation techniques that are user friendly and sustainable at the household level can augment the utilization and avoid the wastage. Dehydrated vegetables can be easily converted into fresh like form by rehydration and can be used throughout the year (Karva *et al.*, 2010).

The daily requirement of protein for the males in India is 60 g per day, for females 55 g per day, for adolescent boys 30.8 g and for girls 36.8 g per day (NIN, 2011). The 100 g powder of dry leaves of chickpea contains 24.61 g of crude protein. This amount can supplement 41.02 per cent of the daily protein requirement of males, 44.75 per cent of female and 79.91 per cent of adolescent boys and 66.88 per cent for the adolescent girls. The recommended allowance of dietary fibre is 35-40 g per day for an adult and should be taken in small amounts but at regular intervals. In habitual Indian diets, being based predominantly on unrefined cereals and plant foods, this level of dietary fibre intake is easily achieved (Joshi *et al.*, 1991). The chickpea leaves can supplement this requirement by 34.7 to 39.7 per cent for an adult person easily. Therefore, the study was planned to have a product to be supplemented with its leaves.

II. MATERIALS AND METHODS

2.1 Procurement of material

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 CCS HAU, Hisar were selected for the present study. The young fully expanded leaves (Fourth through seventh nodes from the apex, up in triplicate) at 3 stages of growth of chickpea i.e. 30, 45, 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 (Table 1).

2.2 Estimation of various nutritional parameters

The various parameters like moisture, crude protein, crude fat, crud fibre, ash content, total carbohydrates, total dietary fibre content, soluble and insoluble dietary fibre, vitamin content (β –carotene and vitamin c), antinutritional factors (oxalic acid and phytic acid), minerals, available minerals (Fe, Ca and Zn), antioxidant activity (total phenolic contents, DPPH and flavonoid content) were estimated with the standard methods of analysis as given in Table 2.

2.3 Preparation of *Sev* from dried leaves powder

Total thirty six different types of *sevs* were prepared which were subjected to sensory evaluation to find out the best recipe of *sev* for further nutritional evaluation. *Sev* was prepared by supplementing different levels of dried

chickpea leaves powder (10, 15 and 20%) of both *desi* as well as *kabuli* chickpea leaves powder as per methods given below:

2.3.1 Ingredients and recipe

The various ingredients used to prepare *sev* from the dehydrated leaves is given in Table 3.

Recipe:

1. Mixed bengal gram flour, chick pea leaf powder, carom seed, red chilli powder and salt.
2. Added water and kneaded well to make a stiff dough.
3. Extruded the stiff dough through a vermicelli/*sev* making machine by pressing the piston in the *wok* containing hot oil.
4. Fried the *sev* on slow flame untill golden brown.

Sev were prepared from dried leaves powder of *desi* and *kabuli* chickpea varieties at 30, 45 and 60 days after sowing (Plate-1). The developed products were evaluated for sensory parameters like colour, appearance, aroma, texture, taste and overall acceptability. On the basis of overall acceptability, best products (*sev*) were further analyzed for nutritional evaluation.

2.4 Selection of *sev* for nutritional evaluation

Selection of *sev* for further nutritional evaluation was based on its highest mean scores for overall acceptability as shown in Table 4. The mean scores of overall acceptability for the *sev* incorporating the 20 per cent dried leaves at 45 days after sowing in *desi* and *kabuli* chickpea varieties, HC-1, C-235 were 7.8 and 7.6 scores, 7.3 and 7.4, respectively, which were the highest when compared to other stages of growth as well as other levels of supplementation of dried leaves. Hence, these products were considered for further nutritional evaluation.

2.5 Statistical analysis

The obtained data were subjected to statistical analysis using Duncan's new multiple range test (MRT) in SPSS version 16 taken from Computer Section, College of Basic Science, CCS HAU Hisar.

III. RESULTS

3.1 Proximate composition of *sev*

The perusal of data for proximate composition of *sev* containing 20 per cent dried leaves powder (45 DAS) revealed that the moisture ranged from 1.24 to 1.27 per cent in different types of *sev* containing leaves powder of *desi* and *kabuli* chickpea varieties; varieties had no significant effect on the moisture content (Table 5).

Among different types of *sev*, the highest crude protein content (21.88 g /100 g) was recorded in *sev* prepared from 20 per cent dried leaves powder of *kabuli* chickpea variety HK-1 which was found to be significantly ($p \leq 0.05$) higher over all types of *sev* containing HK-2, HC-1 and C-235 varieties. Crude fat content of *sev* was found to be significantly ($p \leq 0.05$) higher (22.50 g /100g) in HK-2 variety of *kabuli* chickpea over the *sev* containing all other varieties of *desi* as well as *kabuli* chickpea. The crude fat content of *sev* in HC-1 (22 g /100g) (*desi* chickpea) was at par with that of containing *kabuli* chickpea variety HK-1 (22.14 g/100 g). Similarly, crude fat content of *sev* having 20 per cent dried leaves powder of varieties C-235 (22.24 g/100 g) and HK-1 (22.14 g/100 g) were statistically the same.

Maximum ash content (2.2 g / 100 g) was recorded in *sev* containing 20 per cent dried leaves powder (45 DAS) of C-235 variety of *desi* chickpea and it was significantly ($p \leq 0.05$) higher over the ash content of *sev* containing 20 per cent dried leaves (45 DAS) powder of HC-1 (2.16 g /100 g), HK-1 (2.17 g /100 g) and HK-2 (2.16 g /100 g) chickpea varieties.

There was significant ($p \leq 0.05$) effect of varietal differences on the carbohydrate contents of *sev*; it ranged from 50.34 to 51.15 per cent in different types of *sev*. The carbohydrate content was significantly ($p \leq 0.05$) higher in *sev* having 20 per cent dried leaves powder (45 DAS) of HC-1 (51.15 g / 100g) of chickpea over all those types of *sev* containing other *desi* as well as *kabuli* chickpea varieties.

3.2 Dietary fibre content of *sev*

Data pertaining to dietary fibre contents of *sev* prepared from 20 per cent dried leaves powder at 45 days after sowing of *desi* and *kabuli* chickpea varieties is presented in Table 5. The *sev* containing 20 per cent dried leaves powder (45 DAS) of variety HK-1 (18.45 g / 100 g) had significantly ($P \leq 0.05$) higher amount of total dietary fibre when compared to *sev* having 20 per cent dried leaves powder (45 DAS) of both *desi* chickpea variety C-235 (17.90 g / 100 g) and HC-1 (17.68 g / 100 g) as well as the *kabuli* chickpea variety HK-2 (17.60 g / 100 g); HK-2 variety containing *sev* had significantly ($p \leq 0.05$) the lowest amount of total dietary fibre. Varietal differences had significant effect on the insoluble dietary fibre content of *sev.*

The maximum insoluble dietary fibre content (13.43 g / 100 g) was recorded in *kabuli* chickpea variety i.e. HK-1 which was significantly ($p \leq 0.05$) higher over both the *desi* chickpea varieties i.e. C-235 (12.92 g /100 g) and HC-1 (12.76 g / 100 g) while the lowest insoluble fibre content in *sev* was recorded in *kabuli* chickpea variety HK-2 (12.70 g / 100 g). Similar results were obtained for the soluble dietary fibre content in *sev* prepared from 20 per cent dried leaf powder at 45 days after sowing of chickpea varieties. Significantly higher soluble dietary fibre content in *sev* was obtained in *kabuli* chickpea variety HK-1 i.e. 5.02 g /100 g over *desi* chickpea variety C-235 (4.98 g / 100g) and HC-1 (4.92 g / 100 g). The lowest soluble fibre content in *sev* prepared from 20 per cent dried leaf powder was recorded in *kabuli* chickpea variety HK-2 (4.90 g / 100 g) (Table 4.34). HC-1 and HK-2 containing *sev* had almost similar amount of soluble dieting fibre.

3.3 Vitamin (vitamin C and β - carotene) contents of *sev*

The β-carotene content of *sev* containing 20 per cent dried leaves powder of *kabuli* chickpea variety HK-1 (3.29 mg / 100 g) was at par with that of *sev* containing *desi* chickpea variety HC-1 (3.26 mg / 100 g); β-carotene content of *sev* containing dried leaves powder of HC-1 (3.26 mg /100 g) and HK-2 (3.25 mg/ 100 g) were at par with each other (Table 5). *Sev* containing dried leaves powder (20%, 45 DAS) had the lowest amount of β-carotene (Table 4.34). Vitamin C was not detected in the *sev.*

3.4 Anti-nutrient content of *sev*

Varietal differences had significant effect on the oxalic acid and phytic acid contents of *sev* containing dried chickpea leaves powder (20%, 45 DAS). The maximum oxalic acid content (9.44 mg / 100 g) was recorded in *sev* containing *kabuli* chickpea variety HK-2 which was significantly ($p \leq 0.05$) higher than that having variety HK-1 (9.32 mg / 100 g) followed by that containing dried leaves powder of *desi* chickpea variety HC-1 (9.21 mg / 100 g) and C-235 (9.15 mg / 100 g) in descending order.

The maximum phytic content (362 mg / 100 g) was found in *sev* containing 20 per cent dried leaves powder at 45 days after sowing of variety C-235 of *desi* chickpea which was significantly ($p \leq 0.05$) higher over phytic content of *sev* containing *kabuli* chickpea variety HK-2 (359 mg /100 g) followed by that having *desi* chickpea variety HC-1 (356 mg / 100 g) and *kabuli* chickpea variety HK-1 (348 g / 100 g) in descending order (Table 6).

3.5 Total mineral content of *sev*

The perusal of the data clearly depicted that the total mineral contents like calcium, magnesium, phosphorus, zinc, copper, boron and nickel of *sev* containing 20 per cent dried leaves powder of *desi* as well as *kabuli* chickpea varieties were statistically at par with each other when compared individually (Table 7). Varietal differences had no effect on the total contents of Ca, Mg, P, Zn, Cu, and Ni of *sev* (20% supplementation, 45 DAS). However, total potassium content was found to be significantly ($p \leq 0.05$) higher (588.90 mg / 100 g) in *sev* containing *kabuli* chickpea leaves (45 DAS) of variety HK-1 over HK-2 (585.81 mg / 100 g), but was at par with total potassium content of *sev* containing both *desi* chickpea varieties C-235 (587.40 mg / 100 g) followed by HC-1 (586.15 mg / 100 g).

Significantly higher iron contents were recorded in *sev* prepared from 20 per cent dried leaves powder (45 DAS) obtained from variety HK-1 (26.64 mg / 100 g) of *kabuli* chickpea and *desi* chickpea variety HC-1 (24.67 mg / 100 g); these values were not statistically different. Similarly, iron contents of *sev* having 20 per cent dried leaves powder (45 DAS) of *kabuli* chickpea HK-2 (24.28 mg /100 g) and *desi* chickpea variety C-235 (25.83 mg/100 g) were almost similar. The highest manganese contents (2.46 and 2.42 mg/100 g) were recorded in both the *kabuli* chickpea varieties (HK-2 and HK-1), respectively, which were at par with each other but significantly ($p \leq 0.05$) higher over *sev* containing both the *desi* chickpea varieties i.e. HC-1 (2.22 mg/100 g) and C-235 (2.24 mg / 100 g).

3.6 HCl extractable mineral contents of *sev*

The contents of all the HCl extractable minerals like calcium, phosphorus, iron, zinc, potassium, magnesium and copper in *sev* incorporating 20 per cent dried leaves powder (45 DAS) of *desi* and *kabuli* chickpea varieties were found to be statistically at par with each other (Table 8). The maximum HCl extractable calcium content was noticed in *sev* containing *desi* chickpea variety C-235 (465.12 mg / 100 g) and minimum was recorded in that of *kabuli* chickpea variety HK-1 (452.58 mg / 100 g) but there was no significant difference.

Similarly varietal difference had no significant effect on the HCl extractable contents of phosphorous (167.46 to 172.09 mg/100 g), iron (14.81 to 16.01 mg/100 g), Zinc (2.25 to 2.36 mg/100 g), potassium (404.34 to 418.12 mg/100 g), magnesium (25.23 to 27.92 mg/100 g) and copper (0.026 to 0.039 mg/100 g) in *sev* containing dried leaves powder (20%, 45 DAS) of various *desi* and *kabuli* chickpea varieties.

3.7 Available mineral contents of *sev*

Data pertaining to available minerals in *sev* having 20 per cent dried leaves powder from *desi* and *kabuli* chickpea varieties (45 DAS) is presented in Table 9. The contents of the all available mineral like iron (11.47 to 12.07%), calcium (23.05 to 25.00%) and zinc (51.73 to 64.93%) in the *sev* containing dried leaves powder (20.00%) of *desi* and *kabuli* chickpea varieties were statistically similar. Varietal differences had no effect on the contents of available minerals in *sev*.

3.8 Anti-oxidant activity in *sev*

The *sev* containing 20 per cent dried leaves powder of *desi* chickpea variety C-235 had the maximum (2.55 mg GAE/100 g) amount of phenolic compounds when compared to that of other *sev* containing HC-1, HK-1 and HK-2 (Table 9). *Sev* containing dried leaves powder (20%) at 45 DAS of *kabuli* chickpea variety HK-2 (1.75 mg GAE/100 g) and HK-1 (1.78 mg GAE/100 g) had significantly ($p \leq 0.05$) the lowest contents of phenolic compounds and both the *sev* containing 20 per cent leaves powder of HK-1 and HK-2 were at par with each other.

The highest Diphenyl-I-Picrylhydrazyl free radical scavenging activity in *sev* was recorded when 20 per cent dried leaves powder of *desi* chickpea variety C-235 (85.7%) and HC-1 (83.0%) at 45 DAS were incorporated and statistically both the values were at par with each other. Incorporation of dried leaves powder of HK-1 and HK-2; and HC-1 and C-235 resulted in almost similar contents of DPPH free radical scavenging activity in *sev* as there was no significant difference between them (Table 9).

The *sev* containing 20 per cent dried leaves powder of HC-1 had the flavonoid content (0.33 mg/g) and C-235 (0.31 mg/g) had significantly ($p \leq 0.05$) the maximum and similar amounts of flavonoids while *sev* having 20 per cent dried leaves powder (45 DAS) of HK-1 (0.22 mg/g) and HK-2 (0.19 mg/g) had significantly the lowest and similar amount of flavonoids (Table 9).

IV. DISCUSSION

Sev having 20 per cent dried leaves powder of *desi* chickpea variety HC-1 got the highest overall acceptability mean scores (7.8) followed by C-235 (7.6), HK-2 (7.4) and HK-1 (7.3). Dahiya (2004) also got the same results when *matthis* supplemented with mothbean, spinach and fenugreek were 'moderately desirable' by the panel of ten judges for their colour, appearance, flavor, texture and taste when prepared fresh. Kaur and Kochar (2005) found that the most acceptable level for *prantha* with radish and cauliflower greens was 30 per cent whereas; in case of carrot and turnip greens, it was 50 per cent. The respective scores for overall acceptability ranged from 5.42 (cauliflower greens) to 6.02 (radish greens). *Bhujji* prepared by using cauliflower greens scored highest (6.08). *Poori* prepared by incorporating cauliflower and radish leaves at 40 per cent was best acceptable with scores of 5.42 and 6.30, respectively.

Sev had the highest protein content (21.22 to 21.88 g / 100 g) as well as crude fat content (22.00 to 22.50 g /100 g) due to the addition of Bengal gram besides Bengal gram leaves which contributed to more protein and fat to *sev*. Leaves with high protein values are recommended for patients with protein deficiency diseases (Mensah *et al.*, 2008). *Sev* also had highest total dietary fibre (17.60 to 18.45 g/100 g), insoluble dietary fibre (12.70 to 13.43 g / 100 g) and soluble dietary fibre (4.90 to 5.02 g /100 g). Vitamin C was not detected in *sev*. Vitamin C, the most water soluble and heat labile vitamin might have been lost in large quantity on dehydration (Gupta and Prakash, 2011). The antinutritional factor oxalic acid ranged from 9.15 to 9.44 mg / 100 g. The total magnesium (90.08 to 90.46 mg/100 g), phosphorus (235.12 to 235.86 mg /100 g) and manganese (2.22 to 2.46 mg / 100 g) contents were found to be the highest in *sev* having dried powder leaves of chickpea. When compared with RDA for magnesium in adult which is 350 mg / day (NRC, 1989), the magnesium amount in the *sev* supplements the 25.84 per cent of the total RDA (the highest range was taken for the estimation per cent of RDA).

High magnesium content in leafy vegetables may explain their blood pressure lowering properties. Mensah *et al.,* (2008) recorded the magnesium content in *A. cruentus* (2.53 mg / 100 g), *T. triangulare* (2.22 mg /100 g), Celosia (1.41 mg / 100 g) and *G. latifolium* (1.32 mg / 100 g). The magnesium contents of *sev* having 20 per cent dried leaves powder at 45 days after sowing of chickpea varieties in the present study are higher than reported by Mensah *et al.* (2008). The range of HCl extractable calcium content of *sev* was 458.58 to 465.12 mg / 100 g and zinc content ranged from 2.25 to 2.36 mg /100 g. Calcium is a major factor sustaining strong bones and plays a part in muscle contraction and relaxation, blood clotting, synaptic transmission and absorption of vitamin 12 (Mensah *et al.*, 2008). Gupta and Prakash (2011) reported that calcium content of fresh and dehydrated green leafy vegetables were found to be similar. Slight variations observed were found to be statistically insignificant.

The HCl extractable potassium content in *sev* was 404.34 to 418.12 mg / 100 g. The HCl extractable magnesium content was maximum in *sev* and ranged from 25.23 to 27.92 mg / 100 g. Potassium is known to decrease the blood pressure. It plays a role in controlling skeletal muscle contraction and nerve impulse transmission. Patients with soft bone problems are usually placed on high calcium and potassium vegetable meals (Mensah *et al.*, 2008).

The available zinc content of *sev* was the highest among the prepared products and ranged from 51.73 to 64.93 per cent. Phenol compounds ranged from 1.75 to 2.55 mg GAE/ g and the DPPH free radical scavenging activity of *sev* ranged from 76.0 to 85.7 per cent (Fig. 3 (a, b). Flavonoid content in *sev* were recorded to be the lowest i.e. 0.19 to 0.33 mg / g. Nyonje *et al.* (2014) reported during their study on anti nutrient phytochemical and anti radical evaluation of 10 *Amaranth* varieties, before and after flowering at vegetative stage, flavonoid content ranged between 2819. 9 to 4284.0 mg / 100 g quercetine equivalent (QE), and 1446.5 to 2330.1 mg / g QE at post flowering stage. There was significant decrease in the flavonoid content, from 3254 mg /100 g at vegetative stage to 2033 mg / 100 g at post flowering stge. Flavonoids have been shown to have antibacterial, anti-inflammatory, anti-allergic, anti-neoplastic, antiviral, antithrombotic and vasodillatory activities (Alan and Miller, 1996). The potent antioxidant activities of flavonoids have been suggested to be responsible for many of the above actions, as oxidative damage is implicate in most disease process.

V. CONCLUSION

On the basis of the above results, it can be concluded that the *Sev* having 20 per cent dried leaves powder of *desi* chickpea variety HC-1 got the highest overall acceptability mean scores (7.8) and can be used as supplementation in the daily products in human diet.

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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 DAS	45 to 60 days onwards
				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: Estimation of various nutritional parameters of leaves and *sev* of *desi* and *kabuli* chickpea

SN	Particulars	Method
i)	Moisture in samples	AOAC (2000)
ii)	Crude protein	AOAC (2000), using KEL PLUS Automatic Nitrogen Estimation System.
iii)	Crude fat	AOAC (2000), using the Automatic SOCS plus Solvent Extraction System.
iv)	Crude fibre	AOAC (2000) using crude fibre apparatus
v)	Ash	AOAC (2000)
vi)	Total carbohydrate	Total carbohydrate (%) = 100 – [Moisture (%)

		+ crude protein (%) + crude fat (%) + crude fibre (%) + total ash (%)]
vii)	Total dietary fibre	Enzymatic method given by Furda (1981).
viii)	Soluble and insoluble dietary fibres	As per the standard procedures
ix)	Vitamins: a) β -carotene	Column chromatography and estimated colorimetrically (AOAC, 2000).
x)	b) Vitamin C	AOAC, 2000
xi)	Anti-nutritional factors: a) Oxalic acid	Method of NIN (1983).
xii)	b) Phytic acid	Method of Davies and Reid (1979).
xiii)	Minerals	Method of Lindsey and Norwell, (1969).
xiv)	**Available minerals** (Fe, Ca and Zn) a) Iron (Fe)	Procedure of Rao and Prabhavathi (1978).
xv)	b) Available calcium and zinc	Method of Kim and Zemel (1986).
xvi)	**Antioxidant activity**: a) Total phenolic contents	Singleton and Rass (1965).
xvii)	b) 2, 2-Diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity (RSA)	DPPH method of Hatano *et al.* (1988).
	c) Flavonoid content	Method described by Jia *et al.* (1999).

Table 3: Ingredients used for making *sev*

Ingredients	**Amount**		
	I	**II**	**III**
Chickpea leaves powder (g)	10	15	20
Bengal gram flour (g)	90	85	80
Carom seed (g)	3	3	3
Red chilli powder (g)	2	2	2
Salt (g)	2	2	2
Vegetable oil	For frying		

Table 4: Selection of *sev* having maximum overall acceptability scores for further nutritional evaluation (on dry matter basis)

Characteristics	***Sev***			
	***Desi* chickpea**		***Kabuli* chickpea**	
	HC-1	**C-235**	**HK-1**	**HK-2**
Mean scores of overall acceptability	7.8	7.6	7.3	7.4
Days after sowing	45	45	45	45
Supplementation level of dried leaves powder	20	20	20	20

Table 5: Nutrient composition of *sev* containing 20 per cent dried leaves powder of *desi* and *kabuli* chickpea varieties at 45 days after sowing (on dry weight basis)

Parameters	***Sev***			
	***Desi* chickpea varieties**		***Kabuli* chickpea varieties**	
	HC-1	**C-235**	**HK-1**	**HK-2**
Proximate composition (g/100g)				
Moisture	1.24^{a} ±0.01	1.25^{a}±0.01	1.27^{a} ±0.01	1.25^{a} ±0.01
Crude protein	21.38^{c}±0.02	21.73^{b}±0.01	21.88^{a}±0.00	21.22^{d}±0.02

Crude fat	22.00^{c}±0.06	22.24^{b}±0.00	22.14^{bc}±0.00	22.50^{a}±0.12
Crude fibre	2.10^{a} ±0.01	1.97^{b}±0.01	2.20^{a} ±0.06	1.90^{b}±0.01
Ash	2.16^{b}±0.01	2.20^{a} ±0.00	2.17^{b} ±0.01	2.16^{b} ±0.00
Carbohydrate	51.15^{a}±0.00	50.56^{c}±0.00	50.34^{d} ±0.00	50.97^{b}±0.01
Dietary fibre constituents (g/100 g)				
Total dietary fibre	17.68^{c}±0.01	17.90^{b}±0.01	18.45^{a}±0.01	17.60^{d}±0.02
Insoluble dietary fibre	12.76^{c}±0.02	12.92^{b}±0.01	13.43^{a}±0.01	12.70^{d}±0.01
Soluble dietary fibre	4.92^{c} ±0.01	4.98^{b} ±0.01	5.02^{a} ±0.01	4.90^{c} ±0.02
Vitamin content (mg/100g)				
Vitamin C	3.26^{ab}±0.01	3.16^{c}±0.02	3.29^{a}±0.01	3.25^{b}±0.01
β-carotene	ND	ND	ND	ND

Values are mean ± SE of three independent determinations

The mean values in same row with same superscripts did not differ significantly ($p \leq 0.05$)

ND: Not detectable

Table 6: Oxalic acid (mg/ 100 g) and phytic acid (mg/100g) contents of *sev* incorporating 20 per cent dried leaves powder of different chickpea varieties at 45 days after sowing

Anti-nutrient content	*Desi* chickpea		*Kabuli* chickpea	
	HC-1	C-235	HK-1	HK-2
Oxalic acid	9.21^{c}±0.01	9.15^{d}±0.01	9.32^{b}±0.01	9.44^{a}±0.01
Phytic acid	356^{c}±0.58	362^{a}±0.58	348^{d}±1.16	359^{b}±0.58

Values are mean ± SE of three independent determinations.

The mean values in same row with different superscripts differ significantly ($p \leq 0.05$).

Table 7: Total mineral content (mg / 100 g) of *sev* incorporating 20 per cent dried leaves powder of different chickpea varieties at 45 days after sowing (on dry matter basis)

Total mineral content	*Sev*			
	Desi chickpea		*Kabuli* chickpea	
	HC-1	C-235	HK-1	HK-2
Calcium	612.00^{a}±1.155	612.80^{a}±0.808	611.60^{a}±0.751	644.40^{a}±0.520
Magnesium	90.12^{a}±0.52	90.24^{a}±0.61	90.46^{a}±0.46	90.08^{a}±0.39
Potassium	586.15^{ab}±1.04	587.40^{ab}±1.24	588.90^{a}±0.46	585.81^{b}±0.46
Phosphorus	235.12^{a}±0.52	235.86^{a}±0.51	235.74^{a}±0.51	235.45^{a}±0.23
Iron	24.67^{b}±0.28	25.83^{a}±0.29	26.64^{a}±0.30	24.28^{b}±0.14
Zinc	3.46^{a}±0.29	3.52^{a}±0.17	3.54^{a}±0.12	3.45^{a}±0.04
Manganese	2.22^{b}±0.46	2.24^{b}±0.46	2.42^{a}±0.29	2.46^{a}±0.75
Copper	0.89^{a}±0.10	0.91^{a}±0.10	0.95^{a}±0.11	0.97^{a}±0.11
Boron	0.13^{a}±0.02	0.14^{a}±0.02	0.18^{a}±0.02	0.17^{a}±0.02
Nickel	0.15^{a}±0.02	0.16^{a}±0.20	0.17^{a}±0.02	0.16^{a}±0.02

Values are mean ± SE of three independent determinations.

The mean values in same row with different superscripts differ significantly ($p \leq 0.05$).

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Table 8: HCl extractable mineral contents (mg / 100 g) of *sev* incorporating 20 per cent dried leaves powder of different chickpea varieties at 45 days after sowing (on dry matter basis)

HCl extractable minerals	*Desi* chickpea		*Kabuli* chickpea	
	HC-1	C-235	HK-1	HK-2
Calcium	459.12 ^{a}±39.76	465.12 ^{a}±40.28	452.58 ^{a}±39.19	458.55 ^{a}±39.70
Phosphorous	169.28 ^{a}±14.66	167.46 ^{a}±14.50	172.09 ^{a}±14.90	169.52 ^{a}±14.6
Iron	14.81 ^{a}±1.28	16.01 ^{a}±1.39	15.98 ^{a}±1.38	15.53 ^{a}±1.34
Zinc	2.25 ^{a}±0.19	2.36 ^{a}±0.20	2.26 ^{a}±0.19	2.27 ^{a}±0.19
Potassium	404.34 ^{a}±35.01	411.18 ^{a}±35.60	418.12 ^{a}±36.21	415.92 ^{a}±36.02
Magnesium	25.23 ^{a}±2.18	26.17 ^{a}±2.27	27.14 ^{a}±2.35	27.92 ^{a}±2.42
Copper	0.026 ^{a}±0.01	0.036 ^{a}±0.01	0.038 ^{a}±0.01	0.039 ^{a}±0.01

Values are mean ± SE of three independent determinations.

The mean values in same row with different superscripts differ significantly ($p \leq 0.05$).

Table 9: Available mineral contents (%) and anti-oxidant activity of *sev* prepared from incorporating 20 per cent dried leaves powder of *desi* and *kabuli* chickpea varieties at 45 days after sowing (on dry matter basis)

Available minerals	*Desi* chickpea		*Kabuli* chickpea	
	HC-1	C-235	HK-1	HK-2
Iron	11.47 ^{a}±0.33	11.96 ^{a}±0.36	11.79 ^{a}±0.36	12.07 ^{a}±0.34
Calcium	25.00 ^{a}±0.88	24.80 ^{a}±0.88	23.05 ^{a}±0.81	23.28 ^{a}±0.87
Zinc	51.73 ^{a}±0.26	57.95 ^{a}±0.29	58.76 ^{a}±0.30	64.93 ^{a}±0.31
Anti-oxidants				
Phenolic compounds (mg GAE/100 g)	2.40 ^{b}±0.06	2.55 ^{c}±0.03	1.78 ^{a}±0.04	1.75 ^{a}±0.02
DPPH free radical scavenging activity (%)	83.0 ^{bc}±1.00	85.7 ^{c}±1.7	79.33 ^{ab}±2.3	76.0 ^{a}±2.0
Flavonoids (mg/g)	0.33 ^{a}±0.02	0.31 ^{a}±0.02	0.22 ^{b}±0.01	0.19 ^{b}±0.07

Values are mean ± SE of three independent determinations.

The mean values in same row with different superscripts differ significantly ($p \leq 0.05$).

DPPH: Diphenyl-I-Picrylhydrazyl.

Plate 1: *Sev* supplemented with leaves of *desi* and *kabuli* chickpea varieties